Chapter 6 Development Strategy

6.1 Development Strategy Policy

The development strategy should be harmonized with the Poverty Reduction Strategic Paper with a term of 15 years, so will start in March, 2006 when this study will end in 2020. Its target is nonferrous metal, which enhances foreign currency. Currently, mining production constitutes 14% in GDP, gained mainly by iron mining. Nonferrous metal mining is programmed to make up 10% of GDP 10 years later (2015) by its development promotion. Accordingly, mining will make up 25% of GDP in total, as far as only the iron mining industry is estimated to increase up to 14% in GDP based on its production expansion plan. The development strategic policies consist of three stages based on characteristics of Mauritanian mineral potential, extent of infrastructure and actual exploration activities, which are as follows:

Table 6.1.1 Development of Basic Policy

Stage	Term	Policy
First	2006－2010	To strengthen the exploration for gold, to grasp the potentiality for base metal and restructure the OMRG system.
Second	2011－2015	To promote the exploration for base metal and grasp the potentiality for rare metal resources.
Third	2016－2020	To strengthen the exploration for base and rare metals.

Investment climate will be improved to enhance foreign investment in the first and second stages of the development strategic plan. Staff training that is basic for the investment climate will be scheduled according to the policy of each stage. At the same time, in addition to supporting foreign investors, the above strategic plan should promote mining activities for domestic companies in future. The ore deposits models made by the supplementary field surveys and remote sensing analysis in this JICA study should play an important role for promotion of exploration/development. The plan should be related with PRISM of the World Bank and coincidently consider the environmental management system improved by PRISM in the exploration/development.

- The 15 year-development strategic plan consisting of three stages with 5 years respectively.
- A goal of production in ferrous and nonferrous mining is 25% of GDP in 2015.
- The investment climate should be improved to prioritize foreign investments.
- The ore deposits models are useful for promotion of exploration.
- Good alignment with PRISM.

6.2 Development Strategic Plan

Based on the conditions of the investment base, the investment environment, mining activities and mineral potential in Mauritania, a strategic plan to promote exploration and development in that country was drawn up according to the development strategic policy. Realization of the strategic plan depends on Mauritania's financial condition. Economic growth is vital for poverty

reduction, so the government must give mining top priority for spurring economic growth.

Table 6.2.1 Strategic Development Plan

	1st Stage	2nd Stage	3rd Stage
	2006 – 2010	2010 – 2015	2015 – 2020
Goals	• Improve exploration and development of gold. • Understand potential of base metal resources	• Promote exploration and development of base metals • Understand potential of rare metal resources	• Strengthen exploration and development of base metals • Promote exploration and development of rare metals
Target		• 25% of GDP by 2015 (including 15% of ferrous mining)	
Exploration targets	• Promote OMRG surveys of gold and copper • Extensive areas survey system • Construction of a deposit model	• Promote OMRG surveys of copper, rare metals • Development of a resource evaluation ledger	• Promote OMRG surveys of rare metals • Undertake structural boring
Introduction of foreign investment (Promotion of investment)	• Publish the seasonal magazines • Establish investment promotion office. • Hold investment seminars • Formulate policy for promoting introduction of foreign capital	• Prolongation of depreciation period • Government guaranty for development • Leading policy for development of underground mines	• Expand the Investment Promotion Office (to Agency) • Introduction of foreign investment on underground mines
Human resource cultivation	• Experts invitation system • Overseas training system • English language instruction system • Establishment of mining faculty in the Technical Education Center	• Establishment of Mining Technical Instruction Center • Establishment of mining faculty in the university • Education of resources economics	• Independent management of Mining Technical Instruction Center • Education of quality control
Infrastructure	• Water resources development in the mineral promising areas • Infrastructure construction plan	• Formulate a construction plan of the port (or wharf) for mineral resources. • Systemize the water resources use • Establish the support of infrastructure (road, water, electricity)	• Railway construction • Road construction
Environmental Protection	• Legal framework for environmental management • Mining environmental management plan (Baseline survey)	• Establishment of monitoring center	• Establish environmental standards • Formulate guidelines for mine safety and environment
Compilation and disclosure of information	• Collect and compile mining environment information • Expand the mineral resources database • Improve the archives • Add the ASTER images • Accumulate the GIS data • Information disclosure system • Expand the website • Create 1:100,000 geological maps	• Utilize the database • Create 1:100,000 geological maps • Construct an environment website • Disclose the company financial data	• Develop the 3D data • Information sharing system between ministries • Evaluation of resources amount
Organization Of Mining Sector	• Periodical roundtable meetings between Government and companies • Establish an organization to formulate policies	• Restructure the government mining organization • Establish a mining association • Establish a mining council	• Establish a research organization • Establish an academic society for mineral resources
Nurturing	• Joint acceptance of projects of	• partnership with the foreign	• rental system of development

domestic companies	the international organization with foreign investors • Formulate a plan for growth of domestic companies • Investigate the privatization of SNIM	investors • rental system of exploration equipment • supporting system for development by domestic companies • training and instruction to the domestic companies • privatization of SNIM	machines • interest provision system • rental system of environmental tools and equipment
Institutional reform of OMRG	• Construct the LAN system and connect with MMI's LAN • Provide one computer per main person • Formulate medium and long term plans • Improve the survey equipment and machines	• Restructure the organization • Maintenance of boring machines • Presentation of papers on the survey results • Privatize the repair sector • Establish an analytical center	• Expand and strengthen the analyses center • Nourish researchers
Mining policy	• Formulate the 2nd Stage policy.	• Formulate the 3rd Stage policy.	• Revise drastically the mining policy.
remarks	Institutional reform by PRISM Tasiast Gold Mine operation Akjoujt Copper Mine operation A few gold mines of operation A few copper mines operation		

6.2.1 Methodology for Realization

Promotion measures consist of various fields such as environment, infrastructure, training, economy, etc., so cooperation and coordination between relevant ministries are needed. DMG in MMI and OMRG must gain an understanding of the importance of mining, mining's role as a driving power in economic growth, and budgeting for the strategic development plan from the government and relevant ministries. They must make efforts to gain priority budgeting from the national treasury and cooperation from donor countries and international organizations by aggressively requesting activities for realizing the promotion measures. Recently donor countries and international organizations have increased their supports to African countries. They should separate what they can achieve with their own finances from what they must request from donor countries and international organizations.

To realize the strategic development plan, they must determine independently what they can do with their own finances. If they can not realize some measures under their current financial situation, they must make efforts to obtain support from donor countries and international organizations according to their supporting policies for realizing the promotion measures (shown in Table 8.2.2).

Table 6.2.2 Methodology and Targets for Realization

Methodology	Targets for Realization
National treasury	• To be possible technically and personally • Government basic works like policies, organization reform, medium-long term plans
Donor countries	• To comply with supporting policies of donor countries. • To build bilateral co-operational relationships with donor countries. • To dispatch experts, and receive technical cooperation and loans
International organizations	• To comply with supporting policies of the international organization. • To dispatch experts, receive technical cooperation and loans, and hold seminars
Private funds	• To support the private organizations, semi-private agencies and NGO. • To provide instruction, training, overseas education, and establish organizations

In the 1st Stage, US$ 25 million will be needed, US$ 50 million will be needed in the 2nd Stage and US$ 100 million in the 3rd stage are needed. (And see individual costs for promotion measures in 6.10) Costs in the 1st Stage and 2nd Stage are almost the same with the present PRISM. Royalties from production from a few mines and taxes on mining-related domestic companies are expected in the 2nd Stage. Therefore, it is possible to budget at least some of costs for realizing the strategic plans from the national treasury.

The success of promotion measures will require not only financial problems to be overcome, but also problems with technology, personnel and knowledge. However, mining capability construction demands solving the problems in promotion measures, and it might be a driving power for economic growth by promoting mining development.

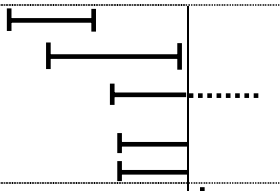
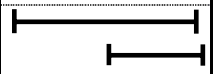
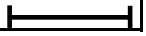
6.2.2 Scheduling of the Strategic Development Plan

It would be desirable that the strategic development plan is implemented according to a schedule (see Table 6.2.3) based on the current status of exploration and development and the investment climate in Mauritania. It will be necessary to send requests to donor countries and international organizations 2 to 3 years in advance. It is also noted that obtaining funding from the national treasury requires consulting activities 1 to 2 years beforehand in order to coordinate the relevant ministries. It is not easy to proceed with the ideal schedule, but constantly changing horse would give better effects from good timing realization of the plan. The promotion measures include some items which do not require a lot of money, and the Mauritanian government could condust. Therefore, the government should start from measures that are not so large economical burdens.

Table 6.2.3 Scheduling of the Strategic Development Plan

Item	Promotion Measure	1st Stage 2006 – 2010	2nd Stage 2010 – 2015	3rd Stage 2015 – 2020
Exploration targets	• Promote OMRG surveys of gold and copper • Extensive areas survey system • Construction of ~~a~~ deposit models			
	• Promote OMRG surveys of copper, rare metals • Development of a resource evaluation ledger			
	• Promote OMRG surveys of rare metals • Undertake structural boring			
Introduction of foreign investment (Promotion of investment)	• Publish seasonal magazines • Release information. • Establish investment promotion office. • Hold investment seminars • Formulate policy for promoting introduction of foreign capital.			
	• Extensive areas joint-venture exploration • Prolongation of depreciation period • Government guaranty for development • Leading policy for development of underground mines			
	• Expand the Investment Promotion Office (to Agency) • Introduction of foreign investment on underground mines			
Human resource cultivation	• Experts invitation system • Overseas training system • English language instruction system • Establishment of mining faculty in the Technical Education Center			
	• Establish Mining Technical Instruction Center • Establish mining faculty in the university • Education of resources economics			
	• Independent management of Mining Technical Instruction Center • Education of quality control			
Infrastructure	• Water resources development in the mineral promising areas • Infrastructure construction plan			
	• Formulate a construction plan of the port (or wharf) for mineral resources. • Systemize the water resources use • Establish the supporting system for ~~of~~ infrastructure (road, water, electricity)			
	• Construction of the port for exclusive use of mineral resources • Railway construction • Road construction			
Environmental Protection	• Legal framework for environmental management • Mining environment management plan (Baseline survey)			

	• Establish a monitoring center • Establish environmental standards • Formulate guidelines for mine safety and environment	
Compilation and disclosure of information	• Collect and compile mining environment information • Expand the mineral resources database • Improve the archives • Add the ASTER images • Accumulate the GIS data • Information disclosure system • Expand the website • Create 1:100,000 geological maps	
	• Compile data for infrastructure, water resources and land use • Utilize the database • Construct an environment website • Disclose the company financial data	
	• Develop the 3D data • Information sharing system between ministries • Evaluation of resources amount	
Organization Of Mining Sector	• Periodical roundtable meetings between Government and companies • Establish an organization to formulate policies	
	• Restructure the government mining organization • Establish a mining association • Establish a mining council	
	• Establish an information center • Establish a research organization • Establish an academic society for mineral resources	
Nurturing domestic companies	• Joint acceptance of projects of the international organization with foreign investors • Formulate a plan for nurturing domestic companies • Investigate the privatization of SNIM	
	• Partnership with the foreign investors • Rental system of exploration equipment • Supporting system for development by domestic companies • Training and instruction to the domestic companies • Privatization of SNIM	
	• Rental system of development machines • Interest provision system • Rental system of environmental tools and equipment	
Institutional reform of OMRG	• Construct the LAN system and connect with MMI LAN • Provide one computer per main person • Formulate medium and long term plans • Improve the survey equipment and machines	

	• Restructure the organization • Maintenance of boring machines • Presentation of papers on the survey results • Privatize the repair sector • Establish an analytical center			
	• Expand and strengthen the analyses center • Nourish researchers			
Mining policy	• Formulate the 2nd Stage policy.			
	• Formulate the 3rd Stage policy.			
	• Revise drastically the mining policy.			

6.3 Importance of Mining and Mining Policies

6.3.1 Position of Mining Industry

Mining industry plays an important role in the economy of Mauritania, from the viewpoint of the GDP, exportation, hard currency and employment. Promotion of nonferrous metal mining supports the diversification of Mauritanian mining industry and leads to strengthening the economic base of the country, activating the local development and improving the infrastructure.

The contribution of the mining industry to the Mauritanian economy is significant, representing 14% of GDP and 50% of the total value of exports. However, as the current Mauritanian metal mining industry consists only of only the iron ore mining, so the Mauritanian economy is strongly influenced by global pricing and the market size of iron ore. If suitable economically exploitable deposits of non-ferrous metals can be found, their development will permit diversification of the mining industry and provide further inflows of foreign exchange. Therefore, the promotion of non-ferrous metals exploration and exploitation is the logical way to build on the present monoculture of iron ore mining and encourage further economic growth.

- Detailed description of influence to the economy.
- Contribution of mining to the Poverty Reduction Strategic Paper (PRSP).
- Social contribution (the employment, local development, transportation and infrastructure).
- Tasks for mining activities expansion in future. (growth of domestic companies, diversification of production and development of water resources)

One characteristic of the mining industry is its ripple effects that create businesses related to boring work during exploration, civil engineering work during development, and material flow, construction and boring work during operation.

6.3.2 Mining Policies

The following draft was made for the mining policy of the 1st Stage of the strategic development plan:

1) Strengthening exploration/development for gold and promoting surveys of base metal resources
2) Improving an investment climate for the introduction of foreign capital
3) Establishing an environmental management system

Regarding 1), exploration/development involves activities that are taking shape, such as the development of the Tasiast gold deposits, OMRG continuing surveys based on the EU gold surveys in the northern Sfariat, and the redevelopment of the Akjoujt Copper Mine. Promising areas identified by this study are effective for implementing this policy, and OMRG survey strategy should be formulated and implemented based upon this policy. Regarding 2), it is preferable for the Investment Promotion Office to be the driving force for implementing this policy, and work has been progressing on improving the Mining Law and geological infrastructure to attract foreign investment. However, organic development based on this study will have to be done to promote this policy. Regarding 3), the Mauritanian Government is requesting the Japanese Government to undertake a Development Survey for technical cooperation related to the Mining Environment Management Plan. This would play a major role for the implementation and promotion of this policy.

Mining policy should be appropriate and practical at each stage. Policies in the second stage must be made, taking results of the first stage policies into account. Several supposed policies at the first stage are suggested in 6.1.2.

(1) Promotion of gold exploration/development and surveys for base metal resources.

Foreign investors have already advanced gold exploration. The exploration for base metal has not been advanced yet; however, it started to reopen a copper mine, which operated for a short period. The gold potential is comparatively higher, and it might not appear that the infrastructure, in particular the road and port, is a hindrance factor for the gold exploration/development, because the gold can be produced as dore at the mine site. At the 1st stage, it is also necessary to grasp the potentiality for the base metal resources, in preparation for the 2nd stage.

- Translation of information on the gold deposits into English and its presentation
  - To compile the survey data.
  - To raise the precision of the ore deposit models.
  - To appeal them in seminars and magazines.
- Supporting the infrastructure system in gold potential areas
  - To develop water resources in the potential areas.
  - To prepare a supporting system for infrastructure (in development).
  - To formulate a construction plan for infrastructure.
- Reduction or exemption system of royalty for a limited period
  - To be effective within 2 years after development.

- To limit applicants by the investment capitals for development.
- To reinvest exempted money in Mauritania.

- Geological surveys for base metal resources by OMRG
  - To systemize attaining the budget, (ex: survey system in extensive areas).
  - To make geological ore deposit maps.
  - To prepare survey equipment.
- Translation of information on base metal resources into English and its presentation
  - To compile the survey data.
  - To raise the precision of the ore deposit models.
  - To appeal them in seminars and magazines.
- Expansion of database for mineral resources
  - To store the survey data and develop the archive.
  - To expand the ASTER images.
  - To prepare the cadastre for resources evaluation.
- Staff training
  - To instruct English.
  - To prepare a system for inviting experts.
  - To establish an Instruction Center for Mining Technology.

(2) Improvement of investment climate for introduction of foreign investment

Although, the legal and tax institutions have been improved by PRISM, the investment climate is still not adequate as a whole to promote foreign investment.

- Promotion measures for introduction of foreign investment
  - The government guarantee for the investment
  - Preferential policy for foreign investment within a limited period
  - Simplification of the investment procedures
- Disclosure of information
  - Disclosure and renewal of information by the web site
  - Periodical investment seminars

  It should be noted that the importance of investment seminars and their implementation methods are mentioned in 8.10.1(1).
- Establishment of Investment Promotion Office, training personnel and functionalizing
  - Establishment of the investment promotion system
  - Transmission of mining information (publication of magazines)
- Construction plan for infrastructure

  Note that the development of a financial market is indispensable for investment

promotion, and it is first necessary to build a financial base of banks.

(3) Establishment of environmental management system

- Establishing the legal framework for environment management
  - To review the Mining Law and Environment Law (ex: to clarify the environmental issues covered in the Mining Law.)
  - To formulate detailed regulations for mining-related environment.
  - To clarify the legal framework of the environmental management related to the mining industry.
- Establishing Monitoring Center
  - To monitor environmental impacts (changes) caused by development and production.
  - To systemize the monitoring methods.
  - Construct and disclose the database on a website.
- Preparing a plan to manage mining environment (Baseline survey).
  - To understand background of rock, soil and water as environmental management.
  - To establish the methodology for environmental protection.
  - To formulate a plan for the environmental management system.

6.4 Improvement of Investment Base

6.4.1 Mining Administration and Function

The current mining administration is centralized in the Ministry of Mining and Industry (MMI), which includes all organizations related to the field of mining. An office building for MMI was newly constructed, and MMI is now restructuring drastically for better function. For example, the energy department in MMI became an independent ministry in 2005. Currently it has no major problem in organization, but it must make its organization more functional and propose the following items such as the reform for practical and functional organization, based on reviewing completion percentage of the strategic development plan every stage, evaluating the status of exploration and development, introduction of the foreign investment, etc.;

- To expand the organization in case development/production is promoted.

  - "Service of Mines" in DMG will consist of "Division of Development & Production", "Division of Safety" and "Division of Technologies". SM will be mainly in charge of the supervision of mining activities.
  - Staff training, improvement of tools and facilities and systemizing.

  This item will be Judged from the results of the 1st Stage. Presently, the development of Tasiast and redevelopment of Akjoujt, are attempts to initiate production activities which

are outside of national SNIM. Given the implementation conditions in the 1st Stage, it is necessary to expand the organization that is suitable for production activities. Therefore, it would be desirable that personnel training is enhanced at this time.

- To expand DMG as General Direction of Mining Policies.
  - The organization to make policies and plans for a long term.
  - Overall control of mining.

  Extent of expansion will be judged from the result of the 1st stage. At present, DMG is an organization which manages mining sector, and PRISM implements mining policy practically. However, in 2008 when PRISM will be terminated, the organization of DMG might be strengthened and improved as a policy maker to formulate various plans by PRISM.
- Restructuring and independence of OMRG
  - To restructure the organization to be independent.
  - To privatize the repairing divisions.
  - To systemize the work using IT. To utilize the database.
  - To maintain exploration equipment and machines.
  - To make a medium and long-term program.

  Systematization by IT involves the construction of a LAN system and the procurement of 1 computer per person. As IT comes into greater use, it will be necessary to add performance and organic power that can formulate a mid- to long-term plan which uses the database. The repair cost for OMRG machines are not small although there are not so many machines. It would be desirable that the OMRG repair section to enhance the functional organization and emphasize survey work. The repair section should be privatized in the 2nd Stage; however, prerequisites for privatization are the expansion of OMRG survey operations and maintenance of equipment and machines in 1st Stage. There are still many uninvestigated areas left for mineral resources in Mauritania. Exploration will depend on improving the survey capability of OMRG, and on whether or not OMRG can provide the attractive data and information for the foreign companies. Currently surveys are hampered due to a lack of complete survey equipment. Institutional reform should be a priority task to help OMRG play a role as a geological survey organization for encouraging exploration.
- To establish Mineral Information Center.
  - An organization in MMI or a part of DMG
  - To collect and compile mining information (geology/ore deposits, tendency of exploration and development, tendency of technical development, policies, legal/tax institution, environment etc.) as well as present it to relative organizations.

- To clarify the role of information analysis section in case of its establishment at the Investment Promotion Office.

This center is planned to be established in the 3rd Stage, but collecting the oversea mining information itself can be linked with promotion of investment, reviewing policies, introduction of survey methodology. Therefore it would be desirable to collect information in each organization from the 1st Stage. This should be done to share information that each organization obtains with all members inside the organization and with other organizations. The timetable for establishing the center should be determined after evaluating the results of the IPO in the 2nd Stage.

- Mining Association

It is necessary to keep balance between the government and private companies for healthy growth of mining industry. At present, most of the private mining companies are foreign, aiming at exploration. However, if exploration and development were activated in future, the number of domestic companies, as partners to foreign investors or independent companies doing exploration and development might increase. Mining Association is an organization guiding private companies to promote mining activities. In other words, it is a communication pipeline between the mining industry and the government and communities and also a counter of requests for the administration. This is the 2nd Stage promotion measure which assumes that production companies will increase at the 1st Stage and domestic companies will grow.

- To be an organizer of private companies.
- To be established by the NGO funds, etc.
- To consolidate the information of private mining activities.

- Roundtable meetings between mining companies and the Government

Presently, there is no means by which foreign companies that are undertaking exploration and development can publicly discuss and debate about things the government should do in the investment climate and its base in Mauritania. The opinions of foreign companies are very important to improve the investment climate.

- Examination of mining policy
- Analysis and revision of factors hindering exploration and development
- Formulation of measures to promote mining
- Implementation of promotion measures

The first roundtable meeting was held in Nouakchott, in November 17, 2005.

- Organization to evaluate and examine the mining policies and institution

A specific organization is necessary to evaluate the effects of the mining policies and

institution and correct them in their implementation. It will consist of mining companies, NGOs, universities, international organizations and etc. It will examine objectively the policies and institutions made by the government. However, it is too early to establish such organization in Mauritania, which is going to promote the mining industry. It is desirable at first to prepare above-mentioned roundtable meetings consisting of foreign companies, government agencies and international organizations.

- Periodical round-table meetings (once per each three months).
- Establishment of a mining committee from the second stage.
- Correcting and improving the mining policies and institutions.

6.4.2 Policies for Poverty Reduction and National Budget for Mining

Poverty Reduction Strategy Paper (PRSP) gives importance to the mining field, but the weight of mining is comparatively lower in the program in PRSP and the national budget in 2001 to 2004, and the national investment on mining has no substance except for the investment to SNIM. National budget related to mining is based on PRSP and has the same stance. The important task in the poverty reduction policies is the economical development in the communities with many poor people, and mining can play an important role here.

- To budget the action programs in the strategic development plan.
  - To select programs that can be implemented with government funding.
  - To schedule asking the donor countries and international organizations for other programs.
  - To formulate programming and estimating the budget.
- To clarify the relation between the development strategic plan and poverty reduction according to yearly actions.
  - To develop the 1st Stage program at the outset.
  - To evaluate the effect on poverty reduction.
- To select promoting areas to develop mineral resources in the mineral potential areas.
  - To select promotion areas from the promising areas in the 1st Stage.
  - To formulate concepts for community development.
- To strengthen the relationship between promotion of mineral exploration/development and development of water resources and construction plan for infrastructure, accompanying the local development.
  - To link up with DHA, CNRE, MET, OMRG and DMG.
  - To formulate a plan for business related to mineral development, accompanying the local development.

It should be noted that the annual progress of the strategic development plan and the

reduction of poverty will be analyzed by the working group of MMI and PRISM, or establishment of a lateral organization under MMI initiative. When two mines under development begin production, they will provide various development results such as operational results, employment and related business development, as well as basic data for analysis which could be used to measure the poverty reduction resulting from the plan realization.

6.4.3 Financial Market

Construction of the financial market is a national economical policy, which has influenced the economical growth in Mauritania. Its industrial structure consists of the primary industry, mining, fishery and agriculture; thus, the company activities will not proceed without advancement of the industrial restructuring. The future tasks are privatization of SNIM and its subsidiary companies, diversification of mining industry and growth of mining-related business. Construction of stock market will influence the activation of companies' activities, economical growth, privatization and development of mining companies. Investment fund for domestic companies and operation fund for foreign companies resulting from the promotion of exploration/development will be necessary to be collected at the Mauritanian financial market.

- To make a system for the low rate of interest in commercial banks.
- To make a long-term loan system (1 to 3 years).
- To make a government subsidy for the rate of interest. To give government guarantees.
- To construct the stock market in future.

Financial liberalization was completed and foreign cash can now be easily transferred, so currently foreign investors are not having any problems with bringing their money to Mauritania for exploration and development. However, there will be demands for financing production activities in the future. Therefore, it is desirable to enable borrowing money from the city banks. It is also noted that a long-term loan system and subsidy system for interest payment would be indispensable for the local companies to obtain capital if exploration and development by local investors are promoted in the future. If financial marketing base is strengthened, exploration and development by both foreign and domestic companies would benefit from it.

6.5 Improvement of Investment Climate

6.5.1 Promotion System

It is absolutely necessary for the mining promotion to make several systems for advancement of exploration/development activities. An extensive survey system and provision of information are essential for promoting exploration. While OMRG is charge of extensive surveys and has already implemented them, given the use of the GIS database, remote sensing technology, and

geological deposit survey techniques derived from this study, it is necessary to systematize it for organization promotion. Although it is possible to undertake joint-venture extensive area exploration with foreign companies or organizations, the systematization would improve exploration efficiency and enhance the profitability of OMRG and the foreign companies. OMRG has already studied on the introduction of JOGMEC joint venture exploration system. Specification of the future roles and rights of foreign companies and organizations is linked to implementation of the system. Information is also being provided through associated developments, disclosure of documents, etc. If the above system is used to provide information to foreign companies and undertake joint-venture exploration, then further investigations would need to consider how to handle information and rights if a foreign company withdraws from a project.

- The exploration system
  - Survey system in extensive areas
    - To systemize the extensive areas surveys by OMRG.
    - To carry out the base metal survey in the first stage and the rare metal survey in the second stage by the national budget.

  Details of this system are described in 6.10.1(2).
  - Joint-venture extensive areas exploration system
    - Joint-venture exploration between OMRG and foreign companies
    - To keep the OMRG exploration right and give OMRG engineers' services. Foreign companies cover the exploration costs.
    - OMRG transfers the exploration right to foreign companies after the exploration.

  Details of this system are described in 6.10.1(2).
  - Interest provision system

  In case exploration works are independently carried out by domestic companies, the government provides them the interest for commercial bank loans during the exploration period. Presently, commercial bank interest is high and there are no long-term loans. Thus, it is necessary to systematize interest provision in conjunction with the development of a financial market.
  - Disclosure of information

  The data gained in the extensive areas survey system will be input in database in OMRG and disclosed to foreign companies for free. In case foreign companies do not accept the right transfer in the joint venture system, the information will be given to other companies for certain payment. The information provision is described in 6.10.5.

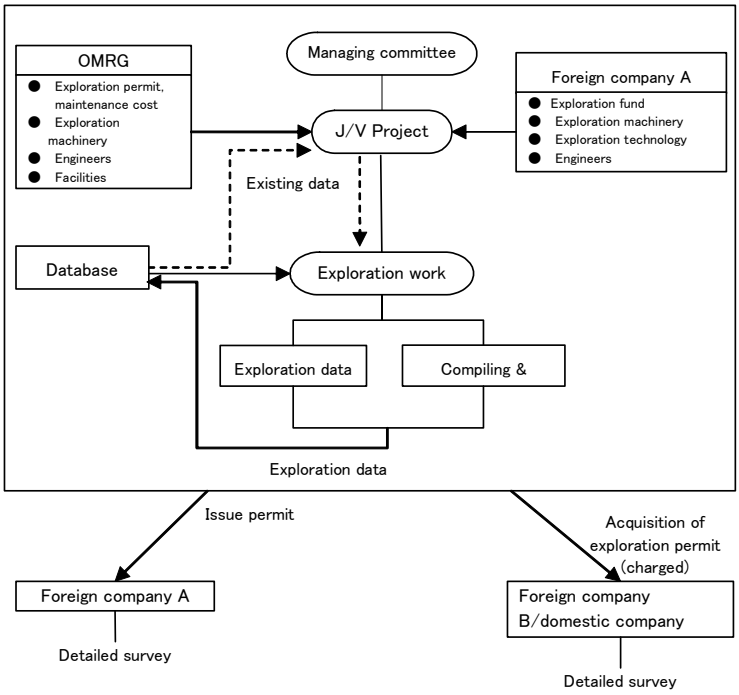


Fig.6.5.1 Schematic Diagram for Joint Venture Extensive Areas Exploration System

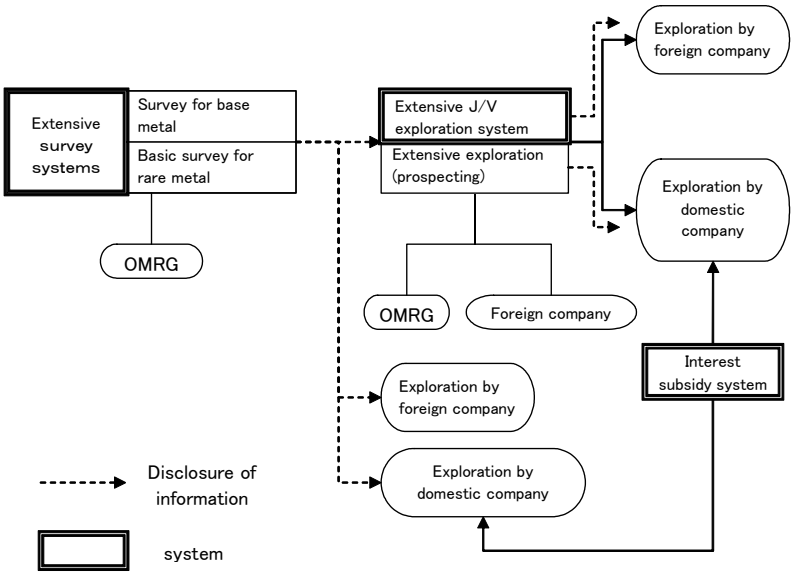


Fig.6.5.2 Location of Exploration System

- Infrastructure support system

  The infrastructure support system for mining development companies at the present time gives companies a 20% tax exemption of total costs for road construction. Support for infrastructure construction is based on negotiations with the government. Under the current financial conditions, however, it is difficult to get government infrastructure support for mining development areas. However, in the case of Tasiast, the private company must bear

the cost of 70km of road construction and its maintenance. Therefore, if the government's roles and responsibilities such as cost burden for subsidies, ancillary maintenance, etc., are not clarified, it will be difficult to promote development, so it is necessary provide specifics at least 2nd Stage if not earlier. For example, when a development project is decided after the bankable feasibility study and a development plan is determined, the government gives the developer support with the construction cost of access road to the mine site (as a subsidy or governmental expenditure). In case the government covers total cost, the access road is treated as a national road and its maintenance cost is also taken by the state. Subsidy will be given for the development of water resources and the government will keep the right of utilization. However, the budget allocation for managing this system is difficult under the current financial situation, so capitals for constructing infrastructure should be obtained from supports of the international organizations.

Table 6.5.1 Tasks for Supporting System for Infrastructure

Infrastructure	Content	Tasks
Road	Total government expenditure	Construction limit, maintenance, financial funds, utilization and responsibility of developers.
	Subsidy	Subsidy amount, subsidy extend, financial funds, responsibility of developers
Water resources	Subsidy	Subsidy amount, national utilization extend, financial funds
	Total government expenditure	Based on water utilization standard, development cost, maintenance
Electricity	Subsidy	Object (cables), subsidy amount, financial funds

- Development system

  - The government guarantee system

    ・ To guarantee the development right period except for the political power shift or change (same in the exploration right).

    ・ To guarantee property (including capital) in superior force (political change or war).

    ・ To guarantee the pocket value (including deposit money) under the economical policy (currency policy) or deviated exchanging rate.

  - Special measure for depreciation

    ・ To shorten or prolong the depreciation period regarding machines and facilities.

    ・ Machines and facilities appointed by the mining organizations or property resulted from development works.

- Environmental measures and protection measures

  - The subsidy system for environmental technologies, tools and facilities

  Foreign companies bring the environmental technologies, tools and facilities by themselves at the development phase. However, it is supposed to be very difficult for domestic

companies to prepare everything due to their financial shortage. Therefore, this system should be located as one of promotion measures for domestic companies.

- Recommendation for environmental measures

Foreign companies have sufficient know-how and technologies for the general environmental measures, but need advices for specific desert conditions. On the other hand, local companies need instruction and recommendation on environmental protection and measures due to lack of mining experience. The recommendation and instruction will be given by DMG, but it is necessary for DMG which is now acquiring knowledge and technologies for mining environmental measures through PRISM's supports. However, it must be strengthened more in personnel training.

- Presentation of environmental information

・ Presentation by the web site for environmental protection utilizing the environmental management database (SIGE)

・ Disclosure of environmental survey data (exhibition)

- Baseline survey

・ Necessity and summary of the extensive baseline survey are described in 7.5.5. It is necessary to systemize the baseline survey and fix the method, target areas, precision and period.

Table 6.5.2 Summary of Extensive Baseline Survey

Item	Summary
Target areas	• Mineral potential resource areas. • Mining districts (There are already activities in progress.)
Target objectives	• Rock, soil, water quality, water level (ground water), fauna, flora, air
Method	• Grid sampling (one sample/1 to 5km) for rock and soil. • Well and river analysis for water quality. • Processing of ASTER image data • Chemical analysis of samples
Compiling	• Database of chemically analyzed values and observational
Analysis	• Selection and analysis of anomalous zones • Hydraulic structure
Result	• Baseline map • Analysis

The baseline map resulted compiled from during the baseline survey will be entered into PRISM environmental management database (SIGE) of PRISM. SIGE is linked with the data base for of geology and ore deposits (SIGM) by LAN, so it is possible to compare the baseline map with data on geology, ore deposits, geography, infrastructure, vegetation and well locations etc. Once the monitoring system is operational, environmental management will be enabled by by comparison with the baseline map.

The content of baseline surveys is described in 6.10.5(2).

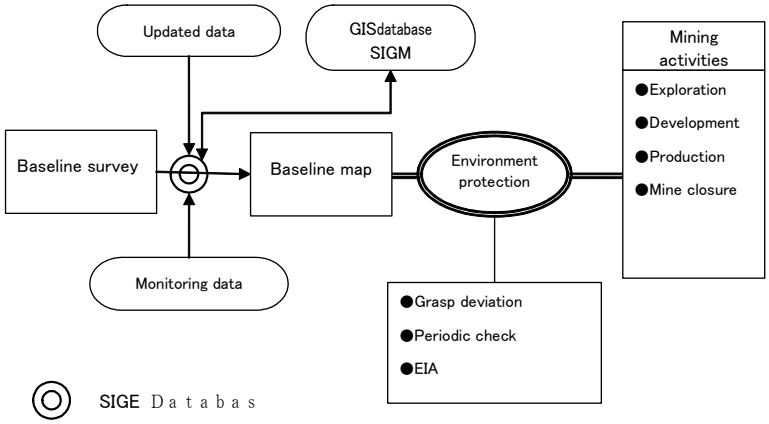


Fig. 6.5.3 Location of Baseline Survey

6.5.2 Infrastructure

The infrastructure support system was described earlier. Infrastructure development is important for promoting exploration and development; it is necessary to develop roads, water and power supply systems, and so forth. Work is progressing on building roads with support from the EU, donor countries and international organizations, but from the perspective of exploration and development, there has not been any real road development. Therefore, future infrastructure construction plans will need to include areas that are being promoted for exploration and development.

- Dedicated wharves for mineral resources

  In Mauritania, there is only one port that is strictly for mineral resources: SNIM's iron ore port at Nouadhibou. If there is no port that can ship several hundred thousand tons of concentrates for export, then it will be impossible to promote exploration for medium to large base metal mines. Nouakchott currently has a port with three wharves which handle 1.5 million tons of goods a year, but it is already near capacity. Therefore, a 4th wharf is being planned that will be built with assistance from the Chinese government (with cost of US$80 million, commenced the construction in December 2005. Construction period will be 2 years, during which time the Chinese government will provide a combination of government loans, grants, and loans from private sector banks). Although this might increase capacity by 500,000 to 600,000 tons, it will not be designed for handling bulk ore for export, so concentrates would have to be shipped in containers or bags. Thus, to promote the exploration and development of medium to large-scale base metal deposits, there would have to be either exclusive port facilities for mineral resources, or a new wharf constructed. At the very least, the plan would have to be formulated at the 2nd Stage.

- Water resource development in areas with promising mineral resources

A water supply is essential at the exploration and development stages. Under the present conditions, water has to be transported 100 to 300km at the exploration stage, which hinders the promotion of exploration. The MHE, MMI and OMRG all have a keen desire to develop water resources in promising mineral areas, and in fact, PRISM started a water development project to provide SNIM in the Zouerate area. The development of water resources in promising areas selected by this study is tied immediately to the promotion of exploration and development. In fact, it is extremely important for resource development areas, as described in 6.10.2 (2).

- Formulation of an infrastructure construction plan

  A mid-term plan for infrastructure construction would be very effective for the formulation of a development plan, because it is linked to acceleration of exploration activities. The detail of the infrastructure plan is described in 6.10.4 (1).

6.5.3 Environmental Management

The system of environmental management should be built according to proceeding of exploration/development, implementing the following items for practical function. Regarding the legal framework for environmental management, PRISM and MMI pointed out its inadequacy, so it should be improved as soon as possible. What are needed first are guidelines and detailed regulations for EA (Environmental Assessment) and EIA (Environmental Impact Assessment). Tasiast and Akjoujt are at the development phase and thus require these immediately. To establish the legal framework, cooperation is needed from the EU and the World Bank. The Mining Environment Management Plan is taking shape through its background learned from baseline maps prepared by the implementation of baseline surveys. Should be formulated a kind of environmental master plan which includes groundwater surveys, hydrological analyses, and database construction. The formulation of this plan may require assistance from Japan and others. The installation of a monitoring center was considered by examining the current state of a monitoring center in Senegal in this study. Given that the monitoring points would be selected by using remote sensing technology involving the use of ASTER and LANDSAT images and the abovementioned baseline surveys and environmental management plan as well as reviewing activities of SNIM and other mines at the development stage, it shouldn't be too hard to concretize.

- To establish the monitoring system.

  The monitoring system will be established steadily by modularity, according to mining development and economical situation. First of all, the mineral potential areas selected by this study should be considered. Water wells are included in the monitoring points. Monitoring points are distributed around the developing mine sites for the mining

environmental monitoring system. It is desirable that the Mauritanian global environmental system is established by increasing monitoring points (including water wells) distributed all over the country, starting from this mining environmental monitoring system. The installation of the monitoring center in the 2nd Stage is outlined in the Strategic Development Plan, but it is already possible to use a database (SIGE). In the present study, satellite images are being prepared for areas with mineral resource potential and areas targeted for development. Therefore, if comparable satellite images are obtained in the 1st Stage, it would be possible to observe environmental changes over several years.

- Periodical measurement at each monitoring point (measuring system)
- Procurement of monitoring tools
- Construction of monitoring database (using SIGE of PRISM)
- Observation by the satellite image

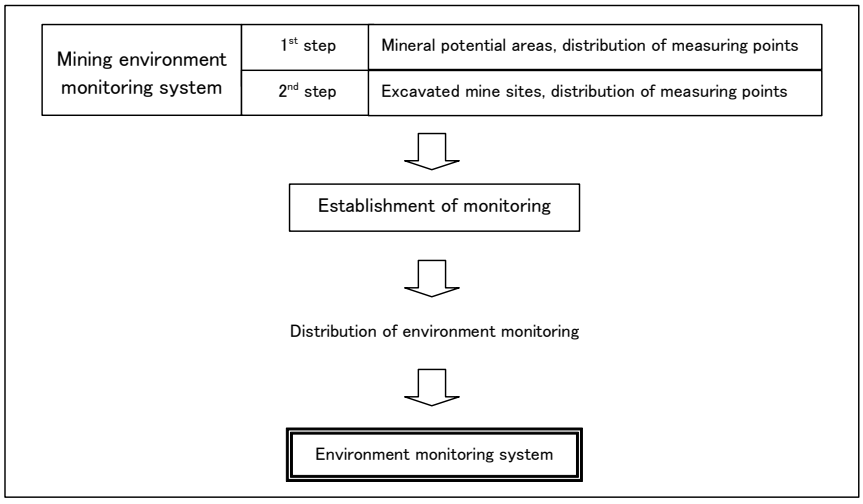


Fig. 6.5.4 Construction Steps for Environmental Monitoring System

- To establish Monitoring Center.

  Monitoring Center will compile and analyze the data, conduct the satellite image analysis, input data at each monitoring point in the SIGE of PRISM and utilize the linkage system of SIGM of PRISM. Therefore, the center would be functional if the staff and computers were prepared. Details on the monitoring center are given in 6.10.5 (3).

- Disclosure of environmental information by the website

  Monitoring data and baseline data compiled in SIGE or information related to environment should be disclosed by the website (website for environmental protection). It is also desirable to access freely to data in DGM/ IPO and disclose information by CD-ROM or brochures.

- Collection of mining environment information

Environmentally contaminated data in the soil, groundwater, rivers and so on around the mine sites should be collected from the related organizations for use of understanding the current environment states or comparing monitoring data. These data should be given to SIGE.

- The environmental management system of the government and its function

  The related organizations are described in 7.5.6.

  - To link the government organizations related to environment with SIGE.
  - Utilization of the environmental protection web site by the government organizations .
  - To install the intranet between relative ministries and organizations.
  - To establish Mining Environmental Protection Committee.
    - It will consist of ministries and organizations related to mining activities.
    - The international organizations, donor countries and NGO will participate.

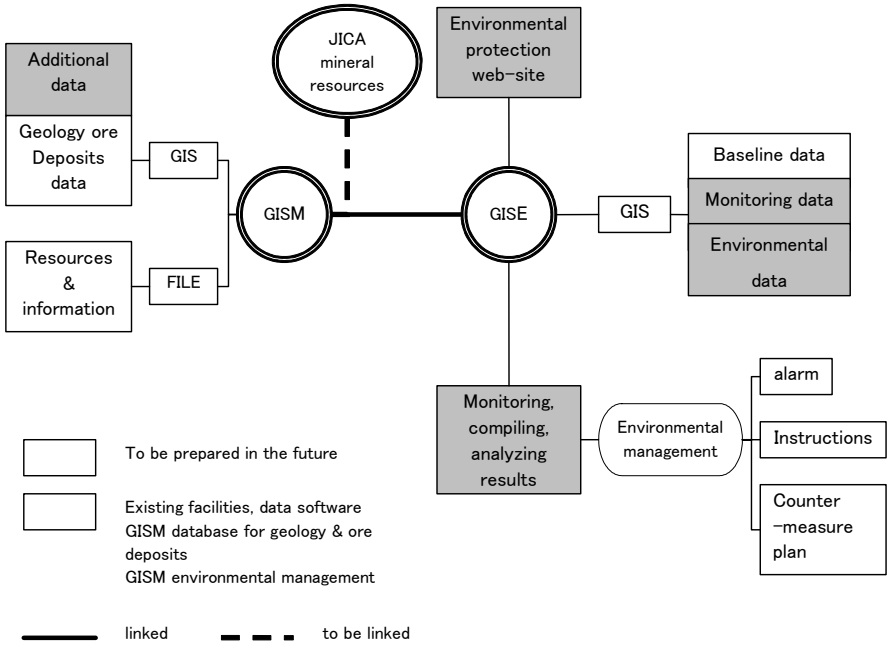


Fig. 6.5.5 Location of Environmental Management Database

- To nurture environmental experts.
  - To invite experts to have their direct instruction.
  - Training system in foreign countries
  - To introduce environmental projects prepared by international organizations or donor countries.
- Establishment of legal frame including environmental management regulations

  Legal framework related to environment is now improving, but the legal framework related

to environmental management needs to be established through systematic review. Furthermore, the development of environmental regulations can in no way be said to be satisfactory. It is necessary to make regulations for practical environmental management, in the legal system, harmonizing with the Mining Code and laws related to environment. For example, mining activities consist of main four phases, exploration, development, production and mine closing. Regulations are requested according to each phase for environmental management. Establishment of legal framework is described in 6.10.5 (1).

- Environmental standards

  Mauritania has no environmental standards in place. Two mines are scheduled to commence production around 2006. Environmental standard is considered in the 3rd Stage, but it's better to establish standards earlier. Detail of the environmental standards is described in 6.10.5 (4).

- To hold seminars and workshops for environmental management.

  The environmental management is a common task for the world. It is gainful for acquisition of knowledge, technologies and information of environmental management to participate in international seminars and open international workshops in Mauritania. At the same time, it will be an opportunity to raise an interest towards the environmental management.

- To establish Laboratory Center.

  There are some analyzers and an analyzing division in OMRG, which can analyze partial elements like gold. Analyzing capacity in OMRG should be expanded as well as the staff - trained in order to establish a laboratory center, able to do full analysis of rocks, soils and water. However, the support from international organizations and donor countries is needed under the current situation of the national budget.

- Mine closure funds and reserve

  Mining industry has the following particular characteristic that the other industries do not have: a mine can continue giving some impact to the environment even after stopping its operation. Specific environmental works should necessarily be conducted when a mine closes. Thus, some mines need to continue monitoring after closing as well as take relative measures against pollution. However, the economic situation of a mine cannot be guessed at the point of the mine closure, and the expenditure for closing it may be impossible in a certain situation. Therefore, the reserve and fund for the mine closure are one solution to the expenditure problems. It is a system to pool the money for mine closure while it still manages normally the operation. It is a very important system from the viewpoint of permanent management of mining environment.

  A mine developer should be given a bank guarantee according to the mining-related decree

enacted in July, 2004. It is now necessary for banks or insurance companies to study relative practical management.

- Instruction to local companies

  Mauritanian companies have not grown up yet, but instruction method and system should be studied as a future task. Instructing and nurturing local companies is described in 6.10.8.

- Formulating a plan for environmental management

  Making a long-term plan or master plan for mining environmental management in harmony with poverty reduction strategic paper (PRSP) and this development strategic plan, as well as implementing the administration for mining environmental management with medium and long-term view, will lead to sustainable development of mineral resources. The baseline survey mentioned above will be a basic structure for formulating the plan.

- Mine safety and environmental guidelines

  In Mauritania, there are no mine safety and environmental guidelines. At the 3rd Stage, which envisions full-scale mine operation, it will be possible to establish guidelines to match the conditions in the country. With 10 years of production experience with the 1st and 2nd Stages, items and contents can be arranged, and it may be possible for Mauritanians to formulate guidelines. Details are given in 6.10.5 (5).

6.5.4 Information Disclosure and its Methods

Disclosure of information on mineral resources is indispensable for the promotion of exploration/development, and the disclosure by the web site is the first step of such disclosure for investors. The second step is to disclose the detailed exploration information on ore deposits, etc. The web site, presentation, exhibition system and translation of information into English will be necessary, as described in 7.3.5.

- The web site

  - To link the web site of OMRG constructed under this study with the web site of MMI and SNIM.
  - To link the environmental protection web site with the mining-related web sites .
  - Searching (retrieval) system.

- Translation of information into English.
  - Literal information on the web site
  - Documents, reports etc.
  - Various figures like geological maps, etc.
  - Input data in the database

- Installation of facilities for disclosure of information on mineral resources

- Systematic compilation of information on mineral resources and searching system
- To nurture staff for information system
- Installation of facilities for public disclosure (in Investment Promotion Office, etc.)

- Information disclosure system

  It is necessary to disclose the information on data stored in the GIS database and the newly attained materials as much as possible to promote the overseas investments through the OMRG web site. The contents of the web site should be renovated every 2 to 3 months to have the foreign companies understand it. That may increase number of access which can link with investment.

- To formulate rules and regulations for disclosing and providing information.
- Disclosure of business finances data of companies

  It is a key for a joint venture between foreign and domestic companies conducting exploration and development activities, as well as for the growth of the financial market to keep the transparency of business finances and companies activities. The investment climate for foreign investors will be improved by the introduction of the international accounting and reporting standards, disclosure of financial statements and punctually following the deadlines for submitting financial reports. An appropriate instruction by the government organizations will be useful for the growth of domestic private companies. Disclosure of business finances data links to improving financial status of local companies.

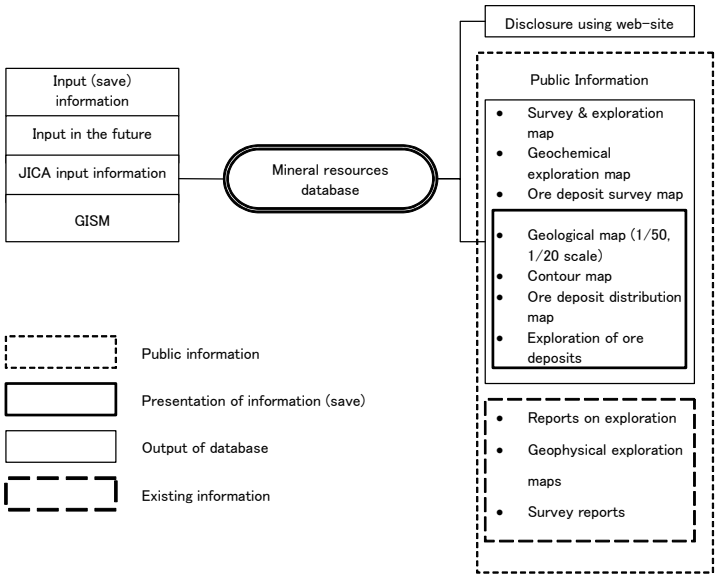


Fig.6.5.6 Mineral Resources Database and Exhibition of Information

6.5.5 Maintenance and Management of Mineral Resources Database

Maintenance and management of mineral resources database is to master the function and availability of GIS for data addition and its full utilization. Recently the geological maps have been partially prepared by PRISM; however; the geological maps with scale of 1/100,000 are the minimum requests for investors. It will be related with the maintenance and management of the database to output the information requested by investors.

- To expand the database (Mineral Resources Database).

  A mount of data and information, reports and drawings prepared in the projects cooperated with international research organizations such as BRGM, stocked in the OMRG document room, should be put in order to transform documents to PDF format, and to rasterize and to vectorize maps by compiling and scanning.

  - To add data.
  - To add information. ⟶ To digitalize the literal information like reports.
  - To expand the software and hardware.
  - To establish the renewals for software and hardware. ⟶ To budget them.

  Digital data (PDF files and spatial information files) is stored in the GIS database which needs location information, and can be linked from GIS database. Usability of the database shall be increased by customizing retrieval tool.

- To utilize GIS.

  - There are many utilization of GIS, for instance, in the studies of geological ore deposits by OMRG, selection of mineral potential areas, elaboration of survey plans and compilation, analysis of survey data and so on. Utilization means and objectives will be concretized through data addition and multi-angle studies of geological ore deposits and exploration potential.
  - To train the staff in foreign countries.
  - To cooperate with experts of geological ore deposits and remote sensing.
  - To utilize GIS for reduction of the exploration risk.

- To make the detailed geological maps with scale of 1/100,000.

  Currently the geological maps with scale of 1/200,000 which covers the main part of Mauritania are under preparation, however the more detailed geological maps are really needed as a first step, such as maps with scale of 1/ 100,000, for companies to study whether or not to invest in exploration. Detailed contents are described later.

  - To select target (promising) areas for the detailed geological maps from the existing geological maps of 1/200,000 scale.
  - To request making the maps from the international organizations and donor countries.

To understand economically the surface geology, mineral distribution, geological structure and topographical information, satellite images covering the all Mauritanian Territory are very effective, and so the additional ASTER data with high spatial resolution should be procure to prepare the 1/100,000 geological maps which will explain later.

- To employ staff.
  - To employ experts in charge of database in OMRG. (IT engineers who speak English.)
  - To request the dispatch of experts from donor countries (for long period).
  - To employ workers for data input

6.5.6 Utilization of Mineral Resources Database

Concerning the utilization of mineral resources database, strengthening the utilization of the database is described in 7.6.1, while the objectives and means of its use in 7.6.2. Data for various sectors like the infrastructure, water resources, meteorological phenomena, flora etc. should be added to the database for its wider use.

With the exception of the mining industry, there is almost no use of remote sensing technology in Mauritania. In the field of mineral resources, the efficient use and continuous accumulation of mineral resource data including remote sensing data, are indispensable for the promotion of exploration and development, and this work has already been done so far by PRISM and this study. The stored data includes partial information on infrastructure and water resources. Specifically, the Strategic Development Plan contains the following items:

- Additional data such as SIGM/SIGE data, OMRG survey data
- Archive development
- Utilization of Global elevation data
- Addition of ASTER imagery
- Acquisition and arrangement of data on infrastructure, water resources, vegetation, land use, climate and so on

If items mentioned above will be conducted, application to other fields (such as agriculture, land use, infrastructure planning, water resource development, desertification monitoring, etc.) based on the mineral resources database can be used in a wider variety.

- Support for the creation of an infrastructure development plan

  Infrastructure development is multi-faceted. The creation of an infrastructure development plan requires various types of data, for example, on mineral resources, water resources, climate, land-use, agriculture, vegetation, topography, desert areas, rivers and streams, existing infrastructure, and environment. Furthermore, monthly and yearly changes must be identified using these data. Presently, however, there is no database to coordinate these data.

In order to provide useful data for use in formulating infrastructure development plans, such as mid-to long-term plans, an OMRG mineral resource database will have to be created with appropriate assistance. In addition, the infrastructure development plan itself should be connected to the promotion of investment in exploration and development of mineral resources.

- To use for the Poverty Reduction Strategic Paper (PRSP) and the local development.

  Farming in Mauritania is limited to a small area in the south. Land conditions (climate, hydrology, topography, soil, state of water resources, etc.) are derived as theme maps from satellite and GIS data. The identification of areas suitable for farming and livestock raising through land classification can contribute to agricultural development. Livestock farming is believed to be strongly affected by the amount of grassland and water resources which greatly fluctuate each year due to rainfall conditions, and satellite data are effective for monitoring (seasonal and annual changes) in grassland and water resources. Location of water resources can detected through utilization of the surface heat data monitored by thermal band data. In such a case, it is necessary to add sufficient topographic factors. This kind of agricultural development is tied to community development, so it would be useful to combine data on water, infrastructure, desertification, resource potential, and other factors.

- To protect from the desertification.

  Application of remote sensing is in environmental issues is seen in monitoring of desertification, environmental variation in lakes and ponds, etc. Combat desertification is done by CILSS (Permanent Interstate Committee for Drought Control in Sahel) whose headquarter in Burkina Faso plays a central role for countermeasures. Some forestation is carried out around Nouakchott to fix the dunes. It is possible to ascertain its effect and the state of desertification by satellite data. Desertification has many factors, but it may be possible to find out the clue for solution of desertification through understanding annual and seasonal changes. The satellite data is very effective to grasp the impacts on the ecology through monitoring the environmental variation like the coastal erosion, change of the sea, lakes and ponds and so on.

- To use for water resources development, water pipeline construction and water supply.

  The development of water resources in Mauritania should be given top priority since it is instrumental for the development of communities, mineral resources, mining, agriculture, and other areas in the country. Currently, water resource development is the responsibility of the Water Resource Center (CNRE) and the Water Bureau. If water resource data can be included with mineral resource data, it could provide excellent material for developing water resources, and could enable data to be provided for making far-reaching decisions on

building water pipelines and developing water supply facilities, among other things.

- To formulate an industrialization plan.

  Because of the sometimes unbearably severe conditions in the countryside, the population in the cities such as Nouakchott has been increasing dramatically. To get a better understanding of this trend, satellite data have been used for monitoring the changing conditions in the cities each year and to promote an appropriate type of urban development. In the formulation of urban development plans, detailed topographic maps based on aerial photos are useful but expensive, so it might be possible to use satellite data in their place. However, medium resolution satellite data from LANDSAT and ASTER, etc., are limited to a spatial resolution of about 1:50,000. High resolution data such as from IKONOS or Quick Bird provide resolution equal to aerial photos.

6.5.7 Support to Investment Promotion Office

It is necessary in the future to examine the content of support in this study as well as the methods for creating a functional organization to fully exert its role in future. Details of Investment Promotion Office are described in 6.10.2 (2).

- To make brochures for investment promotion, publish investment guidebooks and prepare CD-ROM.
  - To make brochures for introduction of the Mauritanian situation, investment climate, mining policies, mineral potentialities and ore deposits.
  - To prepare CD-ROM containing the Investment Law, Mining Code, Environment Basic Code, description of mining policies, roles of mining administration sectors, tax institution related to mining and procedures for acquiring mining concessions.
  - To publish investment guidebooks.
    - ✓ Investment guidebook ---- mining policies, administrational organization for mining, mining law, investment procedures
    - ✓ Geological guidebook --- Geological map of Mauritania, geological index, characteristics of geological structure
    - ✓ Ore deposits guidebook --- Distribution of ore deposits, summary of ore deposits, mineral potential areas, ore genesis, metallogenic provinces
    - ✓ Ore deposit models---Typical ore deposit models, ore deposits formation place
- To publish magazines for introduction of the Mauritanian mining.

  Seasonal magazines will be published to show the Mauritanian mining situation, exploration activities of foreign companies, mining news, etc. The concrete examples of

contents for No.1 and No.2 are shown in 6.10.2 (1).

It appears that the following additional actions will be necessary in future.

- To make videos/DVDs for investment promotion.
- To install a PC for three-dimensional display of ore deposits.
- To expand and increase the staff to formulate plans for investment promotion.
- To prepare a section for investment information analysis.
- To have direct instructions by experts for investment promotion.
- To prepare an investment promotion section for local companies
- To obtain instruction videos/DVDs for introduction of mining technologies, mining companies and development/production situations around the world to local companies.

This unit is planned within the PRISM sector framework program. In support of the Investment Promotion Office this study has considered its needs and likely operational format. Its role and function is shown in Table 6.5.3 and presents this idea conceptualizing in Fig.6.5.7. In addition, the future design, role and function of the Investment Promotion Office is shown in the Appendix I, 1.1 which is a result of cooperative work with PRISM.

Table 6.5.3 Role and Function of Investment Promotion Office

Role	Function
To assist the investor and provide Mauritanian information on Mauritania to the foreign companies.	Organic relationship between the government organizations
To make plan and implements for the focused marketing of the sector to the foreign companies and implement them.	Construction of Web site in OMRG with links to related organizations（Ministry of Finance, etc.）
To research and analyze mining markets information for utilize use in making planning investment promotional work.	DMG database SIGE, OMRG/JICA database, and information counter for investors using GIS.
To nurture domestic companies to invest in mining.	Promotion of investments by collection and analysis of local and market information

The following items are under consideration as materials to be prepared in near future.

- Investment guidebook, CD-ROM and brochures.
- Construction of the web site and linkage with OMRG Web site and others.
- Preparation of showpieces and panels.
- Making a Drafting for investment promotion policies.
- Disclosure of the information in GIS database.
- Display of 3 D deposit models by PC for demonstration.

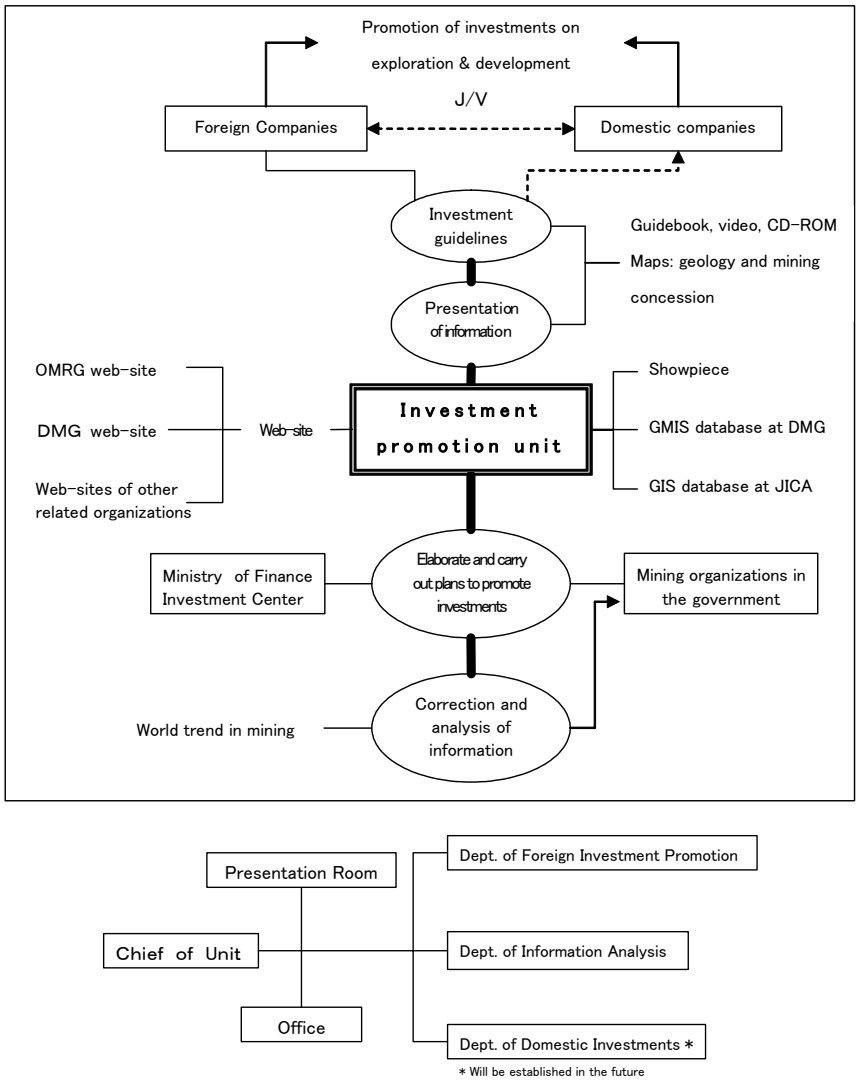


Fig. 6.5.7 Promotion of Exploration/Development by Investment Promotion Office

6.6 Introduction of Foreign Investment and Growth of Domestic Companies

6.6.1 Introduction of Foreign Investment

Improvement of the investment climate for introduction of foreign investment is described in 7.4.1, indicating the current situation for the investment and relative tasks. Respectively, the tasks, measures, promotion policies and implementation plan to be suggested are described as well in 6.3.2 Mining Policies, 6.4.3 Financial Market, 6.5.1 Promotion System, 6.5.4 Information Disclosure and its Method and 6.5.7 Support to Investment Promotion Office in this chapter. Besides the above items, the items below should also be discussed in future.

- To make an incentive in the exploration/development system for attracting foreign investors.

- In case a foreign company has a joint venture with a domestic company, it can prolong the exploration right period up to more than two years at the exploration stage. The foreign company can reduce the royalty at the development/production stage.
- In case a foreign company constructs a road by its own fund at the development stage, it can reduce the royalty for five years after beginning of production. Construction cost should be the national debt which will be repaid back to the foreign company, and also maintenance cost should be paid by the national treasury.
- To fix the rate of interest and exchanging rate to the mining activities fund for a foreign company within a limited period in Mauritanian commercial banks. (The Central Bank guarantees it, but the foreign company needs negotiation.)

- To present digitalized information on ore deposits (ore deposit models, ore deposit diagrams, ore grade map, etc.).
- To make a construction plan for infrastructure, compile and present the information on infrastructure.

6.6.2 Nurturing Domestic Companies

At the moment, exploration/development cannot help the dependence on foreign companies in Mauritania. There are no domestic companies able to do exploration/development works independently, due to their poor capital and technical strength. However, if the dependence on foreign companies continues in future, the capital accumulation accompanied by mining activities will be impossible in Mauritania. The profit will go out of the country, and foreign companies will escape from mining activities according to the deviation of metal price. It might seriously influence the employment rate. From the view-point of economical growth of Mauritania, it is important for domestic companies to carry out exploration/development works independently at the second and third stages of the development strategic plan.

- Proposal for nurturing domestic companies

  To nurture domestic companies, it would be preferable to provide financial support for exploration and development, but it would be difficult under the present financial conditions in Mauritania to establish a system for finance and subsidies. At the 1st Stage, it is necessary to formulate a proposal for nurturing domestic companies and investigate the feasibility of financing and subsidizing them. It would also be advisable for the Investment Promotion Office to consider the specifics of the proposal. The proposal must be formulated from a multi-faceted approach that includes the introduction of technology, specialized knowledge, the acquisition of business skills, and the procurement of funding, among other things. It may be possible to obtain exploration subsidies for domestic mining companies from

royalties paid by foreign companies for their mining operations. However, in that case it would be necessary to study more on the sum of the source, the target(s) of the subsidies, the rate of subsidy, the subsidy management system, and so on. Furthermore, the system for funding exploration is financed for exploration capital. The source and objects of financing, management of funds, financing methods, etc., must be investigated.

The interest provision system is described in 6.5.1.

- To accept project orders of international organizations jointly with foreign companies.

  Accepting the project orders of international organizations jointly with foreign companies is related to acquisition of the necessary technologies and knowledge. If the 1/10,000 geological maps that will be needed in the future (see 6.10.6 (4)) can be prepared by funding from international organizations, etc., it would help to nurture domestic companies.

- Partnerships with foreign investors

  If domestic companies can grow up at the 1st Stage, linkages with foreign companies could be considered. Partnerships with foreign companies are discussed in 6.5.1 "Investment Promotion". There are also some other methods, like cooperative exploration works or joint venture exploration activities with foreign companies. They also can lead to the introduction of technologies and knowledge as well as staff training by OJT.

- Rental system for exploration/development machines

  This is a measure for promoting in the 2nd and 3rd Stage. Based on the rental system, the government mining organizations can lease exploration and development machines to domestic companies that are poor in capital. It is necessary to study the funds source, rental and maintenance conditions, etc. for systemization.

6.6.3 Privatization of SNIM

The World Bank and others require the privatization of the national enterprise SNIM. This is based on the World Bank's guidelines for privatizing nationalized industries and is the trend in the world. Today, mining companies are doing well and SNIM's management is being improved, so now is the time to investigate concrete ways of reforming management

- Investigation of SNIM privatization

  A proposal for privatization of SNIM should be made after a privatization committee is established at MMI. First of all, it is necessary to consider the separation of subsidiaries, the sale or corporatization of welfare provisions sectors, the separate management of railways, ports, etc., and FS in the case of a break-up of the organization.

Table 6.6.1 Separation Plan for Privatization of SNIM

Targets	Separation for Privatization
Mines	● Privatize facilities for Production ● Include the infrastructure related to production
Stockyards and shipping facilities	● Privatize the facilities in Nouadibou ● Privatize the long-distance facilities from the mine site
Railway	● National railway company (partial private investors) ● Include maintenance sectors
Port	● National port company ● capital & management by government but operation by private company
Water and electricity	● National or public management ● Supply for production facilities in Zouerate is managed by the mine.
Subsidiary companies	● Perfect privatization ● Each company is privatized by the foreign and national companies.

- Privatization of SNIM

  Privatization will be implemented in the 2nd Stage based on the above-mentioned plan formulated in the 1st Stage. The major share of the SNIM should be soled or conveyed to the domestic companies with capital.

  It should be noted that this survey team discussed the privatization of SNIM with SNIM during the 5th Site Study. The following is a list of basic results from the meeting:

  - Privatization may be necessary for the future, but first priority must be given to strengthening the economic base.
  - Operating conditions are improving as demand for iron ore increases, providing an excellent opportunity to fortify the economic base.
  - The first importance of privatization is profitability after privatization.
  - If profitability is promising, privatization should be studied practically.

6.7 Human Resource Cultivation

Training engineers related to mining is fundamental for promotion of exploration and development, so it should be a priority matter in the development strategic plan. Its importance has been already pointed out by the foreign companies and SNIM, and in interviewing during in this study a shortage of engineers graduated from university and professional school was indicated as an urgent issue by the Tasiast Mauritanie Limited S.A. which is under exploration and excavation stage. Practically the problems were solved by the foreign engineers from Spain, Canada etc. However, employing the foreign engineers is expensive and it might be disincentive for mining development. On the contrary, Mauritania might loose opportunities of employment. The company is requesting the Canadian Government the engineers training to solve the issue in the future.

Human resource cultivation is an important matter to promote exploration/development activities. Staff training has been carried out by OJT in PRISM and this study. However, promotion of exploration/development would be broken without systematic and continuous training. Staff training

is also required by foreign companies, which have already carried out exploration works in Mauritania. Training system is described in 7.3.8.

- Training system

  - To establish a training system like training for top officials, invitation of experts, skill up for general officials and English lessons

- Establishment of a university faculty of mining engineering

  (Science of ore deposits, exploration engineering, mining engineering, beneficiation engineering, mining environment engineering)

  Due to shortage of instructors, it is intended to keep the number of professors for above-lectures by studying abroad and some training during the 1st Stage. This is implemented during 2nd Stage, based on perspective of instructors.

- The overseas study program (master level)

  In Mauritania, neither OMRG nor the university is nurturing specialists with knowledge about geological units, types of ores, types of deposits, and so on. Foreign companies point out that there are no geological deposit experts with knowledge about the regions being explored. However, there should be experts who can give advice to private companies, provide information about the geological deposits of a region, etc., during the exploration stage. The needs of private companies could be met through study abroad programs that could train specialists at the master level. This would also lead to a qualitative improvement of OMRG.

- To establish a faculty of mining in Technical High Education Center

  The vocational technical educational center which was built by the French funds in 1982, has trained technicians in the field of electrical engineering, mechanical maintenance, civil engineering etc. SNIM's engineers have been trained in this center. (This center was built by the SNIM's request.) A faculty of mining is established in this center. Target fields for training are considered in topography, boring, geological drawing and mapping etc. Details are described in 6.10.3 (1).

- Experts invitation system

  This is a system in which the knowledge and technical base will be enhanced by the direct instructions of the world experts. Feasibility of this system depends on the government financial source. At current situation, it seems to be difficult to implement the system, but it is possible to establish the opportunities of technical training from the experts, by effective utilization of the systems of the donor countries or international organizations. Implementation of the system is realistic in the 2nd Stage of the development strategic plan.

  - Specific knowledge and technologies in each special field

(Mineral evaluation, environmental economy, mineral resources economy, feasibility study, engineering, exploration technologies, mining technologies and processing technologies)

- Mining financing, mining accounting and mining management
- Mining tendency

(Updated mining technologies, environmental issues/countermeasures, mining policies and tendency of major companies)

- To establish an Instruction Center for Mining Technologies.

This is a place for staff training to feed workers in the exploration, development and production within the global mining activities by instruction of practical technologies. It will be built by international organizations or donor countries and it is desirable to become a Technical Development Center in future, including neighboring countries. This promotion policy is positioned in the 2nd Stage which will be a period when many mines are opened and production activities become established. However, this plan should commence during the latter half of the 1st Stage, as it will take several years to materialize. The plan should also consider current conditions regarding the training of other types of personnel.

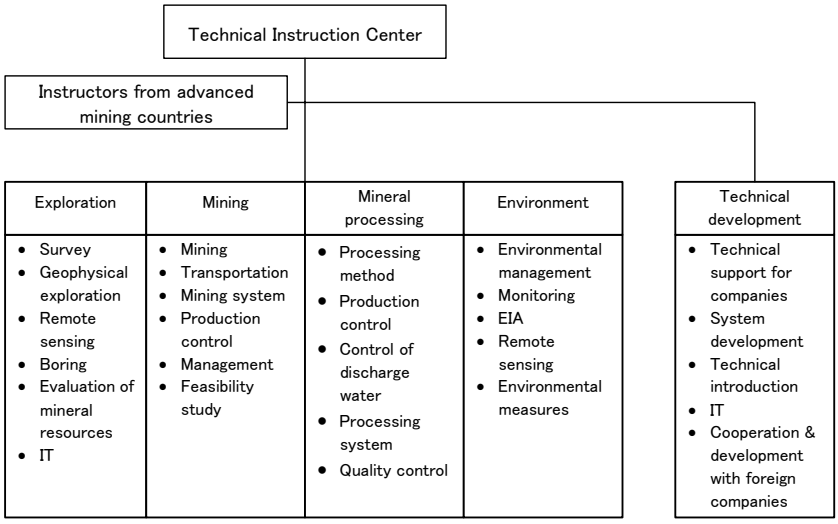


Fig.6.7.1 Organization of Technical Instruction Center

- English-language instruction system

English-language education is emphasized, but there are very poor opportunities for English instruction to the engineers who needs understanding English. English language should be instructed in the above-mentioned vocational technical educational center. It is necessary to improve English ability by systemization of instruction. The detail of this system is described in 6.10.3 (2).

- To utilize the expert dispatch systems in donor countries and international organizations.

Opportunities for invitation of experts should be increased by full utilization of the systems in donor countries and international organizations (for example, dispatch system of JICA).

- Overseas training system

  There is an overseas training system in the Ministry of Education, but no for engineers. At present, Mauritania needs practical technology and knowledge, and so establishment of overseas training system for engineers and government top officers who need understanding the mining technology and know-how of mining business. It is desirable to implement it in the 1st Stage.

6.8 Promising Areas of Mineral Resources

6.8.1 Mineral Resources Survey (Promotion Measures for Exploration and Development by OMRG)

The promising areas were selected and the metallogenic provinces are suggested in the development strategic plan. After this study, the Mauritanian mining organizations, in particular OMRG should continue strengthening the survey capacity and surveying the objective areas of ore deposit models or potential areas applicable to ore deposit models in order to increase the data necessary for promotion of exploration and development. Increasing the data implies specifying the potentiality of promising areas.

- To review the ore deposit models

  Exploration targets will be further clarified by the ore deposit models, prepared through the supplementary field survey, as far as the models will be specified by data augmentation from documents on the similar ore deposits in other countries as well as the field data to be obtained by OMRG in the future.

- The survey in the model areas, carried out by OMRG

  - To continue the geological survey.

    OMRG should continue the survey in the target areas for the models in the supplementary field survey by means of methods and technologies acquired by OJT in this study to expand data from linear to plane.

  - To survey the altered zones.

    OMRG should survey the altered zones, using the tools provided by this study (portable spectral radiometer for mineral identification: POSAM). It is necessary to improve the analysis accuracy in the altered zones by comparison of remote sensing images, as mentioned later. In addition, it is necessary to prepare the alter zone maps to compare with geochemical analyzed maps and geological maps as well as mineralization maps.

  - Geochemical exploration

Sampling should be done to increase the amount of geochemically analyzed data in the supplementary field survey. Increasing the data amount would facilitate finding solution for the metal condensed areas and mechanism through compilation and analysis of the data obtained as a result of the geological survey and altered zone survey. By storing the survey data in the database and using GIS to meticulously manage information, the targets of exploration will become clearer. Furthermore, an important way to improve the quality of the data would be to carry GPS during sampling and use it to acquire accurate positional information.

- Geophysical exploration

OMRG has neither the geophysical exploration equipment nor geophysical engineers. First of all, electrical, electromagnetic, magnetic and gravity survey equipment should be procured and at the same time, engineers should be trained. At this moment, experts should be invited from foreign countries and the geophysical survey be carried out in the model area while training staff by OJT. First of all, it is important for geophysical engineers to have good training to carry out their surveys by themselves.

- To handle the equipment.
- To master the survey method and obtain necessary data.
- To analyze the obtained data.
- To compare the geological, altered and geochemical data.

- Trenching

Trenching survey should be carried out in the anomaly zones revealed by the geochemical survey and altered zones survey should be conducted to condense the data and analyze the anomaly zones. This trench can be satisfactorily utilized within the confines of OMRG's technology and budget.

- Structural boring

At first, an exploration plan should be made based on existed data. At that case, deep underground data is needed to specify the target and reduce the exploration risk. OMRG disposes of relevant boring machines, though currently malfunctioning. If the structural boring were carried out by repaired machine or hiring a subcontractor, OMRG would attain the three dimensional data which might be useful for foreign companies. Provision of effective data would be necessary like these data to review the ore deposit models. This is implemented in the 3rd Stage, but there are now difficulties in logical explanation for geological structure and mineralization because there is almost no three dimensional (3D) geological information in Mauritania. Therefore, it is necessary to improve the accuracy of the background for the geology and ore deposits as soon as possible by implementation

of the structural boring.

- To evaluate the mineral resources.

  Evaluation of the resources potentiality should be carried out using the results of the above mentioned surveys. Potential ore reserve and grade should be calculated to be presented to the investors. During the evaluation of resources, it is necessary to attain the prediction and assessment of the scale, shape and continuity of the ore deposits by the altered minerals, development of fissures as well as the three dimensional expression by the ore reserve calculation.

  - Creation of a standard sheet for calculating reserves
  - How to calculate ore reserves

  Creation of an ore grade distribution map→ Delineation of the boundaries of the deposit

  - To master several methods for the calculation of ore reserves
  - Conditions for scale and continuity of the ore deposits
  - Staff should be trained by instruction of experts from the mining advanced countries

  In this study, basic technology for making reserve calculations was transferred, but there must still be an intensive effort made to learn the technology.

  An economic perspective is important for a resource evaluation, and economic viability must be considered when making standards, delineating the boundaries of deposits, etc. Therefore, the decision must first be made to request the dispatch of experts from mining countries.

- Presentation of papers

  New information would be attained by a series of works reviewing the ore deposit models. It would also connect with exploration/development, attracting the interests of the foreign companies by presenting the new information as research papers. Following themes might become relevant topics to be covered by the papers in the future.

  - Geology of the areas concerned and ore deposits
  - Areas with condensations of metal and mechanism of condensation
  - Development of fissures and distribution of metal elements
  - Metallogenic environment and its conditions

  It is noted that several papers, “Mineralization of the Tasiast Gold Deposit, Mauritania”, “Mode of Platinum Occurrence in Mauritania, Northwestern Africa”, “Structural and Mineralogical Evolution of the Sfariat Banded Iron Formation Area, Northern Mauritania” and “Model of Mineralization in Mauritanides, Western Mauritania”, will be presented in 2006 July in the annual meeting of the Japan Mining Industry Association (JMIA) (Appendix I, 9.1-9.3 in the Interim Report). Papers presentation by OMRG will be

controversial and the surveys accuracy will be improved by increasing investigation view points.

- To make a model for each area.

  It is necessary to make models for the areas which are not modeled by the supplementary field study. These models should be based on the data gained from this study and the future survey. In particular, it might be a large-scale task at the second stage to make models for rare metal resources.

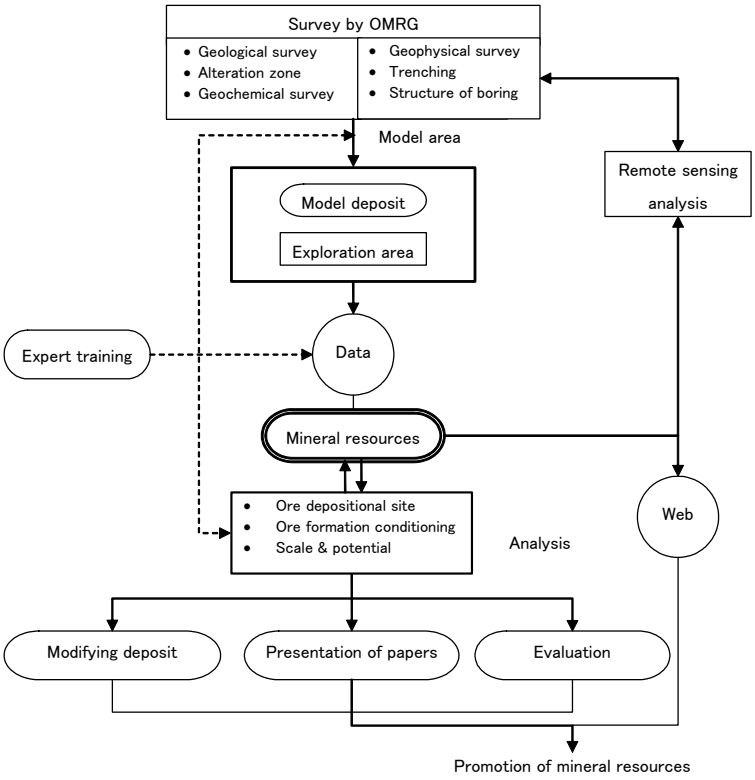


Fig.6.8.1 Survey in Model Areas and Promotion of Expansion

- To verify and utilize the models.

  It might be possible to verify the models in the reviewing process. If a model has led to exploration activities by some foreign companies, it will be adjusted and be utilized in other areas.

- Remote sensing

  The Fe-condensed areas and altered zones could be estimated by remote sensing analysis using ASTER images. If the comparison analysis is done between the altered zones survey by POSAM provided through this study and the result of remote sensing analysis, precise mineral maps can be created, because the distribution of characteristic minerals could be drawn by remote sensing images. The mineral map can be a powerful tool for the selection

of the potential mineral areas. It would be effective to select the basic survey areas for OMRG and attract foreign companies.

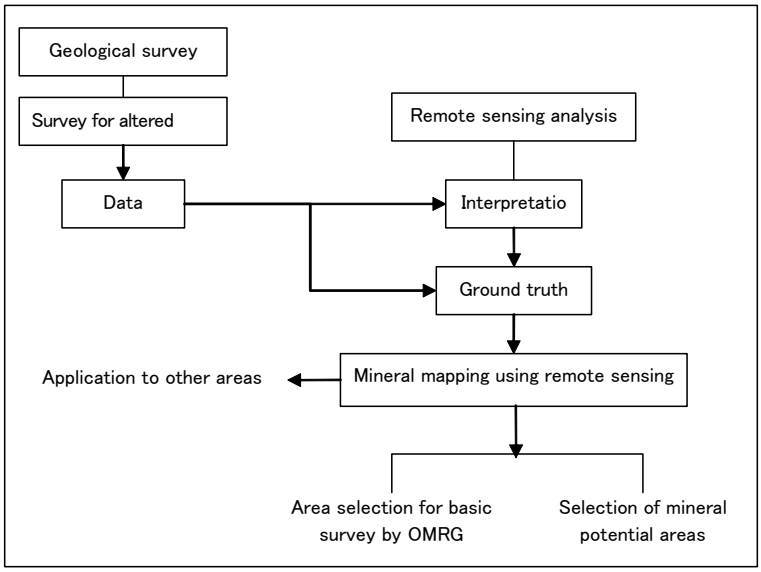


Fig.6.8.2 Mineral Mapping by remote sensing

MMI and SIGM are currently developing the national-wide topographical maps, geological maps, LANDSAT data. This indicates the role remote sensing will look forward to construction of the national-wide standardized database. On the other hand, OMRG has just begun the digitalization such as the remote sensing and GIS. Most of officials in OMRG are geological engineers. Utilization of the remote sensing skill and GIS in OMRG should be specialized in detailed researches and studies related to mineral resources, so the computer skill is indispensable.

- One PC per one man (within 5 years)

  The PC skill of OMRG engineers is currently under development mainly in use of Word, Excel, PDF and power-point by 3 to 4 computers. It is necessary for all main engineers to have their own PCs for engagement in digitalizing and analyzing the geological data through remote sensing, GIS and web site.

- LAN in OMRG (within 5 years)

  It is necessary to construct LAN for daily use of the mails and internet by connection of each PC and PD. The smooth use of the network and communization of IT resources demands the maintenance system managed by a trained specialist or the maintenance contract with the computer company. See 6.10.9(1)

-Training of engineers for remote sensing and GIS (within 5 years)

  It is necessary to select and train 2-3 engineers who engage in remote sensing for technical improvement of remote sensing and GIS. Training should be carried out by 1) the overseas

training (in ITC etc.) or 2) the expert instruction in OMRG.

- Data accumulation by remote sensing and GIS (5 to more than 10 years)

  The remote sensing and GIS data improved by 1) the studies of analysis methods, 2) the comparison with the traditional geological surveys, 3) the trial analyses and 4) accumulating the evaluation data of the analyses, and also the web site and papers presentation.

- Field spectrometry

  For remote sensing image analysis, it might be necessary to find specific phenomena and condensed zones of minerals in Mauritania as the basic document for the field survey. Field spectrometry will be done by remote sensing mineral mapping and surveys in the above mentioned model areas. Moreover, the measurement data will be extremely useful for future remote sensing image processing, so they must be made into a database.

- How to add data for the promising areas by using GIS.
- To increase data amount acquired by remote sensing.
- To display the model areas in three dimensions (3D).

  3D express deepens recognition of the geology and ore deposits, and enables concretization of the geological targets. Above-mentioned structural boring is vital for 3D express. A 3D model of geological deposits can be constructed using integrated analyses of ground elevation grid data (DEM), geological structure determined from structural boring, relative resistance obtained from physical surveys, density distribution, and so on. By outputting structural data using ArcScene (an extension software of the GIS software ArcMap) and VRML format which is the world standard for 3D expression, the 3D model could visually depict structural data using free software like Cortona. Such a model could be used for training OMRG employees, publicly disclosing information through IPO presentations or web sites, or similar purposes.

- To procure exploration machines and equipment for OMRG.

  Even if OMRG is a national organization for geological survey, it is troubled by a lack of machines and equipment vitally needed for its work. Therefore, it is necessary to procure the machines and equipment for the survey in order to perform its function. Financial support should be obtained from the national budget, international organizations and donor countries. The surveys conducted by OMRG could have a significant influence on the induction of foreign countries. See 6.10.9 (2)

  - Survey machines and equipment

    X ray diffraction analyzer, physical exploration (IP, electromagnetic, gravity, magnetic etc.), analyzer, and boring machine

- Vehicles

  Vehicles for survey and transportation

As mentioned above, the promotion of exploration requires that OMRG undergo systemic reformation in order for it to fulfill its role as a survey institute. There is a serious shortage of engineers in various aspects of the survey. Although technical transfer is implemented, continuous training is needed in the future and more personnel should be reinforced in the field to be insufficient.

It is an urgent matter to increase and train staff for OMRG in order to promote the exploration.

Table 6.8.1 Staff for OMRG and Training

Objective	Necessary fields	Means
To increase staff	● Geophysical exploration ● Remote sensing ● Exploration of base metal deposits	● In Mauritania (SNIM) ● In foreign countries (long-term) ● Dispatch from foreign countries
To train staff	● Geological survey ● Evaluation of mineral resources ● Geophysical exploration ● Chemical analysis	● Instruction by experts ● Training in foreign countries ● OJT

6.8.2 Exploration strategy

First priority metal for exploration in Mauritania is gold, next is copper and rare metals. Since exploration is currently dependent on foreign investment, it would be desirable for exploration to be promoted based on the results of OMRG surveys. Based on the result of the present geological survey, the Tasiast and Tijirit areas for gold and the Akjoujt area for copper with gold were selected as promising areas. As for rare metals, the Selibaby and Amsaga areas were considered promising these are the points of probable existence of some metals associated with chrome.

As it was described in Chapter 4 above, although exploration methods differ in each promising area and each foreign company, drilling would be desirable to confirm mineralization. Specific survey and exploration in each area combines the following methods to establish the type of mineral deposition.

- Lineament analysis of satellite imagery
- Aeromagnetic survey
- Structural analysis by detail geological survey, and alteration zone
- Geochemical survey (soil and/or rock)
- Trench
- Drilling

(1) Survey Strategy by OMRG

a. Guidelines

1) Gold deposit

- Rock enclosing BIF related to gold mineralization is greenstone composed of chlorite schist and amphibolite of the Reguibat Shield.
- BIF is dominant in magnetite.
- As alteration minerals, sericite is confirmed in the vicinity of gold deposit, but nontronitization and kaolinitization are formed by the supergene enrichment.

2) Copper deposit

- Host rocks of copper deposit consist of magnetite-bearing carbonates in green schist.
- Surface of the deposit is subjected by intensive silicification
- Copper mineralization is formed in the carbonates and near the boundaries between chlorite schist and carbonates.

3) Chromium deposit

- Deposit is a podiform type chromite deposit in the serpentine.
- Aeromagnetic survey is an effective method, because chromium ore is composed of ferro-magnesiochromite, chromite and magnetite.
- PGM exist as platinum group elements and their sulfides in the chromite ore.

b. Survey strategy

1) Gold deposit

- Greenstone belts in the Shield and in their vicinities are extracted by the regional geological survey.
- Aeromagnetic survey data by PRISM is analyzed, and positive aeromagnetic anomalies are confirmed in the greenstone belt.
- Oxidation zone is extracted by rationing of the ASTER image. The conjunctions of the major lineaments and the secondary lineaments are extracted by the lineament analysis.
- Reconnaissance survey is done around the above-described aeromagnetic anomalies, oxidation zone and conjunction of lineaments.
- When mineralization and hydrothermal alteration are recognized, geological survey and soil geochemical survey are carried out around mineralization area and alteration zone. Clay and alteration minerals are confirmed by using of POSAM. Geological map is made on the basis of route map, and geochemical map and alteration zoning are also made.

2) Copper deposit

- Greenstone belts are extracted by the regional geological survey, and positive aeromagnetic anomalies are confirmed by aeromagnetic data analysis.
- Oxidation zone is extracted by rationing of the ASTER image.
- Reconnaissance survey is done around the above-described aeromagnetic anomalies and

oxidation zone.

- When mineralization and hydrothermal alteration are recognized, geological survey and soil geochemical survey are done around mineralization area and alteration zone. Alteration zoning is made by using of POSAM.

3) Chromite deposit

- Area lying ultrabasic rock as serpentinite is selected by regional geological survey.
- Aeromagnetic data of the area lying ultrabasic rock is analyzed, and positive aeromagnetic anomalies area extracted.
- Reconnaissance survey is done around the above-described aeromagnetic anomalies, and distribution of chromium ore is clarified.

(2) Exploration strategy

It is desirable that exploration by foreign company is based on the above-described survey strategy of OMRG and they link with each other systematically.

a. Exploration course

- First priority metal for exploration is the Tasiast and Tijirit areas for gold.
- Next target is copper with gold in the Akjoujt area.
- Moreover, at the third stage, the Selibaby and Amsaga areas are selected where the chromite deposit exist with platinum group minerals.

b. Exploration strategy

Draft exploration strategy and exploration schedule are shown in Table 6.8.2 and Fig. 6.8.3. Exploration method and amount are presented in Table 6.8.2. When detailed geological survey, geochemical survey, trench and drilling survey are carried out, it is desirable that the amount of exploration at the next stage is decided taking account of the results of their surveys

Table 6.8.2 Draft exploration strategy

	Tasiast (Au)	Tijirit (Au)	Akjoujt (Cu, Au)	Selibaby (Cr, PGE)	Amsaga (Cr, PGE)
Lineament	—	40km x 50 km, 4 sectors	—	—	—
Aeromagnetic survey	50km x 150km	30km x 40km	60km x 40km	30km x 40km	40km x 30km
Detailed geological survey	3km x 3km, 6 sectors	3km x 3km 5 sectors	1km x 1km, 6 sectors	1km x 1km, 10 sector	1km x 1km, 10 sector
Geochemical survey	3km x 3km, 6 sectors	3km x 3km, 3 sectors	1km x 1km, 6 sectors	1km x 1km, 10 sector	1km x 1km, 10 sector
Trench	300m x 5 lines 3 sectors	300m x 5 lines, 2 sectors	—	100m x 5 lines, 5 sectors	100m x 10 lines, 5 sectors
Drilling	Annual 200m x 10 holes, 5 years	Annual 150m x 10 holes, 5 years	Annual 150m x 20 holes, 5 years	Annual 50m x 20 holes, 5 years	Annual 50m x 40 holes, 5 years

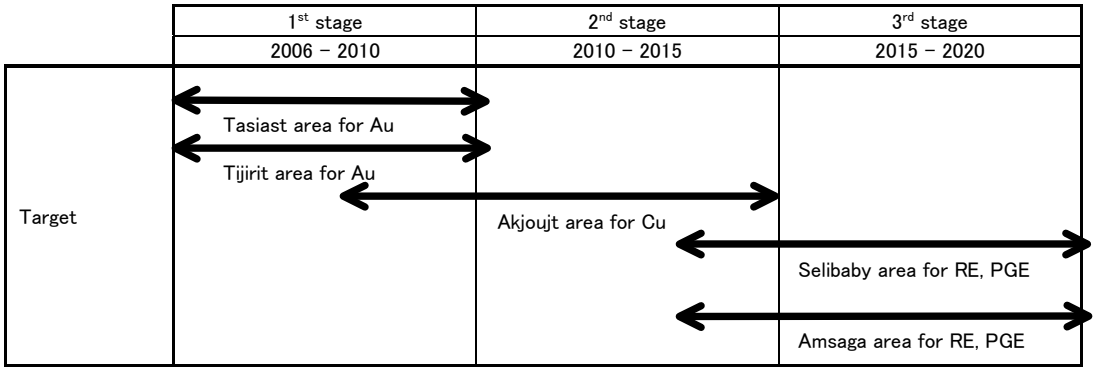


Fig. 6.8.3 Draft of exploration schedule in the promising area

6.9 Action Programs

This development strategic plan consists of three stages (fifteen years), as follows;

Exploration/development of gold

↓

Exploration/development of base metals

↓

Exploration/development of rare metals

This is the range of steps necessary for mining development and promotion, taking into consideration the current status of Mauritania. If action programs including systems are not carried out according to relevant policies at each stage, the effects of contribution to mining growth, economy and poverty reduction will not be gained and the reforming the current situation would become much more difficult. Realization of the action programs requires a lot of funds and support from the international organizations and donor countries. However, promotion of exploration/development will not be achieved, if the Mauritanian government does not increase rate of the national budget allocated to mining sectors and does not implement the action programs by its own funds.

- To suggest the action programs to be carried out in the first and second stages in this development strategic plan.
- To put the focus on the exploration promoting at the first stage and promotion of development at the second stage of the action programs.
- The action programs should be specific and clarify the possibility of realization, projected effectiveness, source of funds, implementing body and evaluation method.
- It is necessary to establish a committee (tentative name: the development strategic committee) in the mining organization of the government in order to suggest, budget, implement, manage and evaluate the action programs.

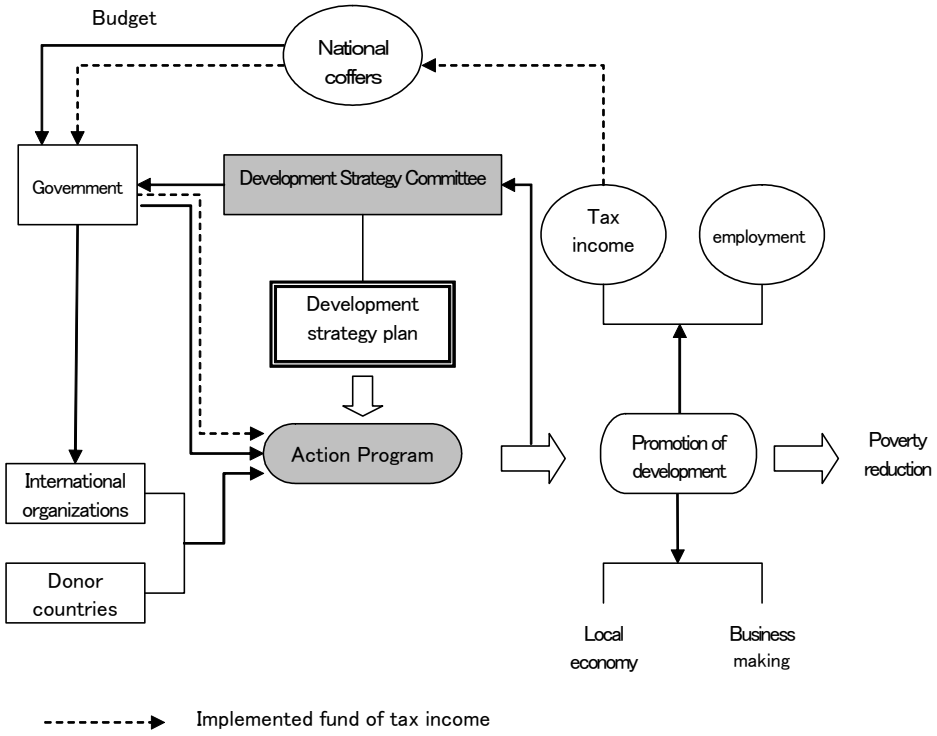


Fig.6.9.1 Location of Action programs

6.9.1 Action Programs at First Stage

The action programs at the 1st Stage are to promote exploration preferentially by introduction of foreign investment. It would be carried out by the supporting system for infrastructure, construction plan of infrastructure, incentives for foreign companies, joint venture extensive area exploration system, etc.

Table 6.9.1 Action Programs at 1st Stage

Programs		Contents
Expert invitation system		● Resources evaluation, physical exploration, remote sensing technology ● Investment promotion, resources economics
Studying abroad system		● "Training system for mining related technology" by development of the current studying abroad system in the Ministry of Education (one year training for exploration, mining, beneficiation, data processing and other technologies)
Investment seminars		● Opening the investment seminars in AMA (Mining Association in London) etc.
OMRG's surveys		● Promotion of the surveys in Tijirit and Inchiri. ● Formulation of the extensive survey system
Extensive survey system		● Quantitative and successive surveys in extensive areas by OMRG
Seasonal magazines		● 1st and 2nd volumes are published in this study. ● Volumes after 3rd are published by OMRG (before establishment of the IPO).
Additional supplement by ASTER images		● Preparing ASTER images for survey areas
Development of the archives		● Storing OMRG data and reports into the database
Accumulation of GIS data		● Storing continuously geological data, etc.
Expansion of the website information		● Renovating the OMRG website content and linking with MMI
System Reform in OMRG	One PC per one man	● IT innovation of OMRG
	Construction of LAN system	● Sharing information and improving deskwork efficiency
	Preparation of survey equipment	● Preparing geophysical equipment and boring machines, etc.
Training of mining technology		● Topography, boring, geology (mapping and digital drawing), geophysical exploration
English language education		● Instruction of basic and mining English
Water resources development in the promising mineral areas		● Promotion of maps for hydrology and ground water potential ● Utilization plan of Water resources in mining areas
Mining environment management		● Baseline survey, master planning of environment management ● Establishing legal framework for environment ● Preparation of mining environmental information
Infrastructure planning		● Formulating the outline of infrastructure plan from the viewpoint of mining promotion

It should be noted that a summary of the action program has already been given. Details about the contents are provided in 6. 10 Main Promotion Programs. In addition, the following Fig. 6.9.2 shows an action schedule for the 1st Stage, especially for information development and systemic reformation related to OMRG.

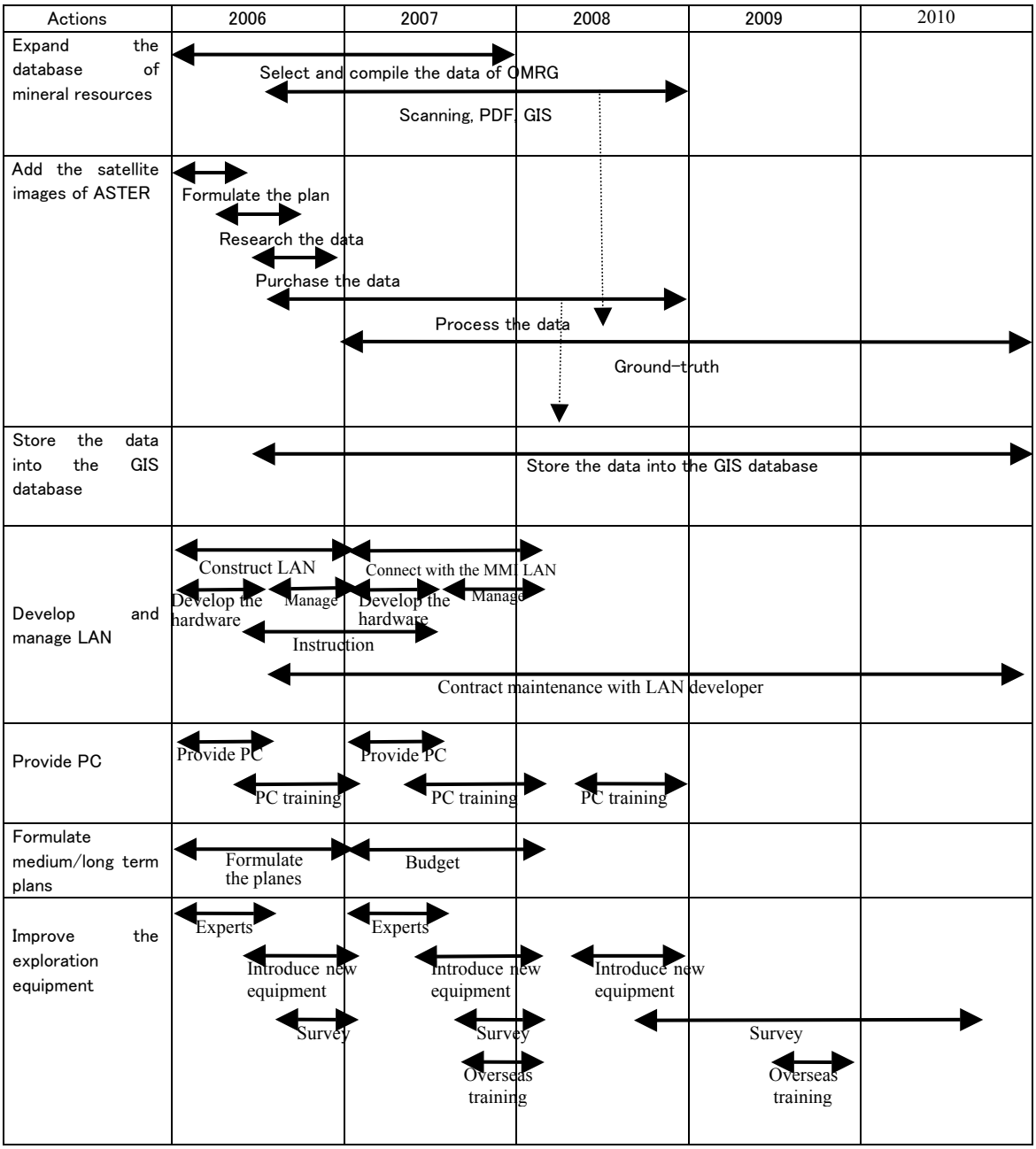


Fig.6.9.2 Action Schedule for Information Innovation and System Reform of OMRG at the 1st Stage

6.9.2 Action Programs at Second Stage

The action program for the 2nd Stage focuses on development promotion and is based on the mining policy that was drawn up in the 1st Stage. However, the 2nd Stage requires large outlays of money, as well as knowledge and technical expertise. Fashioning the program into something workable at the planning stage requires instruction and guidance from experts. Some programs (such

as the creation of 1:100,000 geological maps) may be difficult to materialize if collaborating countries and/or international organizations cannot be found.

Table 6.9.2 Action Programs at Second Stage

Program	Potential supporters	Implementation organization	Issues to realize
To make geological map of 1/100,000 scale	International organizations	OMRG	• Source of funds
Government guarantee system for the development	International organizations	MMI	
Joint-venture extensive areas exploration system		OMRG	• To handle the attained information • OMRG's ability and contribution
Preparation of the resources evaluation cadastre	International organization	OMRG	• To prepare the evaluation data. • Evaluation method
Privatization (SNIM)		MMI	• To evaluate the effect of privatization
Rental system for exploration	International organizations	MMI	• Management method • Rental condition
To establish a Mining Association	Funds of donor countries	Chamber of commerce & industry, DMG	• To coordinate • To receive instruction from advance mining countries
To establish a mining committee		MMI	• Members • Function
To establish a Monitoring Center	Donor countries and international organizations	OMRG	• To select donor countries
To establish an Instruction Center for Mining Technologies	Donor countries and international organizations	MMI	• To transfer technologies
Supporting system for the development of domestic companies.	Donor countries and international organizations	MMI	• Content of support • To study the possibility of two-step loan
Institutional reform in OMRG	International organization	OMRG	• Reorganization • Privatization of repair sector
Dedicated wharves for mineral resources	International organization	MMI, MET	• Location and scale • Funds source for construction

6.10 Main Promotion Programs

6.10.1 Promotion of Exploration

(1) Promotion of Gold Surveys by OMRG

1) Purposes:

- To promote gold surveys and the accumulation of relevant data by OMRG with the goal of attracting gold exploration.
- To develop survey technology and system to enable OMRG to conduct independent surveys.

2) Current situation:

- Necessary survey elements are lacking equipment, machines and engineers.
- Various technologies have been transferred by this JICA study, but OMRG's technical level is still not adequate.
- IT technologies associated with compiling and storing survey data and using the database, have been transferred by the JICA team.
- Some international cooperation surveys have been implemented by EU Sismin, Spain, etc.; however OMRG budget is not sufficient for it to implement independent surveys.

3) Overview of survey promotion

a. Period: 5 years

b. Survey promotion items:

- Preparation of route maps (about 1/1,000) and geological maps (1/100,000).
- Preparation of distribution maps for altered mineralized zones (using POSAM).
- Geophysical exploration
- Geochemical exploration
- Analyzing and observing Au minerals.
- Compiling and analyzing data and storing it into the database.
- ASTER image analyses

c. Target areas for surveys (see Appendix I, 1.10 Request Letter of the World Bank)

- 2 regions (Tasiast and Tijirit) with area of 50 km x 100 km and 1 region (Akjoujt) with area of 100 km x 100 km
- 2 areas /year x 5 years= 10 areas (estimated time required: 2 months/area)
- 10km x 10km/area (total survey route length: 50km/area)

d. Costs

- Total cost for site survey: US$5,000/area x 2 areas/year = US$10,000/year (including travel allowances)
- Ordinary budget (state contribution) or financial support from donors countries
- Including costs for indoor analyses such as laboratory analyses

It is noted that each cost does not include expenditure for trenching and boring. However, boring is indispensable for full scale survey as a tool. Full scale surveys for 3 regions require about US$ 2.5 million for 3 to 5 years (Appendix I, 1.10).

4) Issues

- Machines for surveys

  Currently OMRG lacks geophysical equipment, transport vehicles like motor cruiser, analyzers, etc. Therefore, international assistance from donor countries and international agencies is indispensable.

- Training personnel

  The JICA team attempted to transfer technologies related to geological survey methods, geological mapping, analyzing altered mineralized zones, satellite image analysis, storing data into the database, etc. However, technical level is not enough to conduct surveys independently. More technical transfers should be made by international agencies and donor countries. Also, as there are currently not many engineers in Mauritania, graduates from the geological faculty of the Nouakchott University should have more opportunities to have specialized training for gold surveys.

- Budgeting the surveys

  US$ 20,000 is needed each year to implement these surveys, including expenditure for laboratory, compile and analyzing. It is vital to budget these gold surveys as well as OMRG.

(2) Survey System in the Extensive Areas

1) Purposes;

- To systematize wide area surveys that will expressly define roles and functions and enable surveys to be more effective.
- For OMRG to conduct organic surveys and link them with the promotion of exploration.

2) Current state;

- Although OMRG is currently conducting surveys of both metals and non-metals, it is suffering from a shortage of manpower, money and equipment; thus, the current survey system is not adequate.
- Although surveys, exploration, etc., have been conducted with assistance from the EU and elsewhere, OMRG is dependent on outside sources for planning, budgeting, and so on.
- Survey data is only “spotty”. Since it is not being acquired in an organic and systematic manner, it is not being linked to exploration promotion and the introduction of foreign capital.
- OMRG has drawn up a 10-year plan, but there has been no concrete development of this plan, and the present system for materialization is inadequate.

3) Overview of the system;

a. Roles;

- To conduct surveys that will allow OMRG to proceed from the survey stage to the exploration stage
- To acquire and process data that will enable the survey to proceed to the next stage
- To provide these data to third parties that will be undertaking exploration.

b. Survey targets;

- Metals have been targeted according to the three stages in the Strategic Development Plan. In other words, gold is targeted in the 1st Stage, copper in the 2nd Stage, and rare metals in the 3rd Stage.
- Potential areas selected in this Strategic Development Plan have priority for the survey targets.

c. Contents of the survey;

Table 6.10.1 Survey Content

Item		Reconnaissance	Regional survey
Target		Unexplored areas	Explored areas
Method	Field	・Geological surveys (root map) ・Geochemical survey (Spot sampling) ・Rock and ore survey (sampling)	・Geological survey (1:10,000 or 1:50,000) ・Survey area : 50km by 50km per survey area ・Geochemical survey ・Outcrop survey (including sampling) ・Geophysical survey (preliminary survey) ・Structural boring
	Lab	・Remote sensing analysis ・Ground truth ・ Analysis of geological and geochemical data	・Remote sensing analysis (quantitative) ・Ground truth verification ・Geological structure analysis ・Geological and geochemical analysis
Tangible results		・Geological root maps ・Selection of promising areas ・Maps of outcrops	・Geological maps ・Geological maps of potential deposits areas ・Maps of outcrops ・Anomaly map ・Geological deposit map ・Ore deposit models ・Analysis of mineralization
Period		6 months	2 years per area

d. Costs;

- Costs are in Mauritanian national budget (however, some assistance is required from international organizations and donor countries)
- Reconnaissance US$20,000/area, Wide area survey US$150,000/area

e. Mining concession;

- Reconnaissance is carried out for selecting areas for wide area survey and so does not need application of mining concession.
- Special mining concession (survey rights) is needed for wide area survey during the survey

period. The special mining concession can be maintained until exploration rights are obtained by private sector.

- If private sector has a mining concession in the area for wide area surveys, overlapping areas become the targets for the JV Wide Area Survey System.

f. Provision of tangible results (including data);

- Some tangible results are provided and released on the Internet.
- Detailed data are provided to the party(s) acquiring exploration rights based on nondisclosure agreement.

g. Obligations of parties acquiring exploration rights;

- Data provided by OMRG on areas surveyed by their Wide Area Survey System must be returned to OMRG after the exploration period has expired.

h. Schedule: Preparations and Commencement in 2006

4) Issues;

- Inclusion in national budget;

  This must be included in the national budget as a wide area survey system. Since government finances are in short supply, situation is harsh. However, government authorities must be made aware of the importance of this system in promoting exploration. About US$100,000 must be budgeted for this per year.

- Acquisition of technology;

  In order for OMRG to implement this system, it must secure exploration technologies and survey capabilities. It is essential, for the time being at least, to petition donor countries and international organizations for specialists who can provide instruction.

- Converting tangible results and data into English;

  Conversion into English is required to attract prospectors. This must be linked with the English-language instruction system.

- Lack of machinery and equipment;

  OMRG has shortages of machinery and equipment, so these materials must be brought in from elsewhere to implement this system. Although it is presently difficult to introduce these materials, efforts are being made to petition donor countries and international organizations for them while commencing work that is feasible under the current conditions. Improvements and contents will be added in stages. See 6.10.9 (2) for equipment costs.

- Handling information and data;

  Information and data are materials that can be used to promote exploration and are provided to companies that may be able to invest in exploration. The contents of confidentiality contracts are being considered to devise a concrete way to handle data and information.

(3) Construction of Ore Deposit Models

1) Purposes

- To activate exploration activities promoted by continuous foreign investment.
- To upgrade the knowledge and skills of OMRG engineers.

2) Current situation

- The JICA team is constructing models for several ore deposits surveyed by supplementary field surveys.
- The JICA team has transferred technologies such as constructing ore deposit models and relevant knowledge to OMRG engineers through seminars and workshops.
- It is still difficult for OMRG engineers to construct ore deposit models by themselves.

3) Overview of constructing ore deposit models

a. Period: 5 years : It will be implemented to "promote OMRG surveys of gold and copper"

b. Component items

- Determination of mineralized zones.
- Identification of mineralization characteristics (ages, alteration, strata, structure, minerals).
- Geological section
- Chemical analyses and mineral research
- Sketching geological phenomena of the outcrops and compiling rock sample sketches.
- Verification of the ore deposit model prepared by the JICA team.

c. Target areas for surveys:

- 3 areas (Tasiast, Tijirit and Akjoujt), with 7 other areas for used comparison
- One to 1.5 years per area

d. Costs

- Labor costs : charged to national coffers
- Cost for chemical analyses and mineral research: US$10,000/year x 3 areas = US$30,000 (national coffers or support from donor countries, etc.)

4) Issues

- Engineers

  Construction of ore deposit models requires compiling survey data, obtaining new knowledge and collecting information on geology and ore deposits. However, the knowledge level of OMRG engineers is not sufficient. Currently, JICA training for this survey has been implemented in Japan and there has also been training by the Morocco Geological Survey. OMRG engineers must continue participating in overseas training programs and inviting experts from donor countries, etc.

- Budgeting and relevant equipment

It is possible to for MMI to budget monies for construction of ore deposit models if MMI agrees to it. Except for a chemical analyzer, all equipment such as POSAM and microscopes necessary for constructing models was provided by this study. What is first needed is to obtain and analyze data with existing equipment.

- Exchange of knowledge with mining countries or neighboring countries;
  OMRG could acquire new knowledge on ore deposits in surveyed areas by networking with foreign geological surveys, etc., to exchange information which OMRG could utilize for constructing models. Scholars from AIST (Japanese Institute of Advanced Industrial Science and Technology) have joined the JICA study team and OMRG has started exchanges with JOGMEC (Japan Oil, Gas and Metals National Corporation). It will be useful for the development of ore deposits in Mauritania to keep these exchanges and expand the network.
- Utilization of "Mauritanian Mining";
  The JICA study plans to issue vols.1 and 2 of the seasonal journal "Mauritanian Mining". OMRG will continue issuing the journal with the national budget. From vol.3, construction of models should be discussed in the journal to facilitate exchanges of information with foreign countries and train engineers as mentioned above.

(4) Preparation of the Mineral Resources Evaluation Cadastre

1) Purposes;

- To gain a thorough understanding of the amount of each metal resource existing in Mauritania and to tie this information to investment promotion.
- To use the Mineral Resources Evaluation Register to index OMRG's surveys and provide materials for target areas, and to provide a foundation for increasing the accuracy of quantitative resources information, which is a national asset.

2) Current state;

- With few exceptions, little is known about metallic minerals in Mauritania, thus the information is inadequate for promoting exploration.
- Methods for quantifying and evaluating mineral resources and reserves are not well understood by mining-related organizations such as OMRG.
- Because there is no register that lists important quantitative data that can be used to evaluate resources, there is little progress being made in the systematic use of resources as national treasure.

3) Contents;

a. Project period: in the 1st Stage

b. Executor: OMRG; however, cooperation is required from DMG、SIGM, and the Mining

Cadastre Unit.

c. Methodology;

- Preparation of standards for quantitatively evaluating mineral resources so a register can be formulated.

  For example, 3 categories of mineral reserve (Proven, Probable, and Potential) are set up and their total is defined as quantity of mineral resources.
- Establish a calculation rule based on international methodologies
- Use this rule to calculate proven and probable reserves for ore deposits and for areas that have already been surveyed. Calculation result is indicated as ore reserves, ore grades and metal quantities.
- Potential reserves are calculated by taking mineralization indicators, geological conditions, etc., into account.

d. Costs;

Costs are included in the OMRG's budget. However, in most cases the budget only covers salaries and wages.

e. Technical instruction;

Experts from donor countries are needed to provide training in creating standards and calculating reserves. (Submission of requests to donor countries is necessary.)

4) Issues;

- Creating standards for evaluating mineral resources;

  As the amount of mineral resources might be largely fluctuated according to methodology of evaluation standard, it is necessary to establish clear and concrete standards for quantification methods. Standards and methodologies must be established for evaluating known deposits that OMRG conducted surveys. Because there are appropriate international standards and methodologies for quantifying each type of deposit, it is necessary to adopt these international standards for each type of deposit. Naturally, ore deposits that private companies have surveyed and quantified should be listed in such a register. However, OMRG itself must have a firm grasp of standard quantification methods.
- Calculating the quantity of potential ore deposits;

  While there are great expectations about the potential mineral reserves throughout Mauritania, quantification standards must be established and methods clarified to calculate mineral reserves in area and district units. These reserves become the target of surveys and exploration by foreign companies. Standards and methodologies must be based on international examples, United Nations standards, and so on. Improving the accuracy of potential ore reserve estimates will help to promote exploration and development.

- Utilization in policy and system proposals;

  A strategic plan for promoting exploration and development has been proposed in this study. The results of this study must be incorporated into a register system for evaluating reserves that will be used in policy and system proposals. This information will be used for establishing exploration targets at each stage, and for establishing exploration systems that will improve the accuracy of reserve estimates in target areas and districts.

- Introduction of foreign capital;

  When foreign companies undertake exploration, the amount of reasonably proven ore reserves and the amount of potential ore reserve determined from geological conditions could be important targets, as well as effective materials for making decisions about exploration. Quantitative mineral resources evaluation registers are one important means for coordinating data and information needed to attract foreign investment, so the registers must be designed with foreign investment in mind.

(5) Implementing Structural Boring

1) Purposes;

- To acquire information on underground resources and provide material for building a model of underground structure.
- To obtain basic information for resource exploration, development of water resources.

2) Current status;

- Except for some water wells and exploration areas (Zouerate、Tasiast、Akjoujt), there is almost no geological information.
- PRISM has created 1:200,000 and 1:500,000 geological maps, but they are severely lacking in underground information which could greatly improve the accuracy of the underground structure.
- There is also a lack of materials that could be useful for investigating mineralization processes and the history of geological formation in Mauritania.
- There are no materials that could be used to draw 3D geological maps for each region.

3) Overview;

a. Period of implementation: 5 years (3^{rd} Stage)
b. Target regions: The 4 geological units that comprise the geology of Mauritania (to gain an understanding of the structure of the entire country)
c. Volume and scale of drills: 500m/drill (vertical, core excavation)

10 drills/geological unit x 4 units = 40 drills, so 40 x 500m = 20,000m

20,000m÷5 years = 4,000m/year (8 years)

d. Executive organization: OMRG Group 2

e. Contents of the surveys

- Geology and llithology
- Chemical analyses (trace amounts, whole rock analyses)
- Microscopic observations
- Existence of groundwater

f. Cost: Boring work = US$3 million for the 5 years; boring equipment = US$1 million/machine
Laboratory work= US$200,000 for the 5 years (including the cost of building a core storage facility)

4) Issues;

- Formulating a boring plan

  This plan will be formulated is in the latter half of the 2nd Stage. It will be based on a comprehensive analysis of the data (remote sensing, geological structure, geological history, mineralization processes, water resource potential) stored in the database at that time. The location selection of the 40 drill holes must be tied to an approach that is linked to the solution of issues at each geological unit. At the unit planning stage, it would be preferable for the ASTER images to be complete and a system put in place that can analyze them.

- Securing labor

  The drilling of 4,000m per year will require that workers be divided into two groups. Under its present worker system, it would be impossible to divided OMRG workers into two full-time groups to work for 5 years. Therefore, it will be necessary to consider how the workers will be secured and hired, and then to train them. Furthermore, it will also be necessary to store the data in the database and develop an analytical system, among other things.

- Costs

  Under the present government budget, it would be difficult to implement this program. However, if new mines can increase during the 1st and 2nd Stages, tax revenues increase, and oil production fosters economic growth, then the national treasury would be able to handle the cost. The government should petition international organizations to provide the remaining technologies and funding that would be required, based on the assumption that the national treasury could pay for it in the near future.

6.10.2 Introduction of Foreign Investment (Promotion of Investment)

(1) Publication of Seasonal Journals

1) Purpose;

Provide an introduction to resources and mining activities in Mauritania (to attract investment)

2) Current status;

- Plans call for the publication of the following materials to provide an introduction to the state of the mining industry in Mauritania.
- The world knows almost nothing about the mining industry of Mauritania, including the investment climate, investment potential, mining information, and trends in exploration and development
- Information exchanges with foreign companies, foreign mining organizations, etc., have only just begun.

Table 6.10.2 The Content of Seasonal Magazines Vol.1 and2

Vol. 1	Vol. 2
1. Greetings of Minister and Mining Policy	1. Gold Ore Deposits in Mauritania
2. Activities of OMRG	2. Development in Tasiast
3. Functions and Role of DMG	3. Utilization of Information (GIS data)
4. Mineral Resources in Mauritania	4. Introduction of the Website
5. Development Strategy	5. Environment in Mauritania
6. Results and Plan of PRISM	6. Investment Promotion Office
7. State of Exploration/Development in Mauritania	7. State and Plan of Infrastructure

3) Overview;

a. Name of the magazine: Mauritanian Mining

b. Publication: 3 times per year (once per 4 months)

c. Publisher: DMG, MMI / OMRG

After establishment of the Investment Promotion, it will be its official periodic subscription.

d. Circulation: 1,000 copies

e. Ditribution entry:

Mining/exploration companies, mining associations, geological surveys, seminars (PDAC, INDABA in South Africa) in the world

f. Size of the magazine: A4

g. Volume: 12 pages

h. Languages: English/French

i. Content:

- Introduction to mineral resources in Mauritania
- Mining activities in Mauritania (exploration, development, production)
- Activities of the government agencies

- Information on mining concession, legal amendment, etc.
- News and topics related to mining

4) Issues;

- Publication of Periodicals (Journal);

  Up to now, OMRG has been almost completely uninvolved with providing information. The publication of a seasonal magazine would help to attract investment from foreign companies. OMRG/DMG will have to select a publisher and work to keep the magazine going.

- Budget;

  OMRG will be able to publish the magazine with general funds. Because the Ministry of Economic Development is cooperating with the project, they will be able to handle this on their own, which will improve their abilities.

- English translation;

  One of the current problems is writing articles in English. However, the magazine is small, so some translation work can be contracted out, and the magazine will have articles in both English and French.

- Contents of the magazine;

  Foreign companies need to have information not only about trends in the mining industry, but also the latest economic, financial, and legal information related to investment. The same holds true for activities of relevant ministries and agencies. It is extremely important to provide the latest information on a variety of themes. For the time being, we suggest the following themes for Vol3:

Table 6.10.3 Content Draft of Vol. 3

Vol. 3
1. Current State of Iron Mining
2. Introduction to SNIM
3. Nonferrous Metal Resources
4. Point of the Mining Law and Procedures for Mining Concession
5. Round Table Meeting with Foreign Companies
6. Ore Deposits Models
7. National Parks in Mauritania ----- Banc d' Arguin

(2) Investment Promotion Office

1) Purpose;

- Develop effective means of attracting foreign investment to promote exploration and development.
- Nurture domestic companies and materialize investment promotion

2) Current status;

- PRISM has been developing an investment climate.
- Information can be improved by this study to attract foreign investment.
- Foreign companies desiring to invest in Mauritania must visit mining-related organizations such as OMRG and DMG; otherwise, they cannot obtain the information they require. In addition, information is still being arranged.
- The establishment of the Investment Promotion Office is included in PRISM, but nothing specific has been done to bring this to fruition.
- In this study, the Investment Promotion Office (IPO)/Agent (IPA) was designed with the assistance of PRISM (see Appendix I, 1.1)

3) Contents

a. Staff;

- A person who has a detailed knowledge of mining industry and speaks English well.
- A mining expert
- Two assistants (at least one assistant can speak English.)

b. Training method for the staff;

- Overseas training: England for 2 months (in the magazine publishers related to mines, mining consultants, government organizations, LME etc.), mining country for 1 month (in the resources information center, mining association, private companies etc.)
- A mining expert: the north and south America for 3 months (visiting the gold and copper mines, exploration companies in Canada etc.)
- Assistants: the English language and business skill training for 3months

c. A schedule for establishment of the Investment Promotion Office;

- 2005 June: design of the Unit, June-Dec.: preparation for the Unit, Oct.-Dec. staff training
- 2007 Jan. test start, Aug. official start

d. Contents of the test period and the training;

- Contents of the test period;
  - ♦ Collect and compile the mining information.(mainly by the internet and books)
  - ♦ Compile the information on the current Mauritanian mining activities.
  - ♦ Publish “Mauritanian Mining” magazine.
  - ♦ Communication with the mining organizations (MMI, OMRG) and companies
  - ♦ Held a Investment Seminar.
  - ♦ Build the website.
- Contents of the training;
  - ♦ Instruction by invited mining experts (3 months)

* Instruction according to contents of the test period.

* Lectures on the world mining circumstances, marketing, metal price trend etc.

- ♦ English language training (continuation)
- ♦ Training by OJT.

e. A schedule after opening the Unit;

- The 1st phase: 2006 Jan. to 2008 July (about 2 years);
  - ♦ 4 men-organization at the starting time
  - ♦ Place the Unit work in orbit.
  - ♦ Establish the organization and function of the Unit.
- The 2nd phase: 2008 Aug. to 2010 July (about 2 years);
  - ♦ Detailed organization (Department of Investment Promotion in Foreign Currency, Information Analysis and Investment Promotion of Domestic Investors)
  - ♦ Analyze the work and recommend the policy.
  - ♦ Expand the Unit (10 men-organization).
- The 3rd phase: after 2010 Aug;
  - ♦ Integrate the Investment Promotion Office into MEAD.
  - ♦ Investment Promotion Agency
  - ♦ Promote the domestic investment.

f. Contents of the 1st and 2nd phase;

- Compile the mining information and distribute it to related organizations.
- Publish "Mauritanian Mining" magazines continuously.
- Held the investment seminars periodically.
- Collect and compile the information from the mining organizations.
- Renovate the website.
- Analyze the information on the metal price, demand and supply, exploration and development, etc.
- Collect and compile the information on environmental protection and distribute it to the related organization.
- Held the seminars to give the mining information to the domestic investors.
- Held roundtable meeting for the foreign investors and government.
- Human resource cultivation
- Participate the international investment seminars and invite the investment from the foreign companies.
- Recommend the mining policy and formulation of the institutions.

4) Tasks;

- Reinforcement by PRISM

  So far, PRISM has established the Mining Cadastre Office, SIGM, etc., but the costs of maintaining these established facilities (including payroll) are increasing. PRISM is also considering establishing the Investment Promotion Office, but this should include consideration of MMI managing this facility by itself once it is established.

- Nurturing staff

  Staff, who forms the core of the Investment Promotion Office, should have an overall knowledge about the mining industry and English proficiency. However, the number of staff is limited, and some staff will have to be trained by foreign experts. Furthermore, it will take time to train staff. If a program is not created that will enable the syatematic training of staff, then the Investment Promotion Office might not be able to fulfill its functions.

- Relation with the Investment Bureau of the Ministry of Economic Development

  The promotion of investment in Mauritania is a national priority that is closely connected with poverty reduction. Once the Investment Promotion Office (IPO) gets well under way in the mining sector, its functions must be expanded to cover all sectors in the future. It is necessary to discuss the differences between the IPO concept described in this report and the content of IPO/IPA in Appendix I, 1.1 to formulate a practical plan suitable for Mauritania.

(3) Investment Seminars

1) Purposes;

- To explain to prospective investors about the attractive mineral potential and necessity of improving mining capability to help promote mineral exploration and exploitation in Mauritania.
- To serve as a vehicle for expanding communication with English-speaking countries.

2) Current situation;

- No investment seminar has yet been held.
- Documents for the investment seminar have not been systematically prepared yet.
- It has become possible to provide information for investors as a result of PRISM and this development strategic study.

3) Overview of investment seminar;

a. Period: 5 years (in the First Stage)

b. Organizer: Investment Promotion Office (-cum- secretariat), MMI (DMG and OMRG), MEAD and MFA

c. Number of seminars per host city;

Two times in London (AMA seminar might be appropriate.)

One time in Tokyo (Collaboration with JBIC, JETRO or UNIDO might be necessary.)

One time in Toronto

One time in Nouakchott

d. Contents;

Table 6.10.4 Content of Investment Seminars

item	In London, Tokyo and Toronto	In Nouakchott
Objectives	Junior companies, banks, trading companies, mining companies and government organizations	African mining companies from South Africa, Morocco, etc, and domestic companies
Period	One or two days	One day
Contents	(1) Presentation ・Mauritanian mineral resources and ore-deposit models ・Current mining activities ・Investment procedure (2) Individual consulting ・Up to 10 companies ・Government organization ・Mining association	(1) Presentation ・Mauritanian mineral resources and ore-deposit models ・Current successful examples ・Investment procedure (2) Individual consulting ・Instruction to domestic companies ・ Requesting support of domestic financial companies ・Up to ten African companies
Cost items	Meeting costs, arrangement costs, traveling expenses (for Mauritanian attendants)	Meeting costs

e. Cost;

- US$10,000 to 20,000 per seminar in a foreign country
  (except Mauritanian sponsors and attendants)
- International organizations and donor countries should be asked to provide support.
  PRISM and the Mauritanian Government should be joint organizers for the seminar during the time PRISM is in effect.

4) Issues;

- Investment Promotion Office;
  It is preferable that an Investment Promotion Office act as a window for coordinating the seminar. Accordingly, it is very important to establish said Investment Promotion Office at the earliest time possible to train members in effective seminar management.
- Expenses and support for seminars and their support;
  The expenses for the seminars would incur a large financial burden on the Mauritanian government. Therefore, it should be studied whether or not seminars could be held jointly by PRISM and the government. In other areas, it is necessary to find other sponsors like international organizations which can bear the costs of joint hosting.
- Human resources;
  It is important use on-the-job-training for staff so that they can learn how to manage the

seminars. It would be preferable to train personnel who are assigned to the Investment Promotion Office.

- Preparation of document;

  Some books, CDs, brochures, etc. have already been prepared as a result of this development strategic study. However, it will be necessary to prepare additional materials based on the needs and goals of each seminar.

It is noted that supports from EU would be possible, but it will take one tear for preparation.

(4) System for Wide Area JV Exploration

1) Purposes;

- For OMRG to conduct a joint ventures (JVs) with foreign companies to promote exploration
- To develop the results of Wide Area Survey System by OMRG and to acquire technology from foreign companies

2) Current state;

- Although surveys are being conducted with assistance from the EU and elsewhere, there is little experience conducting a full-scale exploration survey as a joint venture (JV) with a foreign partner.
- Survey data is currently being processed. However, this data is only from surveys in which foreign companies were invited to Mauritania to help promote prospecting.
- While OMRG has a role in implementing surveys, this is not helping it to obtain sufficient technology.

3) Overview;

a. Timing to establish the system;

The 2nd Stage after the Regional Survey System for the 1st Stage is conducted.

b. Role and share of responsibilities;

- For regions where surveys are being based on the Wide Area Survey System, or where OMRG had conducted surveys with a previous system, OMRG is linking up with foreign partners to undertake exploration.
- OMRG is creating joint ventures with foreign partners and retains a certain share of exploration rights.
- OMRG provides technicians, machinery/implements and data from the Wide Area Survey System to facilitate prospecting (investment in kind)
- In principle, the share of the joint venture is 50:50.

c. The roles of foreign partners;

- To bear the burden of exploration costs and to conduct exploration

- To transfer technology to OMRG through joint prospecting operations
- To determine their share based on evaluation of OMRG investments-in-kind, and then determine the cost of their prospecting operations. In the case of cost overruns, they will make up the difference. (OMRG share decreases).

d. JV contracts and operations;

- OMRG and foreign companies sign JV contracts which clearly state the exploration period, the roles of each participant, the share of interests, and other information.
- A management committee is established to manage the joint venture.

e. Handling interests after exploration;

- OMRG rights are transferred in payment to the foreign company(s) which is (are) its partner(s).
- After the foreign company acquires OMRG rights, it can, within a designated period, establish a provisional joint venture with another party, or transfer the interests to a third party.
- If, within the designated period, the company possessing the rights does not engage in further exploration, these rights, plus the data provided by OMRG, plus the data acquired from the regional joint venture exploration system, must be returned to OMRG. However, it should be considered that the foreign company can transfer the acquired data to a third party within a limited period under acceptance of OMRG. Also, it should be discussed whether the previous right holders of exploration can get reasonable share or not when OMRG attains money for data acquired by the JV exploration system from new right holders of exploration or exploitation.

4) Issues;

- Evaluation method for determining OMRG share;

  The investment-in-kind that OMRG can contribute includes survey data, machinery and equipment, human resources, and OMRG office facilities. Because there is no standard way to evaluate this investment-in-kind economically, it is necessary to establish a reasonable standard that can be understood by the foreign companies.
- Method for evaluating technical transfer to OMRG;

  For example, in the case of a 50:50 investment ratio, the investment by the foreign partner must include the appraised value of the technical transfer to OMRG. Therefore, the investment from the foreign partner = hard currency investment – the appraised value of the technical transfer.
- Compatibility with mining laws;

  It is necessary to consider this system within the context of mining laws and ensure that it is compatible with said mining laws.

- Handling the acquired data;

  In the event that exploration does not proceed to the next step and/or does not lead to development, data should be handled in such a manner that it will not dampen the interest of subsequent foreign investors. Concrete measures to this effect must be studied for inclusion in the system.

(5) Attracting Foreign Investment in Underground Mines

1) Purpose;
   - Formulate specific measures for attract foreign investment to develop deposits in underground mines
   - Investigate ways of introducing underground mining technologies

2) Current status;
   - Currently, foreign investors are targeting open pit mines.
   - Boring is being done to determine continuous ore for shallow depth from the surface.
   - Even if the existence a deposit is confirmed in a deep underground area, Mauritania has absolutely no technology for underground mining, so it will not be a target for development.

3) Overview;

a. Period: 2nd Stage

b. Proposed plan for attracting investment
   - A method should be devised to interest foreign investors in underground mines
     - Tax incentives (infrastructure support, depreciation, amortization, etc.)
     - Support for exploration from OMRG
   - Introduction of underground mining technology
     - Joint development with other African countries such as Morocco
     - Instruction of mining technology based on the establishment of model mines
     - Invite experts from advanced mining countries to provide instruction
     - Acquire technologies/techniques by training overseas
   - Nurturing employees
     - On site training in African countries
     - Training in mining countries

c. Organizations in charge: OMRG, DMG

d. Methodology:

Experts from mining countries would be invited to share their expertise on exploration, development, and production. For this purpose, OMRG, DMG, etc., would have to formulate

attracting measures.

e. Cost;

Costs would be paid from the national budget. However, donor countries should be asked to pay the costs to invite foreign experts.

4) Tasks;

- Confirming deposits for underground mining

  Presently, little progress is being made in promoting exploration that is linked to confirming deposits for underground mining. Exploration for gold in the 1st Stage must provide ore deposits for underground mining. OMRG must acquire knowledge and skills to determine which deposits should be mined by underground technology from the exploration results by foreign companies.

- Tax incentives and preferential treatment

  Currently mining law provides preferential tax treatment for investors. Furthermore, to develop tax incentives and preferential policies that will encourage exploration and development, information will have to be obtained from sources such as mining countries and roundtable discussions with foreign investors.

- Model mine

  At the exploration stage, an underground mine is set up as an on-site model mine for practicing exploration, engineering, development work, etc. that would be effective for introducing technologies, attracting foreign investment, and nurturing human resources, and would be the best way of disseminating technology and techniques. It could also serve as a training site in Mining Technology Center described in the promotion policy. Although it would cost some money it would be preferable if the initial stage focused on drifting for exploration, with the mine itself being developed over time.

6.10.3 Human Resource Cultivation

(1) Establishing Faculty of Mining in Technical High Education Center

1) Purposes;

- To train high level engineers for the mining sector.
- To promote the mining industry by sending highly trained engineers to mining industries and government organizations.

2) Current situation;

- The vocational-technical education center was built in 1982 by the Ministry of Education, which operates the center with government funding.
- The center has trained technicians in the fields of electrical engineering, mechanics,

maintenance, construction and automobile engineering who have subsequently been sent to SNIM, government organizations and private companies as high level engineers.

- There are few engineers in the mining sector, so it is necessary to train engineers in this field to promote the growth of the mining industry.

3) Overview of mining sector training courses;

a. Training Period: 2 years per course

b. Names of courses: Mining geology, Mining, Mineral Dressing and Analyzing and Boring

c. Estimated number of graduates: Total 50 engineers (10 engineers per course) in the first stage (2006 to 2010)

d. Contents of each training course;

Table 6.10.5 Content of Curriculum in the Mining Faculty

Item	Mine Geology	Mining and Boring	Mineral Dressing and Analysis
Main subjects	・resource geology ・exploration methods exploration equipment ・geological drawing and mapping ・topography	・mining and boring methods ・mining plan and management ・mining and boring machines systems ・mine economy ・topography	・mineral dressing theory ・basic analyzing theory ・mineral dressing machines ・production management
Training materials	・survey equipment ・exploration equipment ・computers	・drilling machines ・boring machines and related machines ・survey equipment ・computers	・small mineral dressing facilities ・analyzer (atomic absorption) ・computers

e. Instructors: Engineers from SNIM, OMRG and private companies (including foreign engineers in Mauritania), and foreign engineers dispatched from donor countries or international organizations.

f. Initial cost: US$ 1-2 million, excluding annual operating costs

g. Projected date of commencement: Sometime during 2006

4) Issues;

- Procuring funding for obtaining training materials and facilities;

  Donations from donor countries, international organizations and SNIM are being considered.

- Training sites;

  Basic classroom instruction should be carried out at the center, and on-site training in the mines of SNIM.

- Instructors;

  There is shortage of instructors because of the limited number of engineers in the mining sector. It is thus necessary to obtain instructors from among SNIM's experienced engineers and foreign engineers.

- Budgeting operating expenses;

It is necessary to budget monies at Ministry of Education for instructors' remuneration, and maintenance, replacement and repair of training materials s.

- Making a step-by-step course program;
  The first course to be established should be the course in mining geology and boring to train engineers for mineral exploration. Subsequent courses in mining and mineral dressing and analyzing should be established in stages.
- Training oil engineers
  The oil sector has the same issue, so MMI must cooperate with the oil sector.

(2) English-language Instruction System

1) Purposes;

- To facilitate the accumulation of mine-related information from English-language sources
- To facilitate communication with English-speaking investors

2) Current situation;

- While English is used in the majority of mining operations around the world, there are very few people in Mauritania who can use it fluently, resulting in a lack of information.
- While English-language instruction has been mandatory for all secondary school students from 1st year in junior high school on up since 2001, the technicians currently employed in the mining sector have not received English-language instruction.
- Communication with investors is in French, meaning that an interpreter is usually required for communication with English-speaking companies. French-only communication also hinders exploration and development.
- A few employees of government mining organizations had English-language training at the American Center of the US Embassy, but it was difficult to continue because of the costs involved.

3) Overview;

a. Instruction period: 2 years (2 one-year terms), but it may be prolonged according to its result.

b. Instruction items: Basic English, technical English, English conversation, business English

c. Target students: Employees of government mining organizations (OMRG, DMG, SIGM, etc)
Domestic mining companies: 15 students/year

d. Content of instruction;

Table 6.10.6 Content of English Instruction

Period	Beginner class	Intermediate Class
1st term	Basic English	Business English, mining-related English, intermediate English
2nd term	Basic English, mining-related English	Mining-related English

e. Instructors: English-speaking Mauritanians or foreigners residing in Mauritania who are experienced in teaching English and specialists in mining fields (geology, deposits, profiling techniques, dressing, resources), are appropriate as instructors. For example, US Embassy economists are appropriate for business English.

f. Cost: US $25,000 per year (for operating)

g. Starting date: within 2006

4) Issues;

- Procuring human resources (personnel);

  It is possible to find instructors who are experienced in teaching English. However, there are few English-speaking experts in mining-related fields in Mauritania.

- Teaching materials;

  Mining-related English-language teaching materials can include mining information taken from the Internet, mining-related translations (French-English) from this survey, materials taken from the web site, and other sources. Inspection of government mining organizations will be required to select teaching materials.

- Budgeting operating expenses;

  It is necessary to either formulate a budget at MMI, or receive instructional supports from donor countries. This includes remuneration for instructors and expenses related to teaching materials.

- Utilization of national research institutes;

  National research institutes have English instruction facilities, so the use of these facilities should be considered.

(3) Experts Invitation System

1) Purpose;

To strengthen knowledge and technologies of OMRG and mining related organizations necessary for exploration and development.

2) Current situation;

- MMI intends to improve knowledge and technologies through instruction by foreign consultants and study tour to foreign countries in cooperation with PRISM.
- OMRG also intends to enhance knowledge and technologies through this study and training programs in Japan.
- Although improvement of base for knowledge and technologies began starting, it is neither systematic nor institutional. In particular, the case of OMRG is not institutional, but impromptu.

3) Content of the System;

a. Period: 5years (the 1st stage), and the system will be reviewed for continuation in the 2nd stage.

b. Fields: Geological survey and mapping, ore deposits survey and ore reserve calculation, drilling technology, geo-physic exploration, resources economics and resources development

c. Contents:

Table 6.10.7 Content of Instruction by Invited Experts

Fields	Contents
Geological survey and mapping	• Geological survey method, concept geology and petrography • Geological mapping methodology
Ore deposit survey and calculation of ore reserve	• Survey method for ore deposits, science of mineral deposit, ore deposit models, survey scheduling and planning • Calculation criteria of ore reserve and calculation method
Drilling technology	• Boring methods and technology, boring planning
Geo-physic exploration	• Exploration method and technology, analysis method • Mineral deposits exploration and geo-physic exploration
Resources economics	• Economic evaluation method of mineral resources, global mineral tendency • Mining and economy, mining and community content
Mineral resources development	• Development method, feasibility study, development design • Materials procurement, financing, business form

Lectures by experts, individual lessons and field demonstrations

d. Invitation methods and period:

- Invitation financed by national budget under the government organizations
- Assistances by donor countries and international organizations ex: JICA programs and experts dispatch system in Japan
- Invitation period: short term (2-3 months) and long term (6-12 months)
- Numbers of experts: annually 1-2 experts invited

e. Scheduling:

- To be prepared in the first half of 2006.
  - Provision of national budget
  - Determination of accepted country or organization for invitation
  - Preparing and sending invitation proposal
- To be started in 2007.

f. Budget:

- In case of national charge, US$ 30,000 to 50, 000/month is needed. (But it is different from the organization or country to which experts belong.)
- In case of the donor country or international organization, charges for hotel and car are necessary.

- It is necessary to allocate funds for purchasing or rending instruction tools and machines.

4) Issues;

- Budget for inviting experts by national charge

  It will cost US$ 50,000 to 120,000 including travel charge and labor cost to invite an expert for three months. It is difficult to allocate for it under current financial circumstances. Accordingly, it must depend on donor countries or international organization.

- Donor countries or international organizations

  It will generally take a long time to complete procedure for donor countries or international organizations. And also it does not always realize. Further, there are some restrictions for dispatching experts who can meet Mauritanian requests. Mauritanian side should formulate an expert invitation plan for mid-and-long term, and study on response action when they cannot realize it.

- Preparation of tools and machines

  OMRG could not prepare all tools for experts' instruction. When this institution realizes, it is necessary to procure tools and machines such as boring machines, geo-physic exploration equipment, etc. If funds allocated by national budget are difficult, it is necessary to request it from donor countries or international organizations.

- Used language and trainees abilities

  English is desirable, but there are differences in English ability among trainees. So it is desirable to prepare an interpreter. It is also necessary to study on selecting trainees for meeting the levels on which experts will focus in instruction.

6.10.4 Construction of Infrastructure

(1) Construction Plan for Infrastructure

1) Purposes;

- To promote exploration and exploitation by proposing a construction plan for infrastructure.
- To establish an organization which has the capability to make a comprehensive plan for building infrastructure that includes roads, railways, electricity, water supply, ports and so on.

2) Current situation;

- The EU and others have made concerted efforts to construct infrastructure.
- A comprehensive infrastructure plan for long term (5 to 10 years) has not been prepared. Each type of infrastructure is planned and constructed independently by related ministries.
- The lack of infrastructure and associated long-term plans is a disincentive for exploration and

exploitation.

- Information on infrastructure and consultation organizations is not integrated. Therefore, this situation could hinder exploration and exploitation.

3) Overview of mining faculty;

a. Period for plan draft: First stage

b. Organization to be established: Department of Comprehensive Planning of Infrastructure, to be established in the Ministry of Equipment and Transportation.

c. Roles;

- To act as a central window for infrastructure development (hear infrastructure requests from each ministry and company, and incorporate them into the plan.
- To make infrastructure policy, vision and long-term plans.
- To develop an infrastructure system.

d. Principal contents;

Table 6.10.8 Infrastructure to be constructed

Item	Content
Roads	・setting firm time periods for construction of roads in mineral areas ・swiftly making construction plans for national highways
Water supply	・setting firm time periods for construction of water supply stations by region ・making plans for extending water supply pipelines
Electricity	・making reasonable plan for electric network harmonized with roads, water supply and development ・setting firm time periods for electrifying regions
Ports	・constructing wharves for exporting base metal concentrates like copper ・determine scale of ports need to accommodate potential mineral traffic; set dates for construction
Telecommunications	・installing antennas for mobile phones between large cities ・establishing fixed telephone service between large cities

e. Implementation methodology;

Establishment of organization → formation of an ad hoc committee※ in each sector → meetings with private companies → consistency with national development plan and Poverty Reduction Strategy Paper (PRSP) → coordination with related ministries → decision-making → setting budgets and making requests of assisting organizations

※ In the case of the mining sector, this committee will consist of mining-related organizations, Investment Promotion Office and other relevant sectors.

f. Expenses: Government budget is set by the time of planning, but the costs of necessary studies will be paid out of the budget of the relevant ministry.

4) Issues;

- Human resources for comprehensive consideration;

  In order to make a cross sectional plan of comprehensive infrastructure development, it is vital to have personnel who can study the entire infrastructure plan in terms of its relation with

the national development plan.

- Consideration and investigation on development plan in each sector;
  Each sector has a long-term plan based on PRSP, but they all have a common interest in infrastructure. Therefore, it is necessary to prepare an infrastructure plan which can promote development of the nation as well as all sectors. Consequently, it is necessary to consider and adjust the development plan in each sector.
- Setting of national priorities;
  In consideration of each sector's development plan, it is necessary to set national priorities which have already been thoroughly discussed.
- Publication of the infrastructure plan;
  It is vital to enhance infrastructure to promote exploration and exploitation. This includes formulating long-term infrastructure plans. The infrastructure plans should be made available on a website which is easily accessible to investors.

(2) Development of Water Resources in Mineral Promising Areas
(Basic Development Plan for Promoting the Mining Industry)

1) Purposes;

- To clarify hydrogeology and locations of water resources in mineral potential areas.
- To develop water resources to promote mineral exploration and mine development, and to remove disincentives that can disrupt the water supply

2) Current state;

- At the mineral exploration stage, water for boring has to be transported 100-300km, increasing the exploration costs and reducing interest in mineral exploration.
- At the mine development stage, large amounts of water are required for mining operations and daily living of inhabitants; currently there are 2 projects at the mine development stage where a 70-100km-long water pipeline has to be laid. In addition, plans in both projects call for development of new water resources to maintain water supplies at the current levels.
- There are mineral potential areas between Atar and the iron mine at Zouerate, but there are no roads, so the EU is conducting a survey to make a road construction plan. However, because it is difficult to supply water from the area along the proposed new road, the plan is not taking shape.

3) Overview;

a. Period: 3-4 years

b. Target areas: 4 areas with mineral potential (Tijirit, Akjoujt, Atar, Amsaga)

c. Contents;

Table 6.10.9 Content of Water Resource Development Project

	1st year	2nd year	3rd year
Hydrogeology	・Geological survey in 4 areas ・Analysis of existing materials (geology, water resources) ・Physical survey (preliminary) ・ Characterization of mineralized zones (extent of mineralization) ・Analysis of water systems, geological data ・Survey of nearby wells	・Analysis of hydrogeology and structure ・Surveys of nearby wells ・Detailed survey of test drilling sites (physical probes, geological surveys)	・Hydrological structure model ・ Quantification of water resources ・Water quality analysis ・ Compilation of water resource data from the Internet ・Map of mineral and water resources
Water resources	・GIS database (preparation to compile water resource maps)	・Analysis of reservoir characteristics ・ Rough estimation of proven water resources ・Water resource map	・Comprehensive analysis of water resources
Development	・Selection of test drilling sites ・ Formulation of test drilling plan ・Environmental survey	・ Test drilling (6 boreholes) at water potential sites ・Analysis of drilling results ・Environmental assessment	・Test drilling (4 boreholes) at water potential sites ・Analysis of drilling results ・Development design (plan) ・Water resources use system for mining ・Operation and management

d. Cost: Aid project from donor countries, international organizations, etc (ex. technical cooperation development survey of the Japanese governments). Total estimated cost: US$ 3 to 4 million

e. Schedule: Preparations in 2006; commencement in 2007

4) Issues;

- Organizations and countries supporting the project;

  To realize this project, it is necessary to request supporting countries and organizations for both technological and financial assistance. A supporter will have to be found as soon as possible to bring the First Stage to fruition.

- Sponsors at the development stage;

  This project will finish at the test drilling stage. In order to assist exploration/development companies with the water supply, it will be necessary to find a water development sponsor and allocate money for the management of water supply wells.

- Selection of sites for test drilling;

  Target areas appear to have possible fissures and also have possible fossil water, so the targets of exploration must be down to 300m below the surface. Target areas are in desert zones, so the TEM method for electromagnetic physical exploration would be most appropriate here.

- Utilization of water supply;

  Water supply constitutes governmental assistance to exploration/development companies and is

part of infrastructure development. Regulations for utilization must be considered, including water use by exploration/development companies and use of data and information obtained during this project.

- Technical transfer;

  This project must result in transfer of such technologies/techniques as hydro-geological analysis, selection of test drilling sites, use of TDEM, environmental assessment, geological surveys, development design, and so on. The means for transferring these technologies to the Mauritanian side will have to be investigated.

6.10.5 Environment Management

(1) Establishment of a Legal Framework including Appropriate Regulations

1) Purposes;

- Mining is mainly divided into the four stages of exploration, development, operations, and mine closure. The environmental impact depends on the stage.
- It is necessary to formulate appropriate measures and specific regulations for preventing mining pollution that is adapted according to the characteristics of each stage.

2) Current situation;

- As a current legal framework for the mining environment, a decree for mining environment was promulgated in 2004 which laid the basic framework for protecting environments in mining areas.
- However, the actual enforcement of this decree is not always satisfactory, so it should be enforced in a more appropriate manner.
- There is no clear, concrete action tailored to the stage of mine development

3) Overview;

a. At the exploration stage, specific regulations will be formulated to match the exploration level, for example, by dividing exploration activities into the following three categories and making regulations accordingly.

- Category 1 (e.g., exploration activities with minor environmental impact such as small-scale geological surveys, geochemical exploration, geophysical exploration, etc.) → Report exploration activities to MMI
- Category 2 (e.g., boring in up to 20 locations, exploration area of up to 10ha, tunnel excavation of up to 50m, whichever is applicable) → Exploration plan and environmental protection plan are submitted to MMI for approval.
- Category 3 (e.g., exploration activities that exceed the above conditions) → An environmental assessment (EA) is submitted to MMI for approval. Note: While EA is

not as detailed as an environmental impact assessment (EIA), it does estimate the potential for negative impacts on the natural, living, and social environments of target regions and contains measures for alleviating these impacts. The EA is publicly released, and affected parties can submit comments within 25 days. The EA is examined for up to 15 days after this period.

b. An EIA must be submitted at the development stage. Specifically, the details of specific regulations for the EIA should be regulated (e.g., baseline methods, scoping methods, impact estimation methods, impact alleviation methods, monitoring methods, etc.)

c. At the operation stage, precise regulations must be established for such things as environmental monitoring (measuring sites, measurement items, measuring frequency), annual mining environment reports (types of environmental activities at each mine), mine closure plan (measures required at time of mine closure, calculation of associated costs), and MMI environmental monitoring (compatibility with the mine inspectorate decree)

d. At the mine closure stage, it is necessary to faithfully abide by the closure plan; however, there must be measures in place in case the closure plan cannot be executed, regulations must be made for MMI management of closed mines, and so on.

4) Issues;

- There are no experts at MMI who have experience or expertise with practical mine operation and mine environment management. (Donor countries and international organizations may be asked to provide technical assistance.)
- There must be compatibility with existing laws and decrees. (When necessary, existing laws will be revised to make them compatible with the new regulations.)
- There must be precise regulations at the exploration and development stages, but if there is no quick response from MMI, this might impede promotion of the mining industry. (All of the regulations should contain provisions for maximizing the time for approvals and permits and avoiding unnecessary time delays. If the promotion of the mining sector leads to an increase in the number of applications, a public organization should be established to process these applications in a timely manner.)
- Because MMI duties are allocated to different areas, there is not enough manpower to actually monitor all the mines in the country. (If the number of mines increases, local MMI offices should be opened to strengthen the supervision of mines.)

(2) Mining Environment Management Plan (Baseline Survey)

1) Purposes;

- To prepare natural background data that will allow objective judgments to be made of EIAs

for new mine development

- To release information to private mining companies that are considering mining activities in promising areas
- To create baseline maps for promising areas to facilitate environmental management
- An environmental protection plan and concrete action plan are formulated with a long-term outlook in conjunction with mining sector promotion.

2) Current situation;

- Mauritanian mining industry has just begun being encouraged, but there is still a lack of natural background data for promising areas.
- PRISM1 has conducted a pilot survey (consisting of nature survey and questionnaire) for the environment of the gold prospecting zone in northern Mauritania. Additionally, as part of PRISM2, environmental surveys are being planned for the Mauritanides, the Akjoujt Copper Mine, the F'derik Iron Mine and the Bofal-Loubboira Phosphate Mine.
- There are almost no data for environment in Mauritania and have been no environmental survey only for mining.

3) Overview;

In the most promising mineralization areas of Mauritania (Tasiast, Akjoujt, the Mauritanides, Zouerate, etc.), regional baseline surveys are taken to attain the following results:

a. Creation of baseline maps;

- Rock and soil sampling and associated analyses are conducted in the surface grid (1km×1km to 5km×5km).
- Analytical values are compiled and depicted as concentrations of metal content (natural state) which are then sued to create baseline maps.

b. Groundwater surveys and hydrological analyses;

- Groundwater is taken from wells and analyzed for metal content.
- The underground hydrological structure is analyzed based on groundwater analyses, geological surveys and existing data, and basic information is acquired for pollution simulation.

c. Expansion of the database;

- The above data and information is stored in the PRISM database for environmental management. Sampling analysis data for mineral potential regions in the JICA study are also stored in the database.
- The database expanded by GIS is applied to environmental management and environmental protection.

d. Guidelines for environmental considerations and technical development;

- Deposit development technologies are concretely examined under environmental consideration.
- Guidelines for environmental protection are prepared in development technologies.

e. Formulation of a master plan for environmental protection;

- Based on the above surveys, a 10-year master plan for environmental protection is formulated for mining activities.
- A 5-year action plan is drafted for current activity targets.

4) Issues;

- Methods for procuring survey equipment and funding. (Technical assistance may be required from the donor countries and international organizations.)
- Personnel shortage at MMI. (Technical assistance may be required from the donor countries and international organizations. OMRG can provide supports.)
- Private companies will vitalize the mining industry. (Efforts will be made to work with the baseline formed by private companies and exchange data and information.)
- Determining the areas for the surveys. (It is necessary to determine areas from the viewpoint of a long-term perspective.)

(3) Establishment of Monitoring Center

1) Purposes;

- To cross-check environmental management conducted by mining companies
- To manage all mining environment management data in an integrated manner
- To identify problems and issues through scientific analysis and propose improved monitoring means
- To have a function of sending information on mining environment.

2) Current situation;

- In Mauritania, neither the government nor private companies are involved in environmental monitoring.

3) Overview;

MMI has its own monitoring system apart from monitoring conducted by mining companies in the regions surrounding active mining areas.

a. Guidance and supervision for environmental management of mines;

- Whenever there is a significant impact from mining operations, the mine will be required to take measures to reduce this impact. (If the impact is severe, the mine will be ordered to cease operations)
- Environmental management of companies engaged in mining activities is

cross-checked.

- When there are significant differences between the results of monitoring by companies and analytical values of MMI, the cause will be identified and the company will be given instruction about monitoring methods.

b. Integrated management of mining environment data;

- All monitoring data from all mines is collected and managed, including MMI monitoring data.
- All information regarding measures for alleviating environmental impacts at all mines is also collected and managed.
- There is the ability, when necessary, to submit acquired data immediately upon demand.

c. Scientific analysis of various data;

- Differences in monitoring data obtained from extracted ores, area attributes (topography, prevailing winds, flora and fauna, rivers and streams, standing water bodies, etc.) will be subjected to chemical analyses to understand the distinguishing features.
- Mapping of analytical results and analyses of changes resulting from temporal trends will be conducted. Also, proposal revisions will be made regarding monitoring methods and sites thorough understanding of advancements in monitoring techniques.

d. Dissemination of mining environment information;

- All types of the above mining environment information are publicly released by the website, etc.
- The environmental awareness of people throughout the country is heightened.

4) Issues;

- Methods for procuring survey equipment and funding;

  A fixed proportion of the mining tax will be budgeted for environmental protection.

- Personnel shortage at MMI;

  Technical assistance may be required from the donor countries and international organizations.

- Site training for locating monitoring sites, monitoring measurements, etc.;

  Practical monitoring training is given at the Zouerate mine which is currently operated by SNIM.

- Monitoring sites;

  It is preferable to locate sites in comparatively extensive areas with a long-term perspective.

- If a lot of public monitoring sites are established, in the future the Monitoring Center itself should have the ability to conduct sampling analyses.

(4) Formulating Environmental Standard Values

1) Purposes;

- To protect the environment which supports the health and lives of the people of Mauritania
- To establish standards for making EIA decisions before beginning mining operations
- To utilize for judging the measured value acquired from environmental monitoring during mining operations

2) Current situation;

- There are no environmental standard values in Mauritania, and judgments made regarding EIA are based on environmental standard values in other countries.
- It is problematic to conduct EIA and environmental monitoring under ignorance of the geographical features of the country.

3) Overview;

At this time, baseline surveys in promising areas and EIA surveys for mining operations in Mauritania are anticipated, and also basic environmental data are expected be accumulated throughout the country. These basic data should be used to formulate environmental standard values that will be able to sustain Mauritania. If there is uneven regional distribution of values, there would be no need to formulate uniform standard values for the entire country; rather, and these discrepancies could be used to formulate different standard values for different regions.

The environmental standard values established in this way would become target values for EIAs and mining operations. Furthermore, the environment around a mine would have to be restored to level less than values once the mine is closed.

4) Issues;

- How much national environmental data is being accumulated?

  The mining industry is the only sector that can accumulate environmental data organically in Mauritania, so there is no choice but to rely on mining-industry-based data collection.
- Lack of technology/techniques for formulating environmental standards;

  Donor countries and international organizations may be asked to provide technical assistance.

(5) Formulation of Guidebooks for Mine Safety and Environmental Protection

1) Purposes;

- To formulate detailed regulations of mine safety and environmental protection during operations as references for all mines operating in Mauritania.
- To give technical advices on mine safety and environmental protection to the medium-small companies, in particular, with a little experience which intend to manage the mines.

- To give MMI engineers technical orientations when they supervise the mines.

2) Current situation;

- There is no technical guideline for mine safety and environmental protection for mining companies. Each company manages them based on their experiences.
- There is a decree for mine inspection formulated by MMI, but no technical guideline as references.

3) Overview;

At this time, some mining operations are expected in Mauritania and various types of mining operations will be conducting. Therefore, some mine safety technologies will be accumulated. It is possible to decrease mine accidents by preparation of guidebooks which can be used for all types of mining operations. In its preparation, MMI should have an initiative and call the representatives of main mines, academic experts and engineers of related organizations to make the guideline together. Once guidelines are prepared, all mines must respect them. Some penalties should be formulated for the infraction. In addition, regulations must be detailed to be referred by workers who engage in the mining operations. (e.g. wearing protective tools, road width for trucks, guide for backing trucks, dimension of underground drifts, angle of underground ladders, installation of purifying facilities for discharged water, dust cleaning methods, securing routes for nomad people, etc.)

4) Issues;

- To be consistent with any operation in all mines;

  In case of appearance of a new type operation, it is necessary to add a new regulation applicable to it under MMI responsibility.
- Legal force guidebook;

  At establishment of guidebooks, a new decree may be formulated to comply with regulations in the guidebooks with legal force.
- Publication of the guidebooks;

  This guidebooks must be easy for all people (including mine workers) related to mining operations to understand with figures and tables and be distributed to them to respect regulations. Furthermore, the guidebooks should be utilized in training programs for new workers.

6.10.6 Compilation and Disclosure of Information

(1) Expanding the Mineral Resources Database

1) Purpose;

GIS data should be accumulated in order to continue to use the JICA/OMRG mineral resource

database, which was constructed by this study. In addition, the JICA/OMRG mineral resource database should be integrated with a database introduced by a joint project with BGS/MMI to make the most effect use of this information.

2) Current status;

- Each GIS database has already begun to be used. However, in order to effectively apply these to other geological surveys, etc., it is necessary to continuously accumulate and store the data from their own surveys of OMRG to expand the current database.
- Presently at the OMRG there exist a GIS database of mineral resource information constructed by this study in the computer room, and the GIS database created by BGS/MMI. Each of these exists as a "stand alone" database and do not share data with each other. Integrating the databases and hardware system would promote the organic use of these data.

3) Overview;

- Target databases: JICA/OMRG mineral resource database and BGS/MMI database
- Project content: System integration, digitization of survey data and storage in GIS database and promote ties with SIGM
- Cost: Total cost US$100,000 ($50,000 for experts, $50,000 for building and maintaining the system)
- Period: 2 years, starting in 2006
- Instruction: Given by foreign experts

4) Issues;

- Dramatic change in awareness

  With past projects, OMRG employees showed a strong deferential will, and showed that they recognized this as being important for maintaining the system. However, it is not efficient to operate a similar but separate database. Therefore, if the two databases can be integrated and expanded, data utilization could become more effective. This requires a "dramatic change in awareness".
- Information base

  The data being acquired in joint overseas projects with donor countries should being stored to the fullest extent possible and the JICA/OMRG mineral resource database should be established as a base for mineral resource information in Mauritania.
- Budget

  Expanding database needs financial assistance and experts from donor countries. The cost of system integration would be prohibitive under OMRG's (national treasury's) current stringent budgetary conditions. In addition, technological conditions preclude OMRG

from standing on its own.

(2) Additional Procurement of ASTER Imagery Data

1) Purpose;

- To accelerate ASTER data usage by an additional procurement of ASTER imagery data covering all the Mauritania territory excluding the western desert area.

2) Current situation;

- As shown in the following Figure, 23 sets of ASTER data were processed and stored in the GIS database mainly covering supplementary geological survey areas.
- Procured ASTER (VNIR-SWIR-TIR band) data was processed, for instance by rationing and statistical analysis, and supplied for the supplementary geological field survey through this study.
- Visual three dimensional maps were created adding topographical shade to several thematic maps using DEM (Digital Elevation Model) dataset in ASTER.
- Donation of ER Mapper, a standard remote-sensing data processing software, was made, and technical transfer was also completed through seminar and daily OJT.
- The present coverage of ASTER imagery in OMRG database for Mauritanian potential mineral resource areas is limited as shown in Fig. 6.10.1.

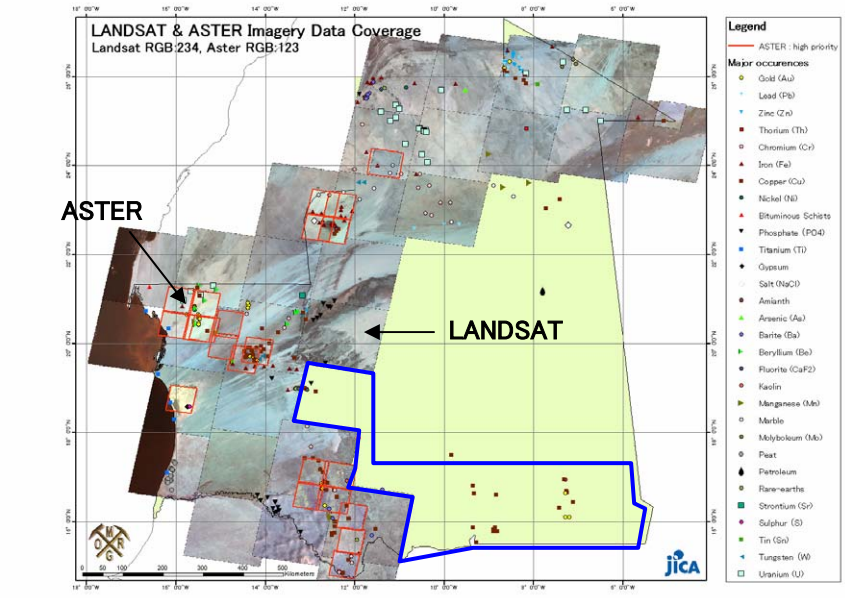


Fig. 6.10.1 ASTER and LANDSAT Data introduced by This Study and Main Mineral Potential Areas

3) Overview;

a. Target areas: The areas covered by LANDSAT data in Fig.8.10.3 (one scene: 180km×180km) and the southern area surrounded by a blue line.

b. Cost: US$300,000 in total (including data cost of US$50,000)

c. Period: 5 years, starting in 2006.

d. Technical transfer: processing data for images.

4) Issues;

- Acquiring ASTER images

  It is not necessary to acquire images all at once, and they can be prioritized according to the budget. If they are acquired in stages, in about 4-5 years the system can be updated

- Utilizing ASTER images

  There is no organization or institution in Mauritania that has bought all ASTER images that are needed. ASTER images can also be used in fields such as agriculture and environment. Therefore, consideration should be given to working with other ministries, agencies, etc., to use these images.

(3) Expansion of the website

1) Purposes;

- To use the website constructed by this project as an effective tool for attracting foreign investors by periodic updating, addition and expansion of information.
- To expand the information stored in the database through the website for inspection. (see Fig. 6.5.6 in Interim Report)
- By expanding the OMRG website created in this study and constructing independently MMI website, to integrate websites as a "service window" for transmitting information about Mauritania's mineral resources to foreign investors.

2) Current situation;

- The website is being constructed by this study. The OMRG's website has been officially opened to provide information about Mauritania's mineral resources to users inside and outside the country.
- The JICA team is transferring technology for website-structure and its renovation to OMRG.
- The JICA team has discussed and exchanged opinions on the website content with OMRG and MMI.
- The mineral resources database is being built.
- The BGS website provides an introduction to MMI and PRISM, and is making partial information available to the public. MMI has received a new web address, installed a web server on site and established a web construction committee for developing its own web site to transmit information, but this project has been put on hold due to a restructuring of the ministry.

3) Content of expansion;

a. Period: An organization for expansion of the website will be prepared in the first stage (5 years).

b. Expansion tasks:

- To fix responsible persons as partial work of OMRG.
- To reflect opinions of the investors who access "Contact us" from the site map.
- To collect the latest information on relevant agencies, activities of foreign investors, revised laws, etc and disclose it in the website.
- To disclose both the data stored in the database and the data which OMRG will obtain in future surveys.
- To make a new website.

c. Expenses: OMRG will budget this as ordinary expenses for the website maintenance (US$500/year), labor and translating French into English. In addition, it is estimated that a total of $US150,000 will be needed to pay the expert, development and maintenance costs associated with integrating the MMI and OMRG web sites.

4) Issues

- "Contact us"

  In order to collect suggestions from foreign investors for improving and renovating the website content, OMRG staff must listen to the opinions of MMI and the foreign investors working in Mauritania. It is necessary for OMRG to take a leadership role in this matter.

- Managers of the website

  Website managers will undertake the periodic updating and collection of information, but they must not be exclusive to the website and also hold other works. It is necessary to review the work of OMRG, reorganize the current organization, assign tasks and train engineers to manage the website.

- Translating information into English

  As engineers currently lack English ability, they should be trained in "Mining English". It is indispensable to keep engineers who manage English information through this kind of education.

- Integrating web sites

  To promote simultaneous coordination within the ministry, a new web establishment committee should be created that is composed of members from MMI、PRISM、OMRG、SIGM、SIGE, as well as managers of mining cadastre. This study developed a web management system and methods for updating information so that the web site can now be operated independently. However, if this work can be expanded to integrate sites, then MMI

will be able to make fuller use of its human resources, and great strides will be made toward fully independent operation.

(4) Creation of 1: 100,000 Geological Maps

1) Purpose;

- PRISM is preparing 1:200,000 geological maps which cover the main areas in Mauritania. However, 1:100,000 geological maps, the basic geological information, are also needed as basic data for investment decision.

2) Current situation;

- The 32 parts of 1:200,000 geological maps was finished mainly in the north, west and south of Mauritania by PRISM as February 2005 as shown in Table 6.10.10 and Fig.6.10.2. However, 1:100,000 geological maps have not been created so far.

Table 6.10.10 Achievement State of 1:200,000 Geological Maps by PRISM

Area	Finished	Under creation	Under project	Total
North	19	0	0	19
West	11	0	6	17
South	2	14	2	18
Total	32	14	8	54

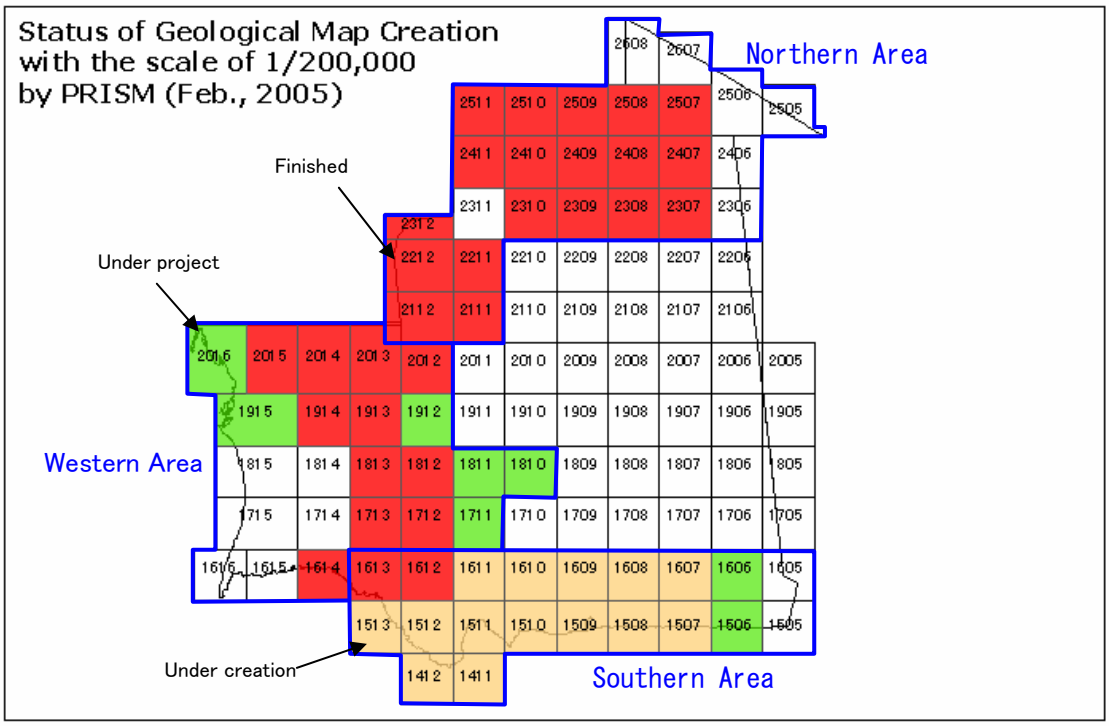


Fig.6.10.2 State of Achievement of 1:200,000 Geological Maps (as of 2005 Feb.)

3) Overview;

a. Creation order;

- Creation of 1:100,000 geological maps is one of the most important task in coordinating information and must be begun with accordance of achievement of the 1:200,000 geological maps by PRISM. In creation of 1:100,000 geological maps, 128 parts which corresponds to the finished 32 parts of 1:200,000, will be started first of all and created in the 1st and 2nd Stages. 64 parts will be finished in each Stage (Table 6.10.10).
- 88 parts of the 1:100,000 geological maps which correspond to the 22 parts of the 1:200,000 under creation and project will be created in 3rd Stage.
- Newly created geological maps will be stored sequentially in the GIS.

b. Period: a plan is formulated in 2006 and creation starts in 2007.

c. Cost: US$ 5 million in total (for 1st Stage). It will be a supporting project from donor countries or international organizations.

4) Issues;

- Alliance with PRISM and its experience are very important. Well coordination and mutual cooperation are needed.
- Technical and financial supports from the related organization and countries should be required. Cooperation of multi organizations is needed such as a case of PRISM.
- Storage into GIS will be carried out simultaneously, but data volume is estimated more than 4 times larger than the 1:200,000 geological maps. Therefore, the manual and hardware supports are needed such as inputting data and so on.
- Recruiting Mauritanian engineers and training them (technical transfer) are also needed.

6.10.7 Organization of the Mining Sector

(1) Regular Roundtable Meetings between Government and Mining Companies

1) Purpose;

- Presently, there are about 10 foreign companies engaged in exploration and development. To give them a chance to meet regularly and directly exchange opinions with Mauritanian government representatives (Technical Committee members), “Roundtable Meeting for Promoting the Mining Industry” are held periodically.
- Meetings are held between the government and the mining industry to discuss ways of improving the investment climate and to promote future exploration and development.

2) Present status;

- Exploration and development of mineral resources is gradually proceeding, but nearly all of it is being done by foreign companies.
- Foreign companies want the Mauritanian government to resolve issues associated with inadequate infrastructure, labor shortages, information networks, and so on.

3) Overview;

a. Responsible organization: MMI

b. Time and place of meetings:

- Meetings held two times per year- May and November
- Location is MMI Conference Room (or meeting room at a hotel)
- Each meeting lasts 3 hours

c. Members:

Minister (Chairman), Technical Committee

MMI Technical Advisor, DMG Director、PRISM Director、OMRG General Director、Mining Cadastre、SNIM、NRE Director、MCM、Federation of Industry and Mines、EU

Foreign companies:

These consist of companies that are currently engaged, or want to engage, in exploration and development, and companies holding mining concessions

d. Topics:

- Issues with exploration and development
- Policy for developing investment climate
- Preparation and disclosure of information

Future roundtable conferences will serve as venues for exchanging opinions on formulating mining and mining promotion policy, constructing systems, and so on.

e. Secretariat:

DMG (which will eventually be succeeded by IPO) will make the arrangements and records the meetings.

f. 1st meeting: Thursday, 17 November 2005

Notices given: during October

Agenda:

- Minister's opening address
- State of investment climate development
- Mineral resource development strategies
- Discussion on topics
  - Opinions of foreign companies
  - Opinions of government mining organizations
  - Question and answer session

Note: The JICA team will attend as observers

This 1st roundtable meeting wad conducted as scheduled with participants from the World Bank and PRISM.

(2) Establishment of Mining Association

1) Purpose;

The association will be established to nurture and develop the mining sector. Specifically, this entails the following:

- Serve as a venue for mining-related companies to exchange opinions and information, and establish cooperative relationships
- Provide input for mining policy and mining industry administration
- Take a leading role in environmental protection
- Act as a "service window" and "conduit" between companies and the community or administration

2) Current status;

- There is no place for foreign and domestic mining companies to get together to exchange information and opinions.
- Mining policy is implemented by government organizations and a state-run company (SNIM).
- There is no place for foreign mining companies to exchange opinions with the local community.
- There is no organization that can coordinate the activities of the private sector and petition the government for revisions and changes in the way it administers the mining industry.

3) Overview;

a. Period: To be established during the 2nd Stage in 2010

b. Activities of Mining Association:

- Lobby the government for policies and systems
- Hold seminars to discuss policies, institutions and regulations
- Collect and share information on mining technology, environmental protection, etc.
- Coordinate activities of the private sector (preparation of annual reports, etc.)
- Serve as a conduit connecting government organizations, schools, and the community
- Hold seminars, conferences, etc.

c. Membership:

Foreign and domestic companies, state-run companies, universities, and companies (transport, civil engineering, etc.) related to mining

d. Procedure for establishment:

- Hold workshop for the purpose of establishing Mining Association composed of mining-related government organizations (DMG、OMRG、SNIM), the Chamber of Commerce, foreign companies, domestic private sector companies, and others.

- Gather information from overseas mining associations

- Establish preparatory committee
  - Select committee members from among private sector and foreign companies (government organizations will be observers)
  - Committee members will formulate action plans, design plans, etc.
- The Chamber of Commerce, Investment Promotion Office and international organizations will provide advice for establishing the association.
- Start-up money will come from cooperating organizations, general fund, etc.
- A secretariat and office will be established to commence activities

e. Costs:

- Source of funding: International organizations, general fund, etc.
- Operating funds: $50,000/year ($1,000/year from each of 50 member companies)

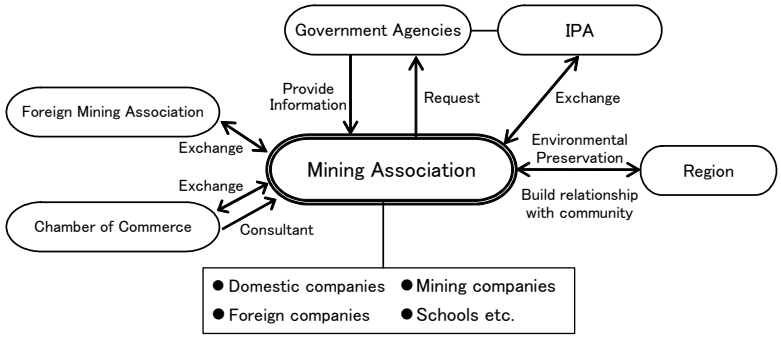


Fig. 6.10.3 Conceptual Diagram of Mining Association

4) Issues;

- Advice for establishment

  The EU provides advice on establishing mining associations, but Mauritania must have a receiving organization to obtain this support. It would be desirable if government mining organizations, the Chamber of Commerce, etc., receive advice from the EU on starting a preparatory committee.

- Secretariat

  Membership of the association would consist not only of domestic companies, but foreign companies as well, and a foundation for its activities would have to be built. In addition, information would be exchanged with overseas associations to enhance the functions of the association, which in turn would raise the level of Mauritania's private sector companies and finally it would link with the investment promotion. Therefore, the secretariat would have to have staff with proficiency in English who could communicate with foreign members and other parties.

- Funding for start-up

Among the general funds provided by private sector organizations in the US, Europe, etc., are funds that are allocated to support associations such as this. It would be desirable if such funds were sought out and supporting organizations asked for assistance.

6.10.8 Nurturing Domestic Companies

(1) Formulation of Plan to Nurture Domestic Companies

1) Purposes;

To nurture domestic companies that can take charge of mining-related business from the onset of the exploration and development stage.

2) Current situation;

- There are no companies that can undertake exploration and surveys at the prospecting stage.
- There are no companies that can undertake boring.
- There are no companies that can undertake feasibility study, construction and engineering at the development stage (except small enterprises for partial civil construction and transportation.)
- Almost all chemical analyses, explosives, spare-parts, machine repairs, etc., have to be made by or obtained from foreign companies.
- There is a shortage of technicians who can handle the above work, and there are no policies in place for planning the organized and strategic training of technicians and nurturing domestic companies.

3) Overview;

a. Period: First Stage 2007- 2009 (period for planning)

b. Target companies:

- Surveying and exploration.
- Boring.
- Small-scale mines (for non ferrous and construction materials)

c. Method for nurturing companies:

- Have the IPO take charge.
- Compile a list of companies and candidate enterprises. → Institute a system for registering companies and compile a roster of technicians.
- Create a company network (and periodically hold roundtable meetings for corporate investment).
- Hold investment workshops.
- Call for participants in courses offered by invited experts.
- Establish private training centers to give opportunities to study in the Technical

Education Center.

- Act as an intermediary for joint ventures, corporate partnerships, etc., foreign companies establish themselves in the country.
- Propose and manage an equipment leasing system.
- Order commission surveys and boring projects funded by the government.
- Privatize national enterprises (ex: subsidiaries of SNIM, etc.)

d. Items requiring action:

- Company management
- Procurement of capitals
- Joint ventures and partnerships with foreign companies
- Training personnel

e. Procedure for formulating training proposals:

- Establish IPO
- Survey the status of management, operations, etc., to gain an understanding of the activities of private companies engaged in surveying, boring, and the mining of non ferrous metals
- Gain an understanding of activities for groundwater development, state-run non-ferrous mining companies national projects
- System investigation
  - System for leasing exploration machines
  - System for training personnel
  - System for conducting joint-venture extensive area exploration
- Investigation items requiring attention, methodologies and scheduling
- Compile lists of companies and technicians, and construct networks with companies
- Investigate sources of funding
- Formulate a training plan. When formulating a plan, it will be necessary to invite experts from other countries for listening to their lectures.

f. Budgeting:

- Survey cost for first two items in mentioned above
- It will cost US$ 5,000 to invite an expert in fostering companies.
- The remaining expenses can be budgeted from the national treasury.

4) Issues;

- Cost;

It would be preferable to undertake tasks as the Investment Promotion Office (IPO ➔IPA). It appears that the national treasury will be able to pay the costs of corporate surveys, etc. the

tasks associated items mentioned above must be paid by the national budget.

- Guidance for formulating a plan;

  The formulation of a plan is a multi-faced task involving many items such as accounting, financing, personnel training, equipment procurement, etc., as well as formulating relevant institutions and mastering the foreign methodologies. Therefore, it is necessary to invite planning experts for having their lectures.

- Privatization;

  Privatization of SNIM has not been so far discussed in detail. It would be effective in privatization to separate subsidiary companies or departments of surveys and boring and nurture them as central private enterprises in the country. If the government gives jobs to these privatized companies for strengthening their management bases, they have large possibility to be core private companies. To formulate this plan, cooperation of SNIM is indispensable.

6.10.9 Institutional Reform of OMRG

(1) Constructing the LAN System and linking with MMI

1) Purposes;

- To use IT to improve the efficiency of OMRG data, data processing, office work, etc., and upgrade the system.
- To install a LAN network at OMRG with shared peripheral equipment such as printers and internet connections in every room. In addition, it will be possible to hook up with the MMI network as well.

2) Current situation;

- A GIS database system was constructed in this study.
- An OMRG web site was constructed by this study to found a base for publicly releasing and transmitting information.
- The methods for handling information stock, making data exchanges, doing office work, etc., at OMRG are outdated and inefficient.
- Internet connections installed during the survey period consisted of only analog connections in the JICA Survey Team room, the computer room, and the director's office. E-mail was very difficult. Furthermore, it appears that there might be some problems with contacting the outside, web management, etc., in the future.
- There has been relatively little progress at OMRG in increasing the use of computers and keeping up with operational technology. The technical level and knowledge of OMRG employees is still at the beginner stage.
- When the survey team is not in Mauritania, it is very difficult to main compatibility between

the data, IT resources, etc., in the SIGM system installed at MMI.

3) Overview of the LAN system

a. Period: 1st, 2006-07

b. Items:

- Installation of one PC per person
- Installing a server and connecting all PCs to a LAN network
- Digitize all documents, maps and diagrams
- Provide access to web site
- Acquire techniques for digitizing maps and diagrams
- Provide instruction in IT techniques

c. Targeted persons: All technicians and office workers

d. Costs

- OMRG general budget
- Support from donor countries and international organizations
- Machines and equipment: US$44,000
- Maintenance: US$3,600

The following table lists the expenses for one year for equipment and maintenance

Table 6.10.11 Overhead costs of the OMRG system

no		Items	quantity	unit	US$	Total (US$)
I	Setting of LAN in OMRG & Connection with MMI					
	1	Server PC	1	set	4,000	4,000
	2	Wireless kit	1	set	5,000	5,000
	3	Switch 24 ports	1	set	200	200
	4	UPS for Server & Switch (1000VA)	1	set	300	300
	5	UPS for Wireless Antenna (600VA)	2	set	250	500
	6	Network materials in OMRG	1	set	600	600
	7	Setting up of Network in OMRG	1	set	700	700
	8	Maintenance	12	month	300	3,600
	9	Training (Networking): for two months	1	person	1,300	1,300
		Sub Total (A)				16,200
no		Items	quantity	unit	US$	Total (US$)
II	PC Implementation & Training					
	1	PC (desktop)	10	set	2,000	20,000
	2	Printer (Laser A4 B/W)	5	set	500	2,500
	3	Printer (A3 Color)	3	set	400	1,200
	4	Training (Windows XP)	20	person	50	1,000
	5	Training (Excel, PowerPoint)	20	person	150	3,000
		Sub Total (B)				27,700
		Total (A+B)				43,900

The machines and equipment are being applied for the World Bank's 2005 Poverty

Reduction Project for Mauritania.

e. IT guidance: It will be provided by PC dealers in Nouakchott and OMRG technicians

4) Issues;

- Expenses for equipment installation

  Although the World Bank is being asked for assistance, if it does not materialize it will be necessary to ask donor countries and international organizations. Or, if the petroleum industry increases government finances, then maybe the national treasury can be tapped to pay for equipment installation.

- IT guidance

  As a result of this JICA study, OMRG is acquiring some IT techniques through technical transfers to OMRG technicians. However, overall LAN system construction is lagging at OMRG, from the viewpoint of the development of IT capabilities for all technicians and office workers. Therefore, it might be desirable that related domestic IT companies are providing IT instruction, and IT technicians at OMRG are taking charge of spreading this technology within the OMRG. OMRG employees need training in basic technology, from basic IT technology to networks. Furthermore, local technicians must be recruited and trained (technical transfer) from maintenance funds.

- Organization management and equipment upgrades

  It costs about US$4,000 per year to maintain equipment and software. Furthermore, IT technology is advancing every day, so the government will have to budget monies for updating equipment, software, etc., about once every 5 years

- Adopting a common language

  It would be desirable for English to be adopted as the common language in the future. However, based on the current situation at OMRG, it is appropriate to teach IT technology in a local language.

- Building a LAN for OMRG/MMI

  System overview: A network server and hub switch have been installed at OMRG, and there are wired connections in each room. Furthermore, OMRG has a wireless (antenna-based) connection with MMI which connects with MMI's LAN. It should be noted that there is already a hub switch on the MMI side, the system will be complete once the antenna is installed (see Fig. 6.10.4). The speed of the Internet connections at OMRG is 10Mbps or better. The total cost is expected to be about US$70,000 ($30,000 for the internal system, $20,000 for maintenance (5 years), and $20,000 for training).

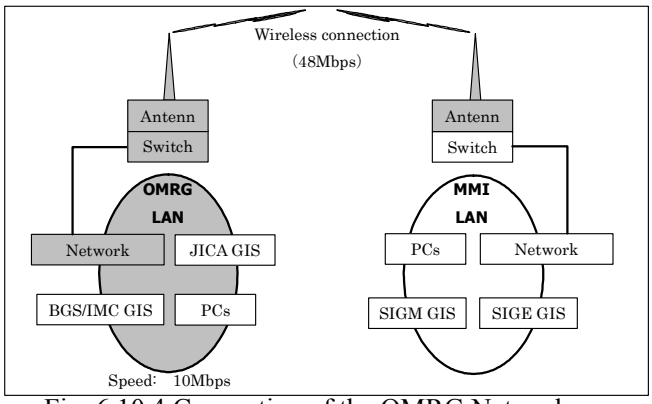


Fig. 6.10.4 Conception of the OMRG Network

(2) Preparing Survey Equipment

1) Purpose

To allow OMRG to fulfill its role as a national geological survey institute and work to promote investment.

2) Current status

- Survey equipment is greatly lacking, and OMRG surveys are limited to geological surveys.
- There are no physical prospecting, analyzers, drilling equipment, etc., so survey data in collected only on what is exposed. This data is not sufficient for attracting foreign investment.
- There are very few transport vehicles, and this has an adverse effect on the volume and safety management of surveys.

3) Overview of development

a. Period: This will be implemented in the 1st stage, but since it will have an effect on the strategic development plan, it may impede the condition survey, so it should be undertaken as soon as possible (in 2006).

b. Targeted equipment:

- Mainly equipment used for physical exploration, drilling, and chemical analysis
- The physical exploration equipment collects information on regional electricity, magnetism, gravity, and electromagnetism to provide information about mineralized zones as well as geological data.
- The drilling machines are used for structural boring to obtain geological data on the underground structure

Table 6.10.12 Equipment needed by OMRG

No	Item	Price (US$)
	Geophysical equipment	
1	Electromagnetic method	100,000
2	Gravity method	150,000
3	Magnetic method	50,000
	Geophysical software	
4	Temix-XL by Interpex for electromagnetic method	4,000
5	Magix by Interpex for gravity and magnetic method	4,000
6	OasisMontaj by Geosoft for spatial analysis on gravity and magnetic survey	10,000
7	Atomic absorption analyzer	80,000
8	Jaw crusher (two)	60,000
9	Vibration mill (two)	90,000
10	Diamond drill machine with max. depth of 200m	140,000
11	Diamond drill machine with max. depth of 600m	190,000
12	Pump (two) for drilling machines	120,000
13	Toyota Land Cruiser (two)	90,000
	Total	1,088,000

c. Costs:

- The above table lists estimated costs of equipment and does not include maintenance costs.
- Total costs are about US$ 1 million. Presently, OMRG is petitioning the World Bank to provide equipment through the Poverty Reduction Project.
- Support from donor countries and international organizations

4) Issues;

- Dependence on donor countries and international organizations

  The acquisition of all needed survey equipment is considered to be the starting point for creating a strategic development plan and as such is of vital importance. Although a petition has been made to the World Bank for assistance, it might not be easy to acquire. If assistance is not acquired, Mauritania will have to petition donor countries and international organizations. Another way is to not become completely dependent on one organization for all equipment, but to petition donor countries, international organizations, etc., for individual pieces of equipment.

- Equipment maintenance

  OMRG used to own drilling and other equipment but it has fallen into disrepair. The introduction of new equipment will thus require the development of a maintenance system.

- Geo-physical exploration

The introduction of equipment for geo-physical exploration will require technical instruction from geo-physical experts. This will entail learning about all technical aspects, such as handling the equipment, acquiring data, and conducting analyses. In the beginning, donor countries and international organizations will be (are being) asked to invite experts to Mauritania. Furthermore, there is no geo-physical technician at OMRG, so it is considering inviting technicians to conduct training in Mauritania, but also sending people overseas for training.

Chapter 7 Recommendations

7.1 Positioning and Role of Mining Industry

7.1.1 Mining Industrial Structure

The globalization of the world's mining structure is leading to the formation of an oligopoly of financially strong companies. Amidst a structure that is heading toward a single market, there is increasingly fierce competition to develop large-scale deposits. In 2005, the global mining industry consists of some 8-10,000 mines, many of which are very small. The majority of the industry's production of metals and fuel minerals is produced by some 120 large corporations (including multinational enterprises: majors) which control nearly 75% of the world's total annual mineral output. These companies are highly competitive and manage very large investments. They are accountable to shareholders and are essentially risk averse. These companies are the most likely to have the financial capacity to invest in new mining ventures. These companies also follow closely the fortunes of smaller, 'junior' mining companies which carry out much of the first stage exploration of promising mineral deposits. There are more than 500 of these companies active in exploration in Canada and Australia alone.

Thus, to entice these two groups occupying the higher ranks in the mining industrial structure (Fig. 7.1.1) to invest in exploration and subsequent exploitation of deposits in Mauritania, it is essential that a comprehensive and accurate information be prepared and actively disclosed to them. It is necessary to promote the investment in Mauritania, understanding these circumstances of the mining industrial structure.

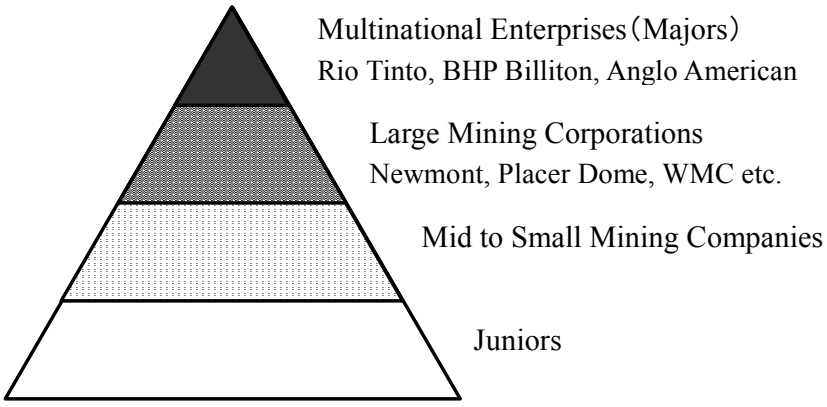


Fig.7.1.1 Structure of Mining Companies in the World

In this global mining structure, juniors have many opportunities to explore for gold and copper. Therefore, it is important to promote exploration by foreign investors, especially juniors. It is also necessary to prepare a system for giving incentives to juniors in PDAC, Canada or INDABA, South Africa by providing the information they require. (There is a possibility to make joint ventures which will be discussed later.)

7.1.2 Role in National Development Plan

In the Poverty Reduction Strategic Paper (PRSP) prepared in 2000, mining was clearly identified as a future driver of economic growth. Mining activity is always related to the natural occurrence mechanism of mineral concentrations. Typically these concentrations are:

- distributed randomly across a geographical territory
- related to specific types of geological activity (e.g. gold and greenstones, diamonds and kimberlites)

Thus mining plays an important part in generating other economic activity in thinly populated areas which, in Mauritania, are the home of subsistence and nomadic farmers. It is also logical that mining should be included within the national strategy as communicated by the PRSP to help make the strategic development plan relevant and effective. It should be noted that this plan is revised according to the results of annual development of the related sectors within the PRSP. In addition, mining plays a large role for promoting economic activities in the areas with the large population of poor people. Therefore, the strategic development plan is basically linked with PRSP.

This promotion of mineral resources development is designed to have the following benefits:

- To diversify the range of mineral types exploited by the host country
- To increase infrastructural development to encourage mineral resources development
- To foster the growth of new business sectors such as:
  - Transportation - specialized vehicles are needed to haul heavy equipment to mine sites
  - Maintenance - machines used for production of the mineral resources need intensive upkeep
  - Material trading ・mining activity consumes many different materials and initially most of these will need to be imported by specialized agents and distributors
- To develop areas around mine sites by employing local people and investing in their communities
- To increase national foreign exchange earnings by exporting mineral concentrates
- To adjust the strategic development plan according to annual development results of the related sector in PRSP.
- To link the strategic development plan with annual development of relevant sectors in PRSP.

Diversification of mineral development should be carried out in three stages. Currently, gypsum and phosphate are being excavated or are under development study. However, for industrial materials it is necessary to conduct resource potential surveys, select main targets, build a

cooperation framework including OMRG and domestic mining companies and research marketing in neighboring countries.

The development of Tasiast requires transportation, mechanical repairs and material sales, but it also depends on developers themselves and/or foreign companies. This is an opportunity to make downstream businesses and increase employment. Government and mining-related agencies should consult each other about the growth of domestic companies and study concrete tasks such as developing mining skills, securing loans for starting production, and so on. For example, an organization like "Office for Mining Related Business Development" should be established and managed in partnership with IPA or as partial work of IPA (see IPA in Mining Sector in Mauritania in Appendix I, 1.1). As a first step, a concrete plan should be formulated with the assistance of various experts from mining advanced mining countries like Japan.

7.1.3 Strengthening the Ability to Formulate Mining Policy

The formulation of mining policy requires information not only about Mauritania, but also about the global mining industry. Presently, there is a shortage of policy makers, there is little capability to analyze information, and the organization is weak. PRISM has been building mining policy capability. Now it is necessary to strengthen the ability to formulate mining policy (Table 7.1.1).

Table 7.1.1 Policy Formulation Capability

Required capability	Tasks involved
Policy formulation	• Policy formulation for each stage • Procedure for approving and implementing policy
Establishing systems	• Establish a system to promote exploration and development • `Procedure for approving and implementing system
Formulation of mid-to long-term plans	• Formulate 3-5-year and 10-year plans for promoting exploration and development • Review and revise plans after implementation
Evaluation of policy system	• Annual evaluation of implementation policy and system • Revision of system and policy after seeing evaluation results
Plan for implementing action program	• Establish plan for implementation based on survey action program • Evaluation after plan implementation, revision of plans

To strengthen policy formulation capability, the current DMG must be expanded as an organization. Strengthening capability will require the implementation of a strategic development plan in the study. At the 1st Stage, DMG staff should be sent to government mining organizations in mining countries (Canada, Australia, etc.) to undergo training. Or inviting experts from mining countries could be effective, as it is with instruction in statistics and strengthening statistics capability given by long-term experts from France at the Statistics Bureau. Or maybe it could be realized as part of the capability building of the PRISM project.

It would be desirable to push this project forward in the following order: building capability of mining policies by PRISM (ongoing now) → expansion of DMG organization

instruction by experts from mining countries (supported by PRISM or donor countries)

It is also necessary to collect information on policies and institutions from mining countries for reference.

7.2 Mining Policy and Mining Promotion

7.2.1 Mining Policy and Organization of Government

By analysis of current mining activities it is possible to specify a mining policy that defines the direction of future mining industry development. In Mauritania, the present policy aims at building a base from which the mining industry may promote mining investment. Using this study a revised policy will be prepared during 2006 and serious promotional activity will start in 2007. At the time of writing, the following policy is needed to execute, as shown in development plan:

- To promote gold exploration and development
- To conduct a survey of base metal resources.
- To improve the investment climate for foreign investors.
- To establish the operation and systems of "Investment Promotion Office".
- To establish an environmental management system including a Monitoring Center.
- To create and establish domestic companies within the mining sector.

The organization and functions of the mining sector have been restructured and improved by PRISM of the World Bank, and there is no problem with the terms of its definition. The issue is whether the reorganized sector management will be able to function as desired because the roles of the mining sector departments, in particular the OMRG and the DMG are not effective, primarily due to personnel shortages, lack of experts, equipment and money. The relevant countermeasures for this issue will be tabled when drafting the training needs and an action plan linked to the strategic development plan. An institutional strengthening of OMRG is indispensable for the promotion of mineral exploration in Mauritania. The following work needs to be accomplished:

- The functions and relationships of the existing departments need to be examined to clarify the best options for the future.
- The role and function of OMRG needs to be redefined taking into consideration the shortage of experts in geology, geophysical exploration, remote sensing, resources evaluation and mineralogy as well as instrumentation and maintenance staff.
- The role and function of the DMG needs to be redefined as there is a shortage of experts and technologies.
- An urgent plan of action needs to be prepared and implemented to rectify these issues at the OMRG and the DMG
- An assessment must be made to define the extent to which inadequate organization and functional capability will have a negative effect on mining promotion.

Table 7.2.1 Summary of Principal Failings

Factors	DMG	OMRG
Experts	• Lack of a comprehensive overview of the situation in the entire mining industry • Failure to collect and compile the mining information • Shortage of Mining engineers, economists & trained technicians • Lack of policy making staff	• Lack of experts with local knowledge of each geological province • Shortage of engineers for geophysical survey, chemical and mineralogical analysis • Shortage of specialists for resources evaluation and environmental management & monitoring
Equipment	Shortages of: • Computers and network • Environmental monitoring tools • Vehicles for site inspection	Shortages of: • Geophysical survey equipment • Vehicles for transportation • Facilities for chemical analysis • Computers and network

7.2.2 Relationships between Economic & Social Policies and Mining Promotion

To promote, sustain and grow a viable mining sector the economic policy framework should include the creation of a financial market which will supply local capital. The financing of exploration is vital for domestic companies but presently this activity is limited even though the reorganized Mauritanian banking sector is operating according to conventional principles. To a certain extent this seems to be related to a cultural and traditional reluctance to invest for long term gains. It would be better to procure mine operational finance from domestic financial institutions.

Foreign investing companies have similar problems with funding operations and reinvesting after mine development. The Mauritanian financial liberalization policy is favorable to foreign investors but lack of growth in the financial sector will be an obstacle for future domestic investment.

Mining promotion is vital for the local economy and to attract foreign investment. Targeted successfully it also contributes to poverty reduction. This study will select several promising areas for exploration. The communities adjacent to the promising areas will acquire opportunities for an economic growth through the mining related-businesses.

Actions to develop economic and social relationships are needed as follows:

- An economic policy that includes the creation of a financial market to provide local capital
- Elaboration of several economic policy elements to include:
  - Up-rating of credit on government bonds
  - Issuance of long-term government bonds
  - Creation of stock and debenture markets
  - Establishment of low-interest and long-term loan systems within the banking sector
  - Establishment of public/private enterprise partnerships

- Fostering of small scale sector by provision of soft loans to cooperatives

- Combining mining with social policies (e.g. sustainable development) to promote local employment and support activities
- Selection of mining related areas for economic development to encourage dispersal of population from the capital.

7.3 Development Promotion

7.3.1 Promotion Measures

Exploration and development strategies of other mining countries provide no suitable references because of the unique conditions in Mauritania. But, it is worthwhile to identify the promotion policies of other countries and incorporate them into Mauritanian development strategy. However, there is a fatal problem for Mauritania under economic difficulty in financing the following institutions like Japan.

- Establishment of Investment Promotion Center (Tanzania)
- Tax exemption when 80% of production is exported (Mali)
- Two-year mining zone tax exemption for small & medium-size companies (Mali)
- Reducing income tax for exploration investment (Canada)
- Possibility of negotiating income tax, customs tax, fixed rates for foreign exchange with regard to 20-year investment (Chile)
- Survey subsidies given to prospectors at the survey stage (Canada)
- Infrastructure subsidies (Australia)
- Exploration subsidies----subsidy of 30-50% of exploration expenses (Japan)
- Three-step domestic exploration system (Japan)
  Extensive area survey (using government funding)---- detailed survey (company pays 1/3, remainder paid by national and local governments)---- company exploration (using company funding)
- Funding for overseas rare metal exploration---- low-interest, exemption of principal or protraction of paying (Japan)

However, given the difficult financial situation of the Mauritanian government, systematization such as that done by Japan (Appendix I, 1.5 in the Interim Report) might be difficult in regard to subsidies or financing.

In Mauritania, OMRG supporting system by spot parcel (providing materials, machines and/or labor) in exploration might be linked to promotion, because it could alleviate difficulties (water supply, exploration works, provision of materials and machines, etc.) in exploration circumstances. At the development stage, it is indispensable to have support infrastructure. To

construct this infrastructure, Mauritania currently depends completely on international organizations and donor countries, so promotion measures for infrastructure could be presented, as follows;

- Company outlay costs which the Government should pay for infrastructure are identified (and the Government approves it).
- The Government will reimburse the company afterward as if it were a long-term loan from the company.

7.3.2 Strategies of the Majors

As financing becomes more liberalized, majors like Rio Tinto, BHP Billiton and Anglo American are aiming for global scale expansion of activity areas by globalizing investment areas. The management strategy of majors is resource development (iron, coal, copper, aluminum, etc.) that can be done as a large-scale, mass-production operation, and they are avoiding ores that have small production scales or are highly vulnerable to market fluctuations. Rather than ”vertical development”, from upstream to downstream as it were, projects are being developed so that mineral concentrates can be produced from various types of ores. In addition, majors have easy access to markets for their products and they are targeting areas that do not involve a lot of transporting costs (Table 7.3.1).

Table 7.3.1 Strategies of Majors at Each Stage

Stage	Strategies
Exploration	• Low-cost minerals with large-scale, long-term production life • Nothing at grass routes level, possible in VP with juniors. • Close to production areas (smelter, etc.), market, etc.
Development	• Infrastructure is being developed. • Operating mines are already nearby. There is potential in the surrounding area. • Promising areas are acquired.
Investment	• Small initial investment • Maximum NPV can be calculated. • Mines (companies) that can create synergy are acquired.

Under the present conditions of the above majors' strategies, it may be difficult for majors to come to Mauritania to excavate gold and other non-ferrous metals. As a first step, we need to assume advancements by juniors. Rio Tinto and BHP Billiton are now looking for diamonds in Mauritania, but it is said to be merely as a way of breaking through the impermeable Anglo America-De Beers diamond syndicate. The acquisition of Ashton by Rio Tinto may have been for this reason.

Generally speaking, juniors often begin exploration activities without sufficient funds for exploration. However, even if a junior abandons an exploration project, another junior will often take over the concession and continue the exploration.

7.3.3 Joint Ventures with Juniors

The main business of “junior” companies in Canada, Australia, etc., is exploration and

they support the mining industry in both countries. In Canada they are listed in the stock markets of Vancouver, Toronto and Montreal, and in Australia they are listed in stock markets like Perth and Sydney. In both countries, there are about 400-500 junior companies listed in stock exchanges, with many more that are not listed. Most of these companies have up to about 10 employees. Their goal is to sell their interests in exploration results to multinational corporations ("majors") or to mid-to-large scale mining companies. There are also many juniors in the UK and USA, they are active around the world. While junior companies can be involved in everything from initial prospecting to detailed exploration and feasibility studies, there are many cases where they disclose their results at the initial prospecting stage and sell them to mining companies.

The strategy of junior exploration companies is to handle the stage with the largest risk to increase the value of the project. The usual approach to procure investment for exploration is to establish a company and make a public offering of its stock. Other ways include joint-ventures or alliances with large mining companies. Investors have the chance to make capital gains through stock price increases resulting from a junior's discovery of a new deposit. Mauritania exploration activities are nearly all at the "grass root" stage, making them particularly attractive for junior exploration companies.

The prepared information by PRISM and this study is considered to be aimed at attracting juniors. OMRG's survey data should be accumulated, arranged, and translated into English for transmission to juniors. While still rare, some junior companies are conducting preliminary surveys in Mauritania. To promote greater involvement of juniors, both OMRG and the private sector must develop strengths that will enable them to become partners with juniors; geologists with fluent English skills are particularly needed.

Australian junior companies which are the target of IOGC are already active in Africa. If they could be convinced of the potential of the IOGC, they might become active in Mauritania as well. A concrete example of this could be the Tasiast deposit, where the survey of gold-bearing quartz veins in the iron layer is being carried out and might be linked to recognition of the OMRG7s role. Joint ventures between OMRG and foreign companies have already been already explained under "Joint-venture extensive areas exploration system" in 6.5.1, Promotion System in the Interim Report.

Joint ventures with juniors are the target of this joint-venture extensive exploration system, and OMRG could attain the following effects through collaborative projects with juniors.

- Expedite juniors' exploration activities.
- Improve technologies, knowledge and English.
- To sale attained profits from provision of spot parcel to juniors.

However, it is also necessary to conduct study on following tasks;

- Evaluating attained profits when juniors withdraw.

- Calculating the ratio of attained profits for spot parcel provided by OMRG.
- Feasibility of providing labor, materials and machines.

7.3.4 Improvement of the Geological Infrastructure

Geological maps at a scale of 1/500,000 have already been prepared and geological maps at a scale of 1/200,000 are being prepared by PRISM, a local agency of the World Bank. They do not yet cover the whole country but include most areas with promising mineral potential. Aerial geophysical surveys have been carried out and their results are logged into databases. The results of surveys in areas of mineral resource potential are being compiled in this study through introduction of GIS based on PRISM database. However, creation of the geological infrastructure has just started and needs to be improved for multiuse in the future. It will take into consideration measures to protect against desertification, improvements in infrastructure, development of water resources and so on. Further tasks needed to complete the geological infrastructure are identified as follows:

- Digitization and consolidation of survey and exploration reports.
- Translation to summarize the above reports in English.
- Addition to the areas presently covered by geological maps at 1/200,000 scale.
- Compilation and digitization of the OMRG exploration data.
- Introduction of satellite imagery (ASTER) covering the whole country
- Preparation of maps including:
  - geological maps at 1/100,000 scale in areas with indications of mineral deposits
  - contour maps at 1/100,000 scale
  - maps showing infrastructure, fauna and flora in relation to the geological maps.
  - maps showing potential water resources and the locations of existing wells.
  - maps relating the geological information to population density

Implementation of these tasks will need a lot of money. In the strategic plan, the disposition and need for infrastructure will be also proposed. Geological infrastructure should be prepared in formats that may be easily related to data on infrastructure, water resources and the environment as it is developed in the future.

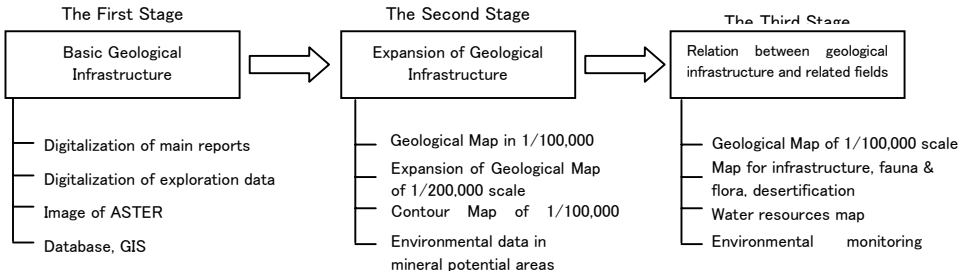


Fig.7.3.1 Phased Improvement of Geological Infrastructure

7.3.5 Presentation of the Geological and Mineral Resources data and Disclosure of Information

Investors do not like risk. There is a direct relationship between risk and knowledge and the less information that there is available about a project or business that seeks investment the higher is the risk to which the investor is exposed. It is, therefore, essential that the information to be provided to potential investors is:

- Accurate - small errors will put into question the quality of all the data
- Transparent – the sources, facts and data need to be clearly verifiable and are likely to be checked for their accuracy
- Quickly available – all possible data, maps and other details need to be available.

In Mauritania investors may buy basic geological information (geological maps at scales of 1/500,000 and 1/200,000) recently compiled by the BRGM and the BGS and funded by PRISM. Furthermore, investors may apply for information on promising mineral areas prepared during this study.

This information will also be available on the OMRG website once it is completed; examples of the information to be disclosed are geological maps, maps showing the distribution of deposits and location and characteristics of promising deposits.

This website will considerably simplify investor access to Mauritanian geological data. However, the website will also provide information about data and services available from other government organizations apart from the mining sector. However, information services for the government organizations except mining sectors as well as disclosure of computerized information (various figures with scales) to investors should be advanced using the geological infrastructure mentioned above.

A further point is that most documentation and information about the geology and mineral resources in Mauritania is only available in French. However, English is the dominant language of business, technology and mining and it is indispensable that all of the information be provided in English to reach the companies interested in investment. The tasks here are:

- As a prerequisite of exploration promotion to provide the information on geology and mineral resources
- To translate this information into English
- To establish effective management of the website system to transmit the data. (Transmission of information can be effectively managed by a website system.)
- To construct an information disclosure system that is simple and easily accessed. (Disclosure of computerized information on geology and resources)
- To define the selection criteria for free view and chargeable data. To communicate these criteria to the public in a simple and effective manner. (Rulemaking of the information for

public exhibit, disclosure by website and presentation)

- To train local technicians:
  - To compile, store and disclose the information
  - To manage and maintain the web site.

7.3.6 Improvement of Infrastructure and Implementation of Construction Plans

Mauritania has historically lacked funds for the installation of basic infrastructure and this is an important issue for the promotion of mineral exploration/development.

Table 7.3.2 Infrastructure - Current Status and Tasks

Item	Current Status	Main Subject
Roads	Main routes started.	Make a construction and maintenance plan for principal routes throughout the country.
Railways	Only one route for iron ore transportation in the north. No plans for additional routes.	Initiate planning for the route Nouadhibou – Nouakchott – Rosso (the Atlantic coast line)
Airports	Few flights to smaller towns.	Improve the international airports and augment services to current destinations. Add new destinations to network.
Ports	Renovate and increase capacity of iron ore loading berth with EU funding.	Plan the construction of a new port facility for nonferrous concentrates shipment in Nouadhibou.
Water	12000 wells. Water supply in rural areas is sparse.	Ensure stability of water supply in areas with mineral potential.
Electric Power	Current plan is to increase electricity generation in line with its consumption.	Develop the supply network to include the entire country. Guarantee electricity supply to areas of mineral potential.
Telecommunications	Telecommunication networks are established in most population centers	Increase the number of relay stations for mobile phones to include remote areas.

A major reason for the lack of mineral exploration to date is the inadequacy of Mauritania's infrastructure. This has been due to: The size of the country in relation to its population and the distances between population centers.

- The extreme desert climate with its lack of rain and high temperatures
- The shortage of technology
- The lack of appropriate machines and trained manpower
- The very specific life–style which, although admirably family centered is not work focused
- The lack of funds, essential to mitigate the above issues

The introduction of foreign investors to the Mauritanian mining sector has only just begun but it appears that attracting further foreign investment will be hampered without improvements to the infrastructure. If developers are asked to construct and maintain connections to existing roads the areas open to economic development will remain severely limited and exploration will be confined to sites accessible from the smaller towns. To overcome this, the government should prepare scheme

drawings that indicate to what extent it will take full responsibility for infrastructure development in areas of mineral potential.

Right now, there is no long-term plan to improve the infrastructure in Mauritania. The time from site exploration to mine development is measurable in years (for large deposits up to seven years) and it is essential to have a clear long-term plan for infrastructure readily available for investing exploration companies. This plan needs to show year by year how the infrastructure will be developed and needs to be updated each year to show the progress achieved. Currently the developers are responsible for infrastructure needed for mine development and they are obliged to carry out exploration work without knowledge of any national infrastructure plan. It is effective to show the current infrastructure maps in the website.

Furthermore, the whole system of infrastructural development needs to be improved. Planning, rights of way legislation, the right of the public to object, the granting of development permits, letting of contracts, and the control of contractors during the work all needs to be considered. In Mauritania all of this will depend on support from international organizations or fully developed countries which are already specialized in all aspects of this work. The important tasks concerning infrastructure are as follows:

- To prepare, agree and publish the Infrastructure Development Plan. This to include:
  - As an urgent priority a program of construction for the main road network
  - A flexible program for the construction of secondary roads adaptable to meet specific priorities
  - To prepare detailed cost estimates for the Infrastructure Development Plan
  - To prepare realistic timescales for the implementation of Development Plan tasks
  - To prepare a budget for Plan implementation in accordance with the capacity of the Treasury to fund each year of the Plan.
- To prepare, agree and publish a plan for the development of water resources in areas of mineral potential. Priorities to be flexible according to need.
- To outline a construction plan for a port facility to ship concentrates. (To make a construction plan for a port facility to ship large amounts of concentrate.)
- To clarify the national responsibility for infrastructure construction costs in the development areas, make and implement a national plan to support the infrastructure construction.

The last two tasks here can only be implemented when there is a specific need. Planning for water resources development needs to be very flexible allowing for action to be taken quickly once each deposit is discovered. The need for a port facility will entirely depend on whether economic mineral deposits are discovered, but the outline for this can consider potential locations, design and capacity options, environmental impact and cost estimates. However, it is premature to

make firm plans.

7.3.7 Introduction of Technologies and Facilities

Recently, several new technologies have been introduced to the Mauritanian mining sector. Mauritanians, working with foreign experts have learned how to use these and interpret data from them. These include:

- The survey technologies adopted by PRISM, the mining sector agency of the World Bank
- The IT technologies used for management of mining concessions and permits
- The introduction, by foreign companies, of some newer exploration technologies for mineral exploration e.g. remote sensing and airborne geophysical survey. (This study has also brought deposit surveying technology, satellite imaging technology and the GIS system to Mauritania.)

However, introduction of technologies and their associated instrumentation is not complete. Furthermore, as all exploration and development moves forward these technologies are improving, changing and being complemented with new methods and systems which will also need to be introduced together with more training for local experts.

The program to promote exploration and development also needs to include innovative methods of stimulating interest and bringing fresh ideas to Mauritania's mining sector. For example:

- Specialist Engineers from advanced mining countries may be invited to come to Mauritania to deliver seminars or to provide short term expertise for very specific issues.
- Foreign companies acting in Mauritania should be encouraged to use the newest technology when implementing their projects.
- SNIM with relevant technologies and facilities for exploration, development and operation of its iron mines should be encouraged to second its technical and operation specialists to work for periods with the foreign companies. Both will gain from the exchange of ideas – The foreign partner by learning better the local culture and capabilities and SNIM people from the new technologies.
- Local companies must also be encouraged to partner the foreign companies so that the new technologies are absorbed by the Mauritanian specialists
- A program of conferences and seminars focused on small specific issues about exploration and mining and focused on West Africa can be hosted by Mauritania. This will enhance the reputation of the Mauritanian Mining sector and encourage specialists worldwide to exchange views. (Why should the South African republic be the only venue in Africa for mining meetings?)
- The most capable technical school graduates should be offered Mauritanian Government scholarships or sponsorship to attend international graduate mining schools

Table 7.3.3 Technologies and Facilities Tasks for Nonferrous Metal Mining

Items	Current Situation	Tasks
Geological Infrastructure	● Being upgraded by PRISM and JICA. ● Includes some technology transfer. ● Introduces basic hardware and software.	● To translate information into English. ● To train many more engineers. ● To improve hardware & software facilities
Survey	● OMRG has a few technologies. ● There is some geochemical and geophysical survey capability.	● To train experts in the interpretation of mineral deposit geology & mineralogy. ● To develop geophysical engineers in exploration techniques. ● To train students in foreign countries. ● To introduce specialized tools and analyzing equipment.
Exploration	● Depends on foreign companies. ● Exploration is confined to few minerals. ● No experience of total exploration.	● To introduce more foreign companies. ● To introduce technologies for collation of exploration data and ore reserve calculations. ● To find a way to introduce the technologies & facilities (geophysical exploration, drilling, mineral testing etc.)
Development, Environment, Mining, Processing	● Lack of basic technologies and know-how. ● Use of old technology because of inexperience. ● Depends on foreign companies.	● Need to obtain technologies from foreign companies. ● Need to introduce new tools and facilities. ● Need to introduce new technology know-how
Resources Evaluation, Feasibility Study	● Lack of basic technologies and know-how. ● Depends on foreign companies. ● No training in place	● Need to obtain the technologies from foreign companies. ● Need to train specialists in foreign countries. ● Need to introduce new technology know-how

There is a lack of technology and facilities in Mauritania and much time and money will be needed to bring these to international standards. There are no international companies mining in Mauritania yet, but they will need the support of consultants and laboratories to conduct mineral processing tests, environmental impact assessments, evaluation of mineral resources, feasibility studies and engineering studies. Even if foreign companies invest, the introduction of technologies and facilities to Mauritania will be limited as much of the test work and design will be carried out abroad.

A detailed action plan that stays in step with the advancing pace of exploration and development is needed for the introduction of these new technologies and facilities. The Mauritanian government should finance this and The World Bank, which has already focused on improvements to institutions and building a mining sector management system, should also be invited to help build a base for the introduction of these technologies. (This study focuses attention on this point and an action plan for the introduction of these technologies and facilities is set out in the strategic development plan section). The key points here are:

- The introduction of new technologies and facilities needs careful planning
- A sound technical base needs to be established before new technology is introduced
- Introduction of technology and facilities will need funding from the national budget as well as by international donor agencies.

- Foreign companies when investing do not always share new technology and facilities.

7.3.8 Personnel Training

Training is also an important issue if the promotion of exploration and development is to be successful. Currently training in Mauritania is largely unstructured and is implemented as 'On the Job Training' (OJT). Some more formal training exists including technology transfers, the seminars and workshops of PRISM and a seminar on remote sensing delivered as a part of this study. However, training is an urgent necessity in all fields related to mining. As a priority, the following categories of staff need training:

- Staff with detailed experience of the global mining industry.
- Experts on the basic geological units in Mauritania.
- Experts on the ore deposit types
- Geophysical engineers with practical exploration experience.
- Experts on the evaluation of mineral resources, the environment, information technology etc.
- Staff with international business skills

The training needs to be conducted at several levels depending on the needs of each individual being taught. As well as technical training two other areas must be considered:

- Improvement of English ability by teaching business English
- Training to teach policy development and organization planning

The training institution must be ready to carry out training organically and systematically. Until a more formal training plan can be implemented the priority is to provide temporary training conducted by experts from international organizations, countries having an important mining sector and donor countries. Local training using the resources of SNIM can be considered in parallel with this temporary action.

Table 7.3.4 Plan for Training System

System		Target	Content
Training system for top officials	Short term	Top officials	Global mining. Training by government organizations in mining countries.
	Long term	Candidates for top officials	Ditto
Training system for specialists		Engineers	Selection according to each specialty or background. Training by OJT and abroad.
Expert invitation system		Engineers	Using OJT and workshops
Advanced training system for general officials		Staff	Using business seminars, IT and lectures on basic mining by foreign experts.
English learning system		Engineers and staff	English language study

The MMI budget should include funds to pay for this need to develop training systems. Promotion of exploration and development in the mining sector will be impossible without a

supporting training program.

7.3.9 Continuing Surveys and Promoting Exploration after the Supplementary Geological Survey

Even after this study, the supplementary geological survey undertaken in the study must be continued by OMRG based on transferred technology. Thirteen of 28 deposits were surveyed and geological maps compiled for 10 of these deposits, which were used for analyses and mineral research. These data, geological maps, etc., were housed in the Mineral Resources Database. A deposit model was created based on the survey data. Investment is promoted through printed materials such as investment guidebooks and introductions of deposits, and also through a website.

Many technologies for geological survey have been transferred to the counterparts, such as mapping skills by OJT in the geological survey, developing methodologies for laboratory tests, explaining the characteristics of each type of deposit, remote sensing analyses, constructing a database and others. Therefore, it is extremely important for OMRG to use the present survey as a reference to conduct continuing surveys, add survey data to the database, and disclose the results on its website to appeal to the investors (Fig. 7.3.2).

- Continue geological surveys
  ---- Creation of geological maps based on mapping of deposits and promising areas.
  ---- Geological sketching of outcrops at mapping.
  ----- Use of POSAM to map altered minerals and abnormal zones.
  ----- Mineral tests, chemical analyses of rocks and ores
  ----- Investigation of mineralization processes
  ----- Storing the above survey data in the Mineral resources Database
- Remote sensing analysis
- Disclosing geological survey results through the website

In addition to undertaking the activities, the deposit model constructed in the study must be periodically reviewed and revised. Moreover, the programs related to geological surveys proposed in the Strategic Development Plan of the study should be given shape and their implementation should be linked with investment promotion. However, there is a limitation on the OMRG's own power with only technologies transferred by the study. In order for OMRG to conduct the above survey, it will be necessary to nurture more human resources, conduct surveys in collaboration with foreign companies, and continue to receive technical cooperation from donor countries and international organizations.

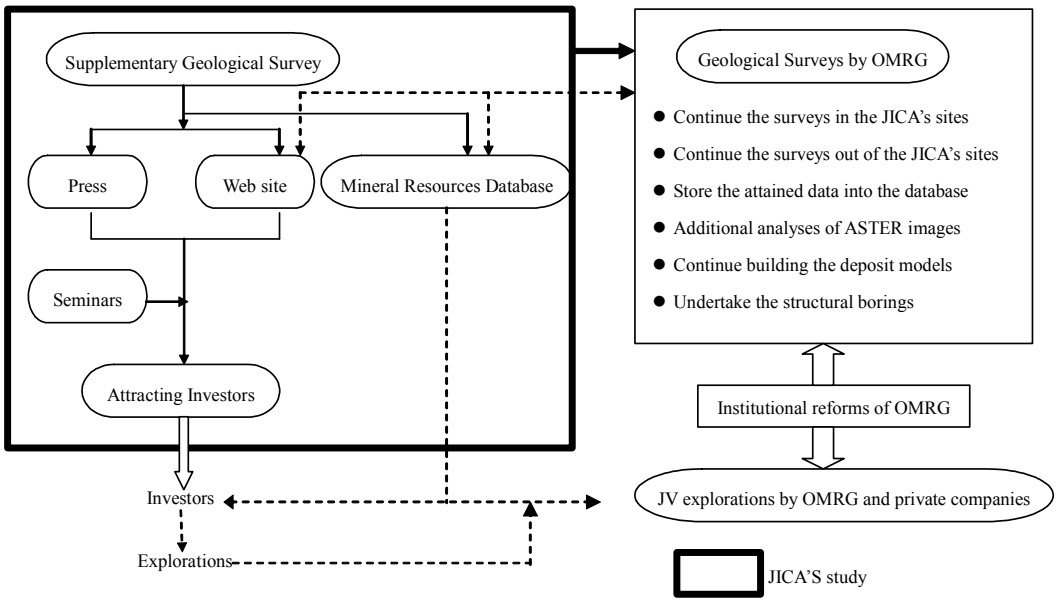


Fig. 7.3.2 Promotion of Exploration attained from Surveys Continued by OMRG

It is also necessary for students studying geology in the Nouakchott University to join in OMRG surveys mentioned above in order to strengthen survey capability and increase geological engineers.

7.4 Conditions for Foreign Investment in Exploration and Development

7.4.1 Introduction of Foreign Investments

Before foreign investment may be introduced, work is needed to prepare the legal institutions, financial markets, infrastructure, the technical base and supporting organizations. With the help of international organizations, work in Mauritania is just starting on this preparation. A basic legal framework is in place but will need improvement and adaptation to meet future conditions. A stable financial market is not in place and infrastructure is insufficient to encourage foreign investment. (see 7.3.6 and 7.3.7) Some recommendations are given on the legal institutions, financial market and infrastructure for the introduction of foreign investment in the strategic development plan of this study.

Also included are recommendations for the technical base and these may be related to the introduction of foreign investment based on the results of the supplementary field survey which is in progress. It will take time to establish the ideal conditions needed to introduce foreign investment. The tasks to be accomplished are:

- Preparation of the legal framework, finance, infrastructure and technical base for the promotion of inward foreign investment. The legal institutions have been built, whilst preparation of the finance, infrastructure and technical bases is just beginning.
- The selection of promising areas from this study based on the modeling accomplished thus

far

- Creation of a satisfactory and stable investment climate to encourage the promotion of foreign investment.

To attract of foreign investment, an Investment Promotion Office needs to be established. This unit will study the tasks described in each field of Table 7.4.1 and prepare promotional plans for implementation.

Table 7.4.1 Tasks for Foreign Investments

Field	Items to be prepared	Current Status	Tasks to be implemented
Legal Institutions	• Investment Law • Tax system • Environmental Law • Management capacity of the mining industry • Institutional strengthening	• Completed by PRISM • Management system for mining concessions being prepared	• Systematic preparation • Implementation of environmental management programs • Government guarantees for investors
	• Institution for promotion of the exploration & development	• Not studied	• Development plan • Institution
Financial Market	• Liberalization policy • Currency exchange • Banking	• Under preparation	• Long-term loan system • Low interest • Stable currency exchange
	• Bond market	• Only at concept stage	• Promotion of new industries
Improvement of Infrastructure	• Plan • Construction	• Steadily advancing construction • No long-term program	• Establishment of basic infrastructure necessary for the promotion of mining • Support system of infrastructure for mining promotion
	• Anti- desertification	• Implementing in the partial/back roads	• Measurements in the mineral potential areas
Technical base	• Geological infrastructure	• Under preparation	• Expansion
	• Information on geology and mineral resources	• Under preparation, capturing data	• Systematic compilation of information • Modeling
	• Each sector (exploration, development, environment)	• Lack of technology	• Introduction and instruction. • Training system
	• Tools & facilities for each sector	• Lack of tools & facilities	• Introduction and renovation

7.4.2 Investment Conditions for Foreign Capital

To attract foreign capital for the mining industry, some preconditions must be met, such as political stability, a well-established legal and regulatory framework (investment laws, environmental laws, etc.), well-established tax laws and system, a stable macro-economy, and a well-established investment climate including a transparent financial system and reliable financing and yearly revisions and improvements which is under development. In addition, there should be revised mining laws, the mining tax system should be equitable, and resources-related information must be easily accessible. Furthermore, it is very important that mining rights be easily acquired and

have guaranteed transparency.

In summary, the preconditions for attracting foreign capital investment include:

1) Political and economic stability
2) Development of legal and tax systems
3) Transparency of mining rights and aptitude for procedures and ownership
4) Compilation and provision of resource information
5) Hiring staff
6) Development of infrastructure

In the case of Mauritania, the investment base and environment are still in the development stage. For foreign investors who intend to conduct exploration and development, it would be very important to hire local staff and secure access to the developed infrastructure.

As has already been mentioned in sections 2.2 (Majors' Strategies) and 2.3 (Joint Ventures with Juniors), there is still a great risk for majors in Mauritania, so at the moment of Mauritania, the target is to promote the involvement of juniors. Items 1), 2) and 3) above are conditions that a junior can clear, and 4) is gradually being provided by PRISM and this study. However, 5) and 6) are still obstacles to the progress of juniors. If 5) and 6) are not resolved and 4) is not improved and expanded, it will be harder to promote exploration and development. The necessity and methodology of 5) and 6) for Human Resources Development are described in Chapter 6, which also describes the development of infrastructure and an infrastructure construction plan. It will take time to realize these concepts, but the government should recognize their importance and make efforts to achieve them by not only asking donor countries and international organizations for financial assistance but also by using their own national treasury. Foreign investors are selecting target countries for exploration and development, so Mauritania must compete with many competitors, including neighboring countries, to attract foreign investment. To encourage exploration and development by foreign investment, the investment climate must be improved in order to prevent 1) to 6) above from becoming disincentives.

7.4.3 Characterization of Mining Investment by Japanese Companies

The Japanese mining industry is characterized by "custom metal smelters" and investing in development projects that can procure concentrates from overseas. There are no junior companies in Japan. The Japanese mining companies are located in the second layer (the large-scale mining enterprises) in the pyramid structure described in 7.1.1 Mining Industrial Structure (Fig.7.1.1), and have smelters for base metals, rare metals, etc. These companies can be characterized as follows:

- Avoiding risk, or low risk (country risk, exploration risk, etc.)
- Investment in the form of providing raw materials (concentrates) to their own smelting

facilities

- Mining company = smelting/processing company
- Vertical development of the mining industry due to their country's status as a processor of raw materials
- Investment in development projects through alliances with large trading companies
- Targets are politically and economically stable countries
- Each company has technology for exploration, extraction, dressing, refining and processing.
- Exploration utilizing the Japanese government system

As reported in 7.3.2 and 7.3.3, the majors aim for horizontal project development which is the opposite approach of Japanese mining companies. Each company engages in projects for ores that it specializes in. Based on these kinds of Japanese mining company characteristics, it is difficult for them to conduct exploration alone in Mauritania. First, it is necessary to understand the conditions in the country, for example, the construction of plants such as oil refineries by large business firms. However, political risks such as change of government became apparent with the coup d'etat of August 2005, which made the Japanese companies retreat, at least temporarily, from investing in Mauritania.

Secondly, it looks as though exploration utilizing such tools as JOGMEG joint-venture resources development base surveys will not occur if large Japanese business firms or mining companies do not make their final decisions which the purpose of their explorations in Mauritania is to import the concentrate or develop the mines. Japanese companies tend to develop a type of consortium for investment in the development stage between majors and Japanese trading companies or mining companies, as shown in Fig. 7.4.1. The target Mauritanian resources for Japanese companies are assumed to be gold and/or rare metals; due to long distances for transporting concentrate, base metals are given low priority at the present time.

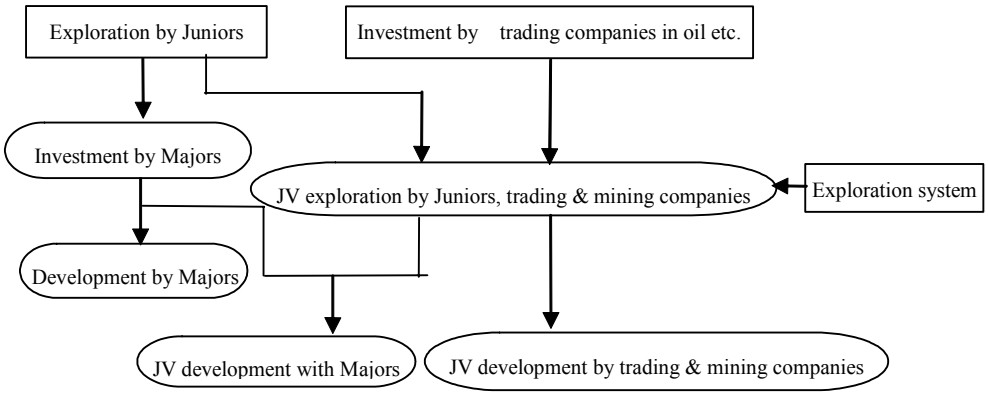


Fig. 7.4.1 Possible Pattern of Japanese Companies' Investment in Mauritania

7.5 Environmental Protection

7.5.1 Environmental Management

The promotion of the mining industry requires much capital investment, so from a short-range view there are great expectations that foreign investors will start mining development in Mauritania. However, with the recent global concern for the environment, the international mining majors tend to stay away from countries with insufficient environmental management, even if the mineral potential is high. This is because a mining disaster would not only damage a company's international reputation that it has built up over the years, but there is also a fear that such a disaster would force companies to spend much money for compensation, clean-up, and so on. In other words, for foreign investment to provide a special stimulation to the promotion of mining, it is urgent that an environmental management system be developed.

At the same time, small to medium-sized companies do not have a financial or technical base to work with, so it is important to note that such companies are very susceptible to mining pollution. In order for the mining industry to contribute to the wholesome economic development of Mauritania, the country must be able to prevent mining pollution through resolute environmental management. Full-scale mining activities have only just begun in Mauritania. Mauritania and the foreign investors should now conduct a baseline survey, establish a monitoring system and create an environmental management system.

7.5.2 Environmental Management and Framework for Mining (Areas for Exploration and Development)

Baseline surveys were partially carried out in exploration and development areas within the scope of PRISM 1 project funded by the World Bank. These included a baseline survey of the natural environment in the gold and diamond exploration areas in the northern district and an enquete survey on the socio-economic impact of mining in the Zouerate district.

Another baseline survey will be implemented in the same manner in the Mauritanides metamorphosed zone during PRISM 2 project. As activity levels in exploration and development are likely to increase in future it is very important that the metal content of rocks, soils, water and vegetation be measured and subsequently monitored prior to development. The purpose of this is:

- To implement a baseline survey and make a baseline map.
- To establish a monitoring framework in the exploration and development areas.
- To introduce the tools, facilities and technologies needed for environmental management.
- To observe environmental management regulations.

The four items above are important tasks for the future as environmental management also requires harmonized cooperation between related government organizations.

7.5.3 Technologies, Tools and Facilities for Environmental Management

Technologies for environmental management include:

- Surveying techniques
- Data measurement technology
- Analysis technology for evaluating data.

The organization and a framework of environmental law applicable to the mining environment is now being established wit the support of international organizations. However, the implementation of environmental management, as well its accompanying tools and facilities is a future matter. A laboratory to analyze water quality is established, but no facility exists for analysis of samples of soil and rock for metals type and content.

Table 7.5.1 Technologies, Tools and Facilities for Environment Management

Technologies for Environmental Management	Tools and Facilities
Baseline Survey	Chemical analysis
Survey and analysis for rocks and soil	Chemical analysis and simulation software for analysis.
Monitoring	Satellite image, imaging software and computers.
Water quality monitoring	Water quality and chemical analysis tools
Atmosphere	Atmospheric and particulate analysis tools

Initially, activities will be focused on geological and mining exploration and drilling and its environmental impact will great. However, once mine operations start the environmental issues will increase at both the development and operational stages. The mine developers must have the primary responsibility for the protection of the environment from mining pollution. The government must have a strict system to control violations and be capable of administering and policing the system which includes important sanctions for non-compliance. To achieve this, the government must introduce the technologies needed for environmental management.

7.5.4 Environmentally Sensitive Areas

National parks and world heritage sites are nominated as important environmentally protected areas in Mauritania. The national parks are located in Banc d'Arguin to the south of Nouadhibou and Diawling at the mouth of the Senegal River in the south. There are four world heritage sites, including Chinguetti in Atar. These areas have little mineral potential and the nearest area is more than 50 km distant, which is considered beyond the limit of mining activity impact. There are no rivers running through areas of metallic minerals resources, although intermittent inundations which temporarily fill dry water courses (wadis) need to be taken into consideration at the time of making potential mine site environmental impact assessments.

The water used during exploration boring does not flow through protected areas. The Bofal district rich in phosphates is close to the Senegal River, about 25km. Similarly, groundwater near the titanium deposits can possibly link with the Banc d'Arguin or Diawling district along the

Atlantic coast and so an environmental impact assessment (EIA) will be necessary before drilling to evaluate titanium deposits. (An evaluation for titanium potential was carried out in this study, so the initial environmental study was also conducted, based on the supplementary field surveys.)

As the Banc d'Arguin national park is located in a marine area close to off-shore oil development wells, it is a very important environmental survey target.

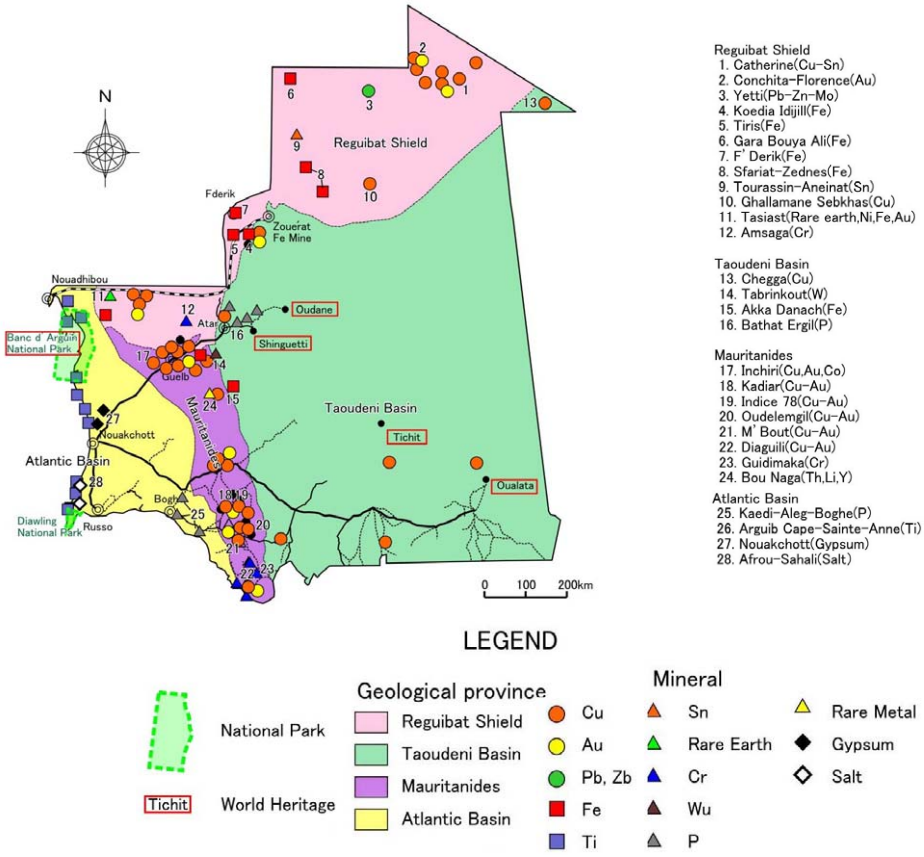


Fig. 7.5.1 Environmental Protected Areas and Distribution of Ore Deposits

7.5.5 Extensive Baseline Survey

The baseline survey is the essential first task for environmental protection in mining districts and its results provide the basic data for the measurement of the impact that subsequent mining activities have on their local environment. A baseline survey is an important task for environmental protection in the mining districts and its results actually represent the basic data for mining activities having environmental impact. This study identifies several mineral resources potential areas where exploration and development may take place in the future and these will be priorities for baseline surveys. The following projects are at different stages of development evolution:

- Tasiast Gold Deposit Project at the development construction stage.
- Akjoujt Gold and Copper Deposit Project at the feasibility study stage intended for

reopening and expansion.

- Bofal Phosphor Deposit Project at the feasibility study stage.
- El Aouj Iron Deposit Project at the pre-feasibility study stage.

It is obligatory for each project to implement the baseline survey and submit the survey report to DMG. Until this is evaluated and agreed as satisfactory in a committee session by the DMG no permit to proceed with the development should be issued. A committee session will be held to permit the development by initiative of DMG. However, as there is no natural background data in the development area, insufficient basic data might cause some delays in the management of the environmental protection for mining activities. Even though there is no natural background data in the development areas and this insufficiency of basic data might cause some delays the EIA must be completed and agreed before mining activity is permitted. In the past, the global mining industry has gained a poor reputation for its environmental management record. The mining sector in Mauritania must quickly introduce baseline survey technology and plan to budget, plan and implement surveys systematically using the example provided by PRISM.

7.5.6 Strengthening Cooperation between Related Organizations

It is essential to reinforce cooperation and the exchange of information between related organizations, because mining activities can have an environmental impact and create water contamination and dust, affecting agriculture, fishing grounds and the health of local inhabitants. The actual situation is best monitored by exchanging information with related organizations.

Environmental protection during mining activities is within the authority of the DMG in MMI, and the OMRG is involved with the baseline survey. The OMRG primary function is geological surveys and exploration, and it needs to carry out these operations whilst maintaining environmental protection management at an appropriate level.

Apart from the ministries and agencies mentioned above, NGOs should also participate in the environmental protection committee for mining, which should convene at regularly scheduled intervals. The DMG sends information related to the mining environment to the ministries and agencies, and receives some information about mining activities in return. It is desirable that the information exchange be implemented by a local area computer network (LAN). Information exchange may be facilitated by the construction of an environmental web site, activated by the environmental database (SIGE) prepared within PRISM. The actions to strengthen the cooperation between government organizations on environmental matters related to mining activities are recommended as follows:

- Establishment of a cross-organizational environmental protection committee for mining.
- Establish a small executive unit to implement the committee policy
- Develop a standardized package of information for exchange between ministries

- Create an Intranet between the ministries and agencies to share the information.
- Create a web site (similar to the Strategic Mining Plan website) for environmental protection.

Table 7.5.2 Organizations involved with Environmental Protection related to Mining Activities

Related Ministry or Agency	Role
MDRE	Overall control of environmental protection for the whole country.
MET	Construction and maintenance of infrastructure.
MHE	Management of water resources and wells.
MPEM	Management of living aquatic resources and fishery.
MHE	Management of health and medical & sanitary affairs of the population.
CNRE	Survey of water resources.
SNIM	State-owned iron mining company.

7.5.7 Information Disclosure

Information disclosure concerning environmental protection is essential to protect against environmentally damaging incidents as well as to prevent local inhabitants from protesting about mining activity. The Government's environmental administration must be transparent and fair, both clarifying the actual status of environmental protection to the mining companies and to NGOs and the local inhabitants monitor the environmental condition. Currently, the amount of data disclosed with respect to environmental protection is insufficient despite the requirements of environmental laws and regulations. Data and information disclosure will increase as exploration and development are encouraged in the future. The information needs to be communicated on websites at public enquiries and in press announcements. Public enquiries need to become institutionalized right and a permanent site should be available for the public examination of data e.g. in the DMG office. The essence of good environmental management is transparency of information, striking a balance between the needs of nature (environmental protection) and the needs of the population (e.g. employment, clean water, access to grazing) and in the case of mining, building confidence between the mining companies and the local inhabitants is also important for this balance.

7.5.8 Environmental Awareness of local residents

Production and environmental protection are the two wheels for economic growth. The environment of Mauritania is mostly still in a natural state. To prevent future exploration and development activities from having an adverse impact on the environment, it is necessary to address ways of enhancing environmental awareness among the general population. The population has been concentrated in the cities, where environmental problems are becoming very noticeable.

Environmental protection activities of NGOs and others would be instrumental in enhancing the environmental awareness of the inhabitants.

Current community related to mining activities is located along the railway between the SNIM iron ore production area and the ore exporting port in the northwestern part of the country. The Tasiast area has no community near the mine, so its development has no relationship with environmental awareness of local residents. However, Akjoujt is located near the community with a population of 8,000, so it must work to improve awareness of local residents from the stage of development construction. As Akjoujt has only a short mining history that is limited in the northern part, awareness of residents is generally low. But, it will be a task for the future to arouse the people's interest in environmental protect and cultivate their environmental awareness. It is indispensable to keep a harmonious balance between environmental awareness and mining activities for future mining expansion. PRISM has started a program related to improving resident awareness of environmental protection, which involves the following:

- To build an environmental website which includes the following information:
  - Information on environmental protection for local residents.
  - Information on environmental management for mining activities.
- To have DMG prepare information on mining environment and distribute it to the government organizations which will explain it.
  - To compile periodic information about mining activities and environmental news. (e.g., to make pages for environmental management in the magazine "Mauritanian Mining".)
  - To have DMG and OMRG participate in international seminars for mining environment.
- To have DMG enlighten local governments about environmental protection management for mining activities.
- To have foreign developers give an orientation session on their mining activities to the local government and residents.
- To have government organizations like DMG support the work of NGOs and NPOs by utilizing donor funds from foreign countries.
- To prepare lectures for mining activities and environmental protection in the environment faculty at the university.

These activities are directly linked with environmental protection and improving awareness of local residents to help construct an organic network for environmental protection from mining activities in Mauritania in alliance with the government, industry, universities, NPOs, NGOs and local communities.

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and local communities.

7.6 Use of Database

7.6.1 Enhancing Development of Mineral Resources

Through this study, a GIS database and system are establishing to store mineral resource information based on the SIGM database created during PRISM 1. A dataset from supplementary geological surveys and ASTER and Landsat imagery data procured during the study are adding to this. Currently, the system is used for plotting spatial datasets for use in for instance creating geological maps, counter maps, interpreting geophysical survey data, and plotting mineral occurrences. The study team is working at technical transformation for counterparts' using the range of the dataset available at present. To extend the scale of use of the GIS database, the following actions are needed.

- Accelerated entry of geophysical and other exploration datasets permitting further discussions and comparison of the results of geophysical data with geological and deposit maps.
- Augmenting mineral alteration data and selecting potential mineral deposit areas from fissure zones, alteration mineral zoning, geology and igneous rock structures.
- Proceeding with more realistic geological interpretations by integrating ASTER, DEM (Digital Elevation Model) of SRTM and relevant information like geological maps.
- Augmenting the amount of relevant input data, alteration minerals and geological field data to analyze ASTER imagery data (ground truth information).
- Entering drilling data to support the definition of geological sections for exploration surveys.
- Postulating and creating the 3D structural model, by adding obtained from drilling.
- Selecting potential geological survey areas by display and compilation of 2D and/or 3D data
- Identifying potential underground resource zones revealed by ASTER image data and comparing the results with ground truth information from the mineral deposit site, procuring ASTER imagery data covering the promising areas.
- Transforming the present data-archive system into an actual exploration system to support geological surveys through input/output of existing information on mineral resources (geological maps of 1/200,000 scale), mineral deposit maps, alteration zoning maps, ASTER image data, geophysical and geo-chemical data, outcrop maps and pictures.
- Interpreting metallogenic processes and selecting potential exploration areas supported by the 2D/3D information.

Completing these tasks will enable the provision of precise information to investors and strengthen OMRG's functional capacity (implementation of research and exploration). Also, they may result in the acquisition of additional knowledge about mineral resources and will facilitate the

dissemination of exploration knowledge from Mauritania to a wider audience. Simultaneously, education, technical improvement and increased staffing at the DGM and the OMRG are urgent issues to be solved in order to accelerate the use of the GIS database.

Several fundamental elements of GIS techniques i.e., the storing of satellite data, the data processing of imagery data and the integration of geological data with DEM, will be achieved through technical transfer during OJT.

Table 7.6.1 Use of Database

Items	Present status of usage	Role of JICA study team	Future use
Exploit the GIS database for total exploration and information system	Compiling 2D data (geological maps etc.)	Instruct counterparts in use of ArcView extension tools	Study interrelation of spatial information and use it as a total exploration system
Satellite imagery data	Satellite imagery data are not used effectively for resource exploration, because of a lack of data analysis by any appropriate processing software	Instruct users in operation of satellite imagery processing software (ER Mapper)	To store ASTER data Effective usage of ASTER data including DEM
Use of geophysical exploration data	Geophysical exploration data are not used	Undertakes data analysis (discuss the relationship with mineral deposits)	To store dataset Effective usage of analyzed geophysical data
Provides data for Investment Promotion Office		Make a proposal Provide application software	Effective usage of GIS database in Investment Promotion Office (OMRG/JICA , DMG)

7.6.2 Potential Fields for Future Usage and Relevant Approach

The mineral resource GIS database can be used in various fields, and its application in areas such as infrastructural development, regional development, water resource development, prevention of desertification, environmental conservation and industrial planning will all relate to the development actions that apply to the whole of Mauritania. Items targeted for entry into the mineral resource GIS database are as follows:

- Topographical maps - elevations, contours, rivers, administrative boundaries, cities etc.
- Geological maps- 1/500,000 1/200,000
- Infrastructure - railway, roads
- Geodetic base stations
  - Geological and mining deposit maps, research data
  - Power stations and network distribution centers
  - ASTER and LANDSAT original imagery and processed data (in areas of supplementary geological survey)
  - DEM data by SRTM

- Analyzed soil data
- Concession data (as of February, 2005)
- National parks
- Geochemical data (in areas of supplementary geological survey)
- Distribution of water wells and water resources
- Weather information (rainfall, temperature, wind)

■ (N.B.) obtainable from the SIGM database in PRISM

Not all of these items are available for the whole territory of Mauritania. By entering the data onto maps of 1/1,000,000 or 1/500,000 scale, the system may be applied also to fields other than the mineral resource sector.

Table 7.6.2 Potential Application Fields Based on a Mineral Resource Database

Fields	Contents	Entry items
Development Plan for infrastructure	Medium to long term plan	Road, water pipeline, power line network, mineral deposits, geology, baseline, water wells, water quality, rivers, population distribution, ASTER imagery, weather, vegetation, DEM
Development Plan for local area	Local area development plan for the whole country	
	Development plan for special district	
Prevention of desertification	Provision plan, green area plan, desertification management	
Water resource management and development	Water quality control, water volume management, development plan	
Use of water resources	Usage plans, utilization management	Water quality, mineral deposits, distribution of mines, roads, railway, water resources, water consumption, water wells, population distribution, farmland, agricultural products and their yield, factory distribution, vegetation, relevant infrastructure, baseline, power stations, electric power supply, DEM
Industrialization plan	Industrial estate plan, deployment plan of gas-pipeline, sewerage plan	
Power supply network	Power supply management, location of power lines	
Environmental protection	Environmental management, environmental conservation, environmental protection plan	Geology, mineral deposits, distribution of mines, topography, rivers, vegetation, water quality, water wells, fauna, baseline surveys, monitoring, distribution of factories, population, rocks, farmland, agricultural products, ASTER, DEM

In order to exploit the GIS database in a field other than mineral resource sector, it is essential to establish a collaboration system between ministry and other interested organizations. Furthermore, a common standard-based data collection and compilation is needed in each field:

- Creation of topographical maps at a scale of 1/100,000
- Establishment of the mineral resource database and technical basis of GIS in the OMRG
- Collection of infrastructure data based on common standards
- Collection of environmental baseline data
- Extension of the mineral resources dataset
- Storage of environmental and agricultural data
- Data collection in areas with insufficient data available

By adding infrastructure data to the mineral resource database, the system may become a useful and efficient tool for the planning and implementation of infrastructural development, local area development and water resource development.

7.6.3 Maintenance and Expansion of Database

The fundamental requirements for use and maintenance of the database are now in process and will enable the entry of information at the volume and scope envisaged. Improving operational capacity and increasing the number of the OMRG staff by an additional five persons to handle the database is also necessary. Considering the database structure, data entry should focus on:

- Selecting the existing research reports and exploration data available in the OMRG
- With the cooperation of the DMG and the OMRG, obtaining and storing the data of exploration surveys conducted by foreign companies.
- Extracting and storing appropriate information for the database from research and exploration reports
- Storing the geophysical datasets

In order to maintain and grow the database it is essential to allocate an adequate annual budget to allow for the costs of personnel, consumables, software upgrades, PCs and peripherals renewal and other operational items. The database terminal should be connected to the Internet to permit registration of GIS and related applications software. The existing OMRG/JICA GIS database system may be connected and integrated with GIS database and hardware of the Ouassat Sfariates province for mutual usage by LAN. In addition, it is important to connect OMRG/JICA GIS database with SIGM database for mutual usage. Following this project, a system of appropriate training or instruction conducted by experts will be needed to maintain, and innovatively grow the GIS database by monitoring technical trends in hardware and software development. Furthermore, a web-manager selected by the OMRG must supervise constant information updates and a technical maintenance contract with a web service provider, both essential to keep the web site up-to-date and looking fresh.

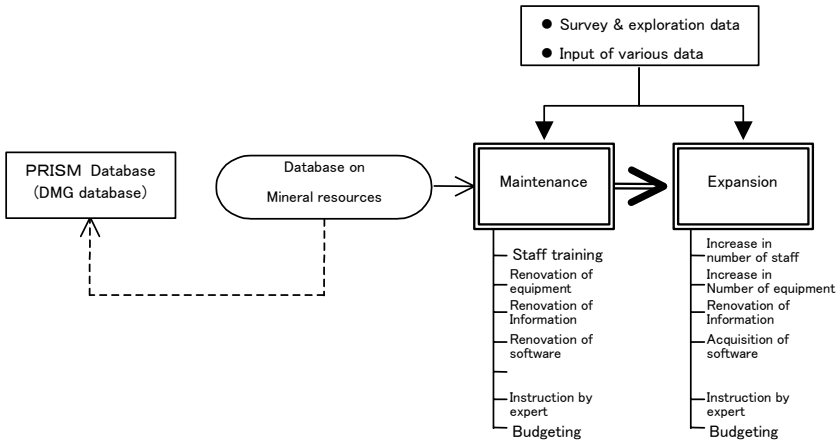

Fig. 7.6.1 General Features for Maintenance and Expansion of Database

7.7 Mineral Resources Promising Areas

7.7.1 Promising Areas

The present supplementary geological survey has been targeted on areas selected using investigative data obtained by the BRGM and the OMRG, which established that the deposits and manifestations in those areas have mineral resource potential. Thirteen target areas for geological survey were selected using remote sensing analysis, laboratory analysis and geological and mineralogical conditions. The target deposits in the supplementary geological survey are located in the Reguibat Shield, the Mauritanides and the Atlantic-coast Sedimentary Basin; these four geologic provinces cover the entire territory of Mauritania. This study will confirm whether or not these deposits are promising following a comprehensive analysis of their mineralization. The result will be a selection of the most promising areas within the entire territory of Mauritania.

Taking into account the present status of infrastructure and the level of interest of foreign investors, targets for the promotion of both exploration and development in Mauritania will be gold deposits as priority 1, copper deposits as priority 2 and rare metal deposits as priority 3. The promising areas targeted in the strategic development plan of this study will be selected within those areas, where exploration for gold and copper is possible. Owing to the investigation on deposits in the Reguibat Shield carried out by this study so far, the following findings have already been confirmed during the selection of promising areas:

- Gold mineralization is revealed within a portion of the banded iron formation (BIF)*.
- Gold mineralization in the BIF has occurred following the formation of BIF (about 1.0 Ma).
- Gold mineralization in the BIF is found along fractures.
- Gold mineralization is accompanied by tungsten enrichment and strong alteration of the host rocks (silicification and argillization)

* (Note: Algoma type - Appendix I, 2.15 in the Interim Report).

In this study, the potential gold occurrences were specified through analysis of fracture systems and alteration zones to make more precise selections in the promising areas. The potential for these fracture systems and networks to develop under the surface were considered

Table 7.7.1 Items for Selection of Promising Areas

Geologic province	Target	Point of selection of promising area
1. Reguibat shield	Au mineralization (veins, disseminated) (medium scale, Au amount of about 50 t)	• Fracture zone in BIF • Development of hydrothermal alteration
2. Mauritanides	Cu-Au mineralization (Carbonate replacement deposit, massive sulphide deposit) (small scale, Cu amount of about 500 thousand t)	• Carbonate rock in mafic schist • Around mafic volcanic rocks
1. Reguibat shield + 2. Mauritanides	Rare metal mineralization (Co, W)	• Hydrothermal alteration associated with 1 and 2 mineralization

7.7.2 Promising Deposits and Mineralization

Potential gold deposits in Mauritania are thought to exist in vein, disseminated and stockwork types in BIF (e.g. Tasiast Piment gold deposit). Whilst multiple ore formations are recognized in a specific deposit, it is important to distinguish whether these have been formed by a series of separate mineralizations or by other associated mineralization taking part in extensions of the mineralized zone. The gold, whether formed by a series of mineralizations or mineralization within disseminated veins, or stockworks, will occur depending on the lithology of the host rocks and the development of fractures and trends in the localization of mineralization. The extent of fracture development and hydrothermal alteration must be examined to determine the shape of each ore deposit and its mineralization.

Potential copper deposits exist in the Mauritanides. The most significant mineral deposits are carbonate replacement deposits in mafic schists, and are accompanied by partial gold mineralization partially (e.g. Guelb Moghrein). These deposits have a close relation to igneous activity, and investigation of the igneous rocks forming the replacement determines the characteristics of the mineralization. It may be possible that other mineral deposits in the Mauritanides will include volcanogenic massive sulfide deposits and their oxidized zones.

It is possible that rare metal deposits co-exist in close association with gold and copper deposits. In the Tasiast Piment gold deposit and the Guelb Moghrein copper-gold deposit, mineral indications of rare metals have been observed accompanying gold and copper mineralization. The clarification of rare metal mineralization characteristics and an understanding of the relationship between gold and copper mineralization and rare metal mineralization are key factors for assessment of potential rare metal exploration targets. The present conceptual thinking concerning potential deposits of gold, copper and rare metal in Mauritania is that:

- Potential gold deposits are vein types and are disseminated deposits related to hydrothermal alteration in BIF.
- Potential copper deposits are carbonate replacement deposits and volcanogenic massive

sulfide deposits found in the Mauritanides.

- Potential deposits of rare metals are a concentration of rare metals which are transported by ore-fluid and which precipitate at the stage of gold or copper mineralization. Besides rare metals had originally contained in the Pre-Cambrian group.

7.7.3 Examination of mineral deposit model

Mineral deposit modeling has an important role to play in encouraging exploration and influencing the selection of exploration methods and imaging the target depth for drilling programs. Therefore, improvements in the precision of mineral deposit modeling are necessary. Factors that will improve the precision include a better understanding of igneous activity, dating, metamorphism, geological structure, alteration, mineralization and ore forming circumstances. In outlining the development strategy, data gathered from supplementary geological surveys will be the best materials to use to examine the models. Using these materials to complement the modeling data it will be possible to recommend specific exploration opportunities. Regarding gold deposits in BIF, improving precision the model of the carbonate replacement copper-gold deposit, should be examined on the basis of comprehensive logic below:

- Gold deposit in the Algoma type BIF

  Formation of the Algoma type BIF on the ocean floor between continental plates during the Archean era → Collision of continental blocks → BIF and the oceanic plate had penetrate the blocks as a suture zone → Metamorphism and cataclasis → Anatexis around the base of the continental block → Generation of new magma → Ascent of magma → Cooling → Partial solid → Emission of magmatic fluid containing gold and tungsten → Fluid rising along fractures → Flow into BIF → Gold mineralization (As dissemination, quartz vein and alteration formations)

- Carbonate replaced copper-gold deposit

  The oceanic plate thrust over the West African shield → Formation of the Mauritanides → Flow of reduced deep groundwater into meta-ferruginous sandstone beneath the separated fault → Outflow of ferric solutions into the deep groundwater → Rising of the deep groundwater → Flow into carbonate rocks of the Mauritanides → Oxidation of the deep groundwater in the carbonate rock during mixture with subsurface groundwater where the oxygen dissolved originated in the atmosphere → Deposition of magnetite → Ascent of neutral magma → Cooling → Partial solid → Emission of magmatic fluid containing copper and gold → Flow into carbonate rock → Copper and gold mineralization

Table 7.7.2 Examined Factors for Improving Precision of Model of Mineral Deposits

Factor	Background of formation	Formation of deposit location	Origin of metals	Concentration mechanism of metals	Deposition place
Au deposit in Algoma type BIF	Collision of continental block and Anatexis	Formation of suture zone by collision of continental blocs, cataclasis	Archean shield	Anatexis – Ascent of hydrothermal solution	Fractures in BIF
Carbonate replacement Cu–Au deposit	Intrusion of neutral plutonic rock	Thrust of mafic plutonic–volcanic rocks contained carbonate rock	Neutral magma and oceanic plate	Magma – Ascent of hydrothermal solution	Carbonate rock in greenstone

7.7.4 Examination of Metallogenic Provinces

Metallogenic provinces are connect with exploration areas and the definition of exploration targets. To encourage exploration, continuous examination of each metallogenic province is as important as improving precision of mineral deposit models. At specific stages of the formation of deposits, and in specific metallogenic provinces, many similar types (genesis and kinds of ore) of ore deposits will form because of common geologic circumstances and mineralization and deposition conditions. To designate an area as a metallogenic province, an accumulation of surveyed data is necessary. This study lays emphasis on the examination of metallogenic provinces, especially for identifying gold and copper deposits by focusing on 13 deposits targeted in a supplementary geological survey. Metallogenic provinces provide useful indications of potential deposits:

- Within each metallogenic province, the basement and process of mineral formation is common to all the deposits.
- Within the same province, there occur multiple similar types of mineral deposit.
- In a specific area, it is possible to find different metallogenic provinces overlapping. These are easily recognizable as having multiple mineralization and showing remarkable differences in their development stages and features.
- It is logical to expect that different metallogenic provinces exist in different geologic provinces.

  The supplementary geological survey identified the two provinces:

  - BIF province including a gold deposit
  - Carbonate replacement copper and gold province.

It is necessary to increase data for continuous examining metallogenic provinces in the future.

Table 7.7.3 Factors to Examine in Metallogenic Provinces

Province	Area	Geologic zone	Deposit	Mineralized stage	Place
BIF province	Zouerate (Tiris)	Reguibat shield	BIF	Archean, Proterozoic	Reguibat shield
Au deposit in BIF province	Tasiast	Reguibat shield	BIF Au	Proterozoic (?)	Margin of Reguibat shield
Carbonate replaced Cu-Au deposit province	Akjoujt	Mauritanides	Cu, Au	Late Paleozoic	Mauritanides

7.7.5 Potential for Rare Metals in Mauritania and Associated Characteristics

Mauritania has potential for rare metals such as platinum-group metals, nickel, and titanium, and their existence has already been confirmed. Exploration, development, and the market for these metals are complex and are different from gold and base metals.

(1) Mineralization Indicators for Pt-Group and Future Development

In the present study, mineralization indicators for platinum group metals (PGMs) were confirmed in the Guidimaka ore body. Geological characteristics have indicated that PGM mineralization potential exists in the Selibaby and Amsaga areas, but surveys have lagged and there has not been a firm understanding of specific mineralization indicators so far. However, it is not indicated quantitatively yet, so it is necessary to grasp expansion of mineralization and possible mineral concentration with preparation of geological maps.

PGMs are found in South Africa, North America, China, Russia, Northern Europe and Australia, but they are in limited quantities, and there are few exploration projects for PGMs in the world (Table 7.7.4).

Table 7.7.4 Exploration Projects for PGMs in the World

Conventional PGM Ore Deposit									
Project	Ore Deposit Type	Country	Company	Resource	Grade				
					Pt	Pd	Au	Ni	Cu
				10^5 tons	g/t	g/t	g/t	%	%
Merensky, UG2, Platreef	Bushveld	South Africa	Major PGM companies of SA, and about 15 Junior PGM companies of Aus, Canada and UK						
River Valley	Bushveld	Canada	Anglo Platinum, PNWC	23	PGE+Au (Pd>Pt) 1.36				
Voissey Bay	Noril'sk	Canada	Inco	125	0.50	0.50		3.02	1.77
Duluth	Noril'sk	USA	Impala Platinum, BBLEM	4,400	0.06	0.23		0.20	0.66
Penikat	Bushveld	Finland	Outokumpu, Gold Fields	?	? Pt 2,892 t, Pd 7713 t			?	?
Pertime	Bushveld	Finland	Outokumpu, Gold Fields	184	0.27	1.15	0.12	0.06	0.20
Fedrovo-Panskoe	Bushveld	Russia		117	PGM 2.5-3.5			0.32	0.33
Jinbaoshan	Noril'sk	China	Pacific Minerals	34	Pt+Pd 1.4			0.17	0.14
Muni Muni	Bushveld	Australia		14	1.10	1.60	0.20	0.20	0.30
Unconventional PGM Ore Deposit									
Sukhoi Log	Orog. Gold	Russia		400	0.86	0.23	2.70		
Udokan	Sedi. PGM	Russia		2,000	0.01	0.96	0.10		1.19
Nizhno-Mamonskoe	Sedi. PGM	Russia		10	PGM<5.1, Au<3.4				0.80
Huarjiawan	Sedi. PGM	China		?	<0.19	<0.24	<0.17	0.95	
Coronation Hill	Sedi. PGM	Australia		5	0.19	0.65	4.85	<3.55	

* Reference: PGM report of JOGMEC, 2003 etc.

Currently, PGMs are being utilized in catalytic converters of vehicles with increase of the global environment awareness and their demand has is increasing. Their supply sources are not general, so it is meaningful to conduct the survey on potential PGM deposits which could link with discoveries of related ore deposits such as nickels, etc. Therefore, Mauritania needs to provide information to foreign investors by clarifying the potential for PMG existence with OMRG surveys,

obtaining survey data, and listing these data on its website, so that foreign investors can be used to conduct exploration activities.

(2) Titanium Prospecting

In the study, a preliminary survey was taken of placer-type titanium deposits that extend along the coastline in northern Nouakchott. This preliminary survey confirmed enriched areas of ilmenite. If OMRG conducts an extensive potential survey to select exploration areas of this type deposits in the near future, it would attract the interest of foreign investors. However, to conduct a meaningful survey, OMRG will have to develop a survey foundation such as that described below:

- To possess boring equipment for placer-type deposits.
- To acquire boring technologies and sample processing techniques (calculating grade of heavy metals, mineral separation, calculating grade of ilmenite, etc.)
- To prepare geologic logs and geological sections.
- To prepare topographic maps, stratigraphic maps and ore grade distribution counter maps
- To acquire and accumulate information about ilmenite deposits.

In the seminar held as part of the study (in June 2004), participants were given an introduction to titanium deposits and ways of proceeding with subsequent surveys (Fig. 7.7.1 ~~9.5.1~~) were discussed. It would be desirable if this approach could be used to arrange the above items and link them to foreign investment at the exploration stage.

Generally speaking, the development of coastal placer deposits emphasizes environmental protection due to its large scale. There are numerous deposits that are already being developed in Australia, Brazil, etc., so if a deposit is not competitive (in terms of grade, volume, cost, infrastructure, etc.), it will be difficult to find a market. Therefore, OMRG must, first and foremost, attract the interest of foreign companies while it is conducting its surveys.

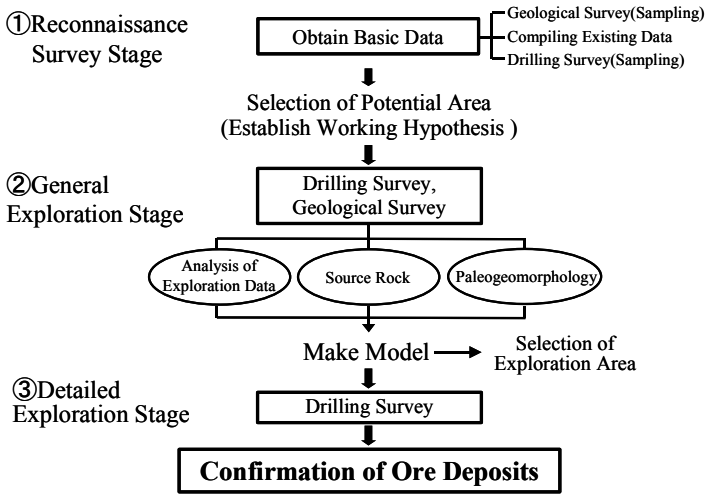

Fig. 7.7.1 Approach for Titanium Exploration Proposed in the Seminar

Surveys and exploration of placer deposits can be made using simple boring machines. However, only Australian company has been using such boring machines in Mauritania. Auger drilling can be used for sandy sampling in ground that is less than 5 m deep. Auger drills are relatively cheap (a few thousand dollars), and easy to handle. Heavy minerals can be separated easily using simple methods like panning. Therefore, if OMRG buys auger drills, it can survey the placer deposits and at least prepare distribution maps for heavy minerals to select target areas for exploration.

7.8 Mining Alliances with Neighboring Countries

7.8.1 Mining Technical Cooperation with Neighboring Countries

Mauritania's neighbors (Mali, Morocco, Burkina Faso, etc.) also possess resources and, like Mauritania, are promoting their development. These countries all have several issues in common, including nurturing human resources, introducing technology, and development. Both Mali and Mauritania are desert countries, so they face the same issues related to resource development in the desert. It is the same way with infrastructure development. There is already a cooperative relationship with Mali regarding hydroelectric power. Cooperative mining relationships are being strengthened with neighbors, and these are also one way of promoting resolutions to issues within these regions for mining promotion. For example, there is likely to be discussion about building infrastructure, a human resource training center, a technical development center, and so on. Morocco has already supported OMRG with exploration technology. The following types of alliances are being considered:

- Joint resource surveys and geological surveys in national boundary areas
  - To provide money and personnel communally.
  - To get donor countries and international organizations to support it.
- Technical development center
  - To make the Mining Technical Training Center proposed in this report a base for mining technology in the western Africa.
  - To hold periodically technical exchange seminars.
- Linkage system for the Website
  - To share and exchange mining information.
  - To access and utilize the satellite images that each country hold.
- Jointly operated investment promotion center
  - To hold the International Mining Seminars in collaboration with the investment promotion office of each country.
  - To hold Infrastructure Development Conferences for enhancing the mining industry.
- Jointly held training sessions, seminars, etc. (by invitation of foreign experts) to nurture

human resources

- To invite experts by communally financing.
- To establish communal faculties of mining engineering and science of ore deposits. (ex: one location among Mali, Burkina Faso and Mauritania)

- Joint geological mineral research (e.g., greenbelt, IOGC)
  - To finance by communal funds or supports from the donor countries and international organizations.
  - To prepare geological maps and ore deposit maps in the western Africa.

To stimulate collaboration, the first step that engineers or organizations like the DMG or OMRG in surrounding countries should take is to hold working-level meetings such as the Responsible Personnel Conference in Western Africa or the Mining Seminars in Western Africa to strengthen relationships with each other and exchange opinions. Another option would be an entrance to mining technical cooperation with neighboring countries to call on them to participate in an expert technical session which is held by the Mauritanian government. At present, it is likely that the donor countries and international organizations will begin increasing their support to Africa. Regional transborder support has also begun. It is possible to enhance international communication, because IT technology has progressed amazingly. As Mauritania is located at the crossroads of northern and western Africa, it is easy for Mauritania to expand technical exchanges with Morocco which has advanced mining technology. Also, geographical location of Mauritania makes it easy to access other countries in western Africa and to learn about the state of mining in those countries. These circumstances will make it possible for Mauritania to take the initiative to construct technical alliances and relationships.

7.8.2 Cooperation in Environmental Protection with Neighboring Countries

In addition to technical cooperation, it is also important to collaborate with environmental protection beyond national borders, because environmental contamination caused by mining activities sometimes crosses these borders. It is necessary to exchange information on environmental management associated with mining activities to deepen awareness of environmental protection in all of western Africa. The following cooperative activities are supposed to be done in the near future:

- To construct a system for linking the websites.
  Construction of websites for environmental management will be a task in the future, but it is desirable for each country to construct a website that can be added to an international link system. Mauritania should take a leading role in this.
- To manage regional environmental protection using satellite images.
  Monitoring by satellite images should be carried out periodically. It is desirable to manage the regional environmental impacts caused by mining activities under an organization such as

"Environmental Monitoring Center of Western Africa" in the future.

- To hold seminars for mining environmental management.

  Seminars in western Africa for mining environmental management should be held to exchange information with advanced mining countries for making an environmental management system or constructing facilities in each country.

7.8.3 Ripple Effect of the Mining Industry

The development of a mining industry leads to the development of associated industries such as transportation, construction, manufacturing, explosives, etc. As development progresses to metal smelting, this can cause a ripple effect for processing industries. Although temporary dependence on foreign investment is essential for the growth of the mining industry, nurturing the industries that mining spawns will lead to economic growth in the future. Mauritania is currently developing a gold mine, and redeveloping a copper mine. The Tasiast Gold Mine is ordering mining equipment from South Africa. Mine development can lead to projects involving the transportation and construction industries. Private companies undertaking such industries under cooperative agreements with neighboring countries must be considered in the future.

The underlying concepts of the "Investment Promotion Agent" (IPA) are shown in the Appendix I, 1.1. One role of IPA would be to nurture local companies and networking in alliance with local companies by, for example, providing parts and materials to the foreign companies. Currently, foreign companies that undertake exploration in Mauritania must depend on foreign sources for procuring materials, constructing, manufacturing, etc., because local companies have not yet developed the capacity to do these tasks. Also, transporting is not sufficient due to shortages of transport loads, road infrastructure and vehicles. However, businesses related to mine development and ore production will create employment and nurture local companies in the future. Transporting needs alliance with neighboring countries, and companies engaged in constructing and procuring materials are also expected to expand their business through alliances and cooperation with neighboring countries.

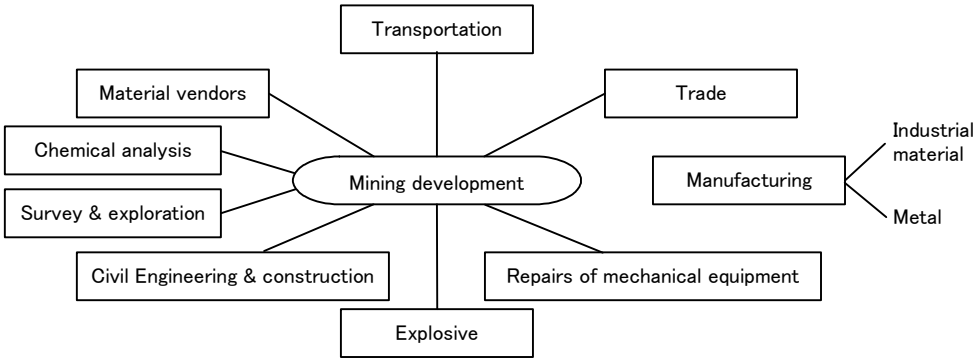

Fig.7.8.1 Ripple Effects in Mining Industry

7.9 Business Skills

7.9.1 Building a Foundation for Improving English Skills and Making English a Semi-official Language

Most potential investors are from the English-speaking world or can use English to communicate with. English is already used around the world for communications, and it is becoming commonplace for information to be collected and transmitted in English. While the main languages of communication which transcend generations and ethnic groups are French and Arabic, these are relatively rarely used as languages of communication. In elementary and junior high schools, science lectures are given in French and arts lectures in Arabic. Today, science lectures are also taught in Arabic in some schools like the Technical High Education Center. English is quite alien as a communication language. But in the mining field, English is the common language for communication and documentation, and most of the major information in English. Therefore, it is vital to collect information in English and access communication in English to "jump-start" the mining industry. An educational base should be built to improve English language skills and make English a semi-official language. The time to start making these preparations for the future is now. In this report, English-language Instruction System is included in the promotion program. MMI must cooperate with the Ministry of Education to build a foundation for improving English ability. This includes:

- Increasing the number of Mauritanian students and trainees in English-speaking countries.
- Providing continuous English instruction to MMI and OMRG personnel.
- Inviting mining experts from the English-speaking countires.
- Using English in the Investment Promotion Office.
- Providing systematic supports for English education in high school from donor organizations such as USAID, etc.
- Giving government supports to private English schools (official subsidies and tax exemptions within limited time, providing facilities, etc.).

The strategic development plan also needs to formulate an implementation plan to attain the national treasury for achieving it from view point of promoting exploration and development.

7.9.2 Implementation of Promotion Measures

If the promotion measures in the strategic development plan can not be achieved, the current situation will not change. The promotion measures are still in the conceptual stage, so it is important to investigate each promotion measure, ways of materializing the content, effects, feasibility, existence of donor countries/organizations, etc., and formulate an implementation plan. Furthermore, some promotion measures will require a corporative plan with other organizations. MMI and OMRG have already begun these operations in their daily work. The strategic

development plan will also have to have an implementation plan for achieving it with the national treasury from view point of promoting exploration and development.

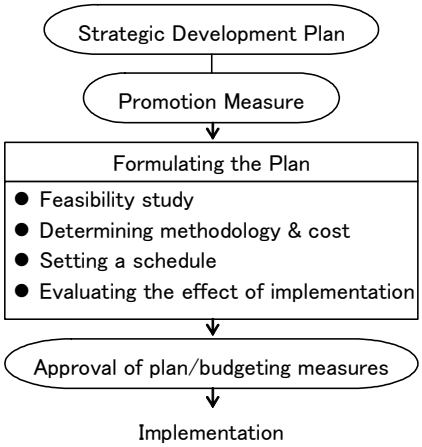

Fig. 7.9.1 Implementation of Promotion Measures

7.9.3 Importance of Planning, Implementing, and Checking

A strategic development plan has been proposed in this study, but this strategic plan is actually composed of various programs that are promotion measures. It is necessary to establish a system that can allow for routine work to be done, such as formulating an execution plan for each promotion measure (the programs) mentioned above, and formulating and executing concrete plans for achieving goals while checking progress and making revisions. It is also necessary to be aware of the importance of planning, implementing and checking. It is just same in goals for each stage in each program and strategic development plan, and it is necessary for each level such as section, division and department to functionate systematically in planning, implementing and checking.

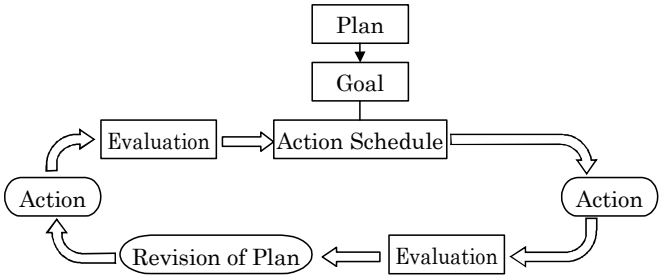

Fig.7.9.2 Implementing and Checking the Plan

There are some questions about whether or not this kind of system has reached the point where it can be used to implement promotion measures, attract investors and investment capital, and meet deadlines, among other things. If it has not reached that point, the system will have to be put into action while checking measures that could be taken to attain this level. This would help to materialize the promotion measures.

In the same way, specific survey plans should be formulated for OMRG surveys, including

period of implementation, targets, and procedures, which must also be clarified by relevant persons, departments, etc. In addition, surveys should be made of ways to procure equipment, etc., while these plans are carefully considered and put into action.

End of Final Report

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1.1 The Mauritanian Mining Sector IPA

1. Introduction.

In June 2004 the JICA team has introduced the concept of an Investment Promotion Agency (IPA) at the June 14th Seminar presented at the Novotel. The need for an IPA was identified by PRISM, the JICA team has cooperated with PRISM to realize this plan. Since then further study to establish an IPA has been carried out by JICA in cooperation with the PRISM team to formulate the whole concept of a Mining Sector IPA in Mauritania including its specific operating parameters.

2. Background Issues

2.1 Mauritania and the global investment picture

Foreign direct investment (FDI) should be attractive to Mauritania as it has the potential to generate employment, increase productivity; permit skills transfer and introduce technology. Investment in exploration and development of the country's nascent mining sector is expected to enhance exports and contribute to the long-term economic development of the country. It is therefore important that at its current level of development the Mauritanian mining sector should plan to leverage FDI for its further development.

UNCTAD, the Geneva based United Nations organization dealing with Trade and Development has analysed FDI trends and their impact on development in order to improve understanding of the issues related to FDI and enhance its benefits for developing countries, particularly the least developed countries (LDCs) of which Mauritania is one. UNCTAD compiles data on FDI, provides advisory services and training on international investment, helps developing countries improve their policies and institutions that deal with FDI and helps these countries to participate in international negotiations on investment. One-third of global trade is intra-firm trade as seen in multinational business, but the benefits of FDI may be seen from the following facts:

- Globally, the foreign affiliates of some 64,000 transnational corporations (TNCs) generate 53 million jobs.
- FDI is the largest source of external finance in the developing countries.
- On average, developing countries' inward stock of FDI in 2003 amounted to nearly one third of their GDP, compared to just 10 per cent in 1980.

The Mauritanian government already has a Private Investment promotional office which is a member of the World Association of Investment Promotion Agencies (WAIPA). WAIPA was established in 1995 and is registered as a non-governmental organization (NGO) in Geneva, Switzerland. The Association currently has 175 member agencies in 145 countries and acts as a forum for investment promotion agencies (IPAs) to provide networking opportunities and facilitate the exchange of best practices in investment promotion. Membership is open to all agencies whose prime function is to promote any country or territory for investment. Its aims are to improve cooperation amongst IPAs on a regional and global basis and to facilitate the exchange of experiences in attracting FDI.

The objectives of WAIPA, which are reflected in its statutes, are to:

- Promote and develop understanding and cooperation amongst IPAs;
- Strengthen information gathering systems and information exchange amongst IPAs;
- Share country and regional experiences in attracting investment;
- Help IPAs gain access to technical assistance and training through WAIPA sponsored events or by way of referrals to relevant international or multilateral agencies; and

- Assist IPAs in advising their respective governments on the formulation of appropriate investment promotion policies and strategies.

2.2 The mid-term future for Foreign Direct Investment (FDI)

UNCTAD reports that the prospects for global foreign direct investment (FDI) are expected to be positive in both the short term to end 2005 and the medium term (2006-2007). The extent and the speed of the FDI growth will vary by region and industrial sector. For example, investment growth in the mining and energy sectors is presently very strong and rapid due to the high demand from China for raw materials.

Despite is growth in FDI, competition for FDI funding is expected to become fierce during the next few years and many host countries are expected to intensify their efforts in investment targeting, in addition to offering more generous investment incentives and further liberalization of their investment conditions. This competitive pressure further emphasises the need for Mauritania to establish and train a professional team to manage its mining sector IPA as quickly as possible.

Three main factors will influence expected FDI growth:

- An acceleration of global GDP growth
- Relatively low levels of interest rates in major capital exporting economies
- An increase in domestic investment and industrial output

This is complemented by rising corporate profits and stock values of the TNCs. UNCTAD reported that all groups recently surveyed agreed that investment confidence is returning and that global FDI flows are likely to increase during the period 2005-2007.

Services are expected to be the sector most attractive to FDI, particularly in tourism, telecommunications and IT. Prospects for manufacturing are also expected to be good, although varying by industry. Electronics, automobiles and machinery are expected to perform better. The primary sector is expected to see a moderate FDI recovery. In this respect, Mauritania is not so well placed, as with little manufacturing industry and a relatively unskilled labour force it will struggle to be competitive with other more developed economies.

Asia and Central and Eastern Europe are viewed as the most attractive regions for FDI, while relatively weaker FDI recovery is expected in Western Europe and Africa in 2005, and in Latin America in 2006-2007.

The United States, the United Kingdom, France, Germany and Japan will continue to be the main sources of FDI, but newcomers such as China and South Africa will also be on the list of top FDI providers.

Mergers and acquisitions are expected to resume their popularity in developed economies, while greenfield investments will be preferred in developing countries.

The worldwide surge in manufacturing offshore indicates that lower-labour-cost countries will benefit most from FDI, in activities such as production, logistics and support and sales & marketing. Infrastructure and skill-dependent investments will also expand in certain countries. Here there are opportunities for Mauritania as, with training, there is a pool of unemployed labour that needs to learn, to find work and to earn income.

These generally positive trends may be counterbalanced by a number of risk factors, including oil price volatility, the potential for a rise in protectionism impeding trade and outward FDI, regional conflicts and increased threats from terrorism. On the down side, some major developed and developing countries continue to struggle with structural impediments to economic growth and FDI flows.

2.3 Mauritania and FDI

The natural resources sector in Mauritania has recently been subjected to considerable scrutiny by foreign mining companies. Following the complete revision of mining law in the late 1990's some 20 companies took out exploration licenses and carried out field surveys, particularly in the North east of the country where Kimberlites were discovered and along the gold and copper bearing Mauritanides belt which runs roughly parallel North West to South East some 200 – 500km from the Atlantic coast. The PRISM program to encourage mining investment has resulted in improvements in mining sector exploration and exploitation, a revised legal framework, strengthened management capability and improved geological data. The two projects that follow here are evidence of the success of that program:

- The Tasiast gold prospect, in the Northern Mauritanides, which is now being developed as a mine
- The Akjoujt gold and copper mine which is being reopened.

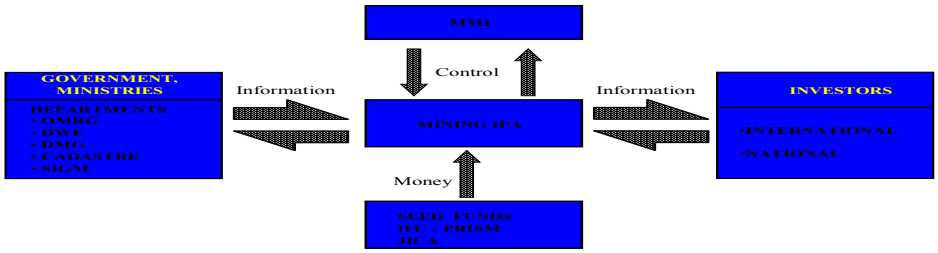
However, in both cases the activity is underlain by very high global metal prices in copper and gold. These two projects will bring Mauritania investment of at least US$80m. (Canadian owned Rio Narcea announced on August 23rd that it will now invest $63.5m at Tasiast before it starts production in 2007).
The question now is, 'How can the Mauritanian mining sector contribute to national economy based on these two successful examples and the mining law progress that is already accomplished?' Clearly, an IPA is needed to capitalize on this progress and some strategic issues must be resolved before a mining IPA can be established:

3. Strategic Issues

3.1 Internal appeal

Whilst among MMI and relevant agencies there is a consensus that an IPA is the ideal mechanism for the promotion of the mining sector there appears to be little understanding of how it may fit within the existing mining sector structure and what work it will do, as the role of the IPA has not been debated, agreed and settled. There is thus a need for internal 'appeal' or 'education' to be carried out within the existing departments of the Ministry to show how the IPA will function and benefit each department. There is little coordination between mining-related departments trying to attract and promote investment. Brochures and information are prepared without any coordination of budget and as no single promotional plan is being followed each department is trying to attract investment without pursuing a clearly defined, common strategy. In the current situation there is not a clear understanding that these separate departments and the Ministry itself are the principal Mauritanian stakeholders of the mining sector IPA. They need not only to understand the need for it but also to sign up to 'ownership' as 'central players' in setting IPA policy. To achieve this they will all need to ensure that a senior person is made responsible for communications and relationships with the IPA. The schematic below shows the mining IPA relationships. (Please note that these are promotional interfaces and not administrative interfaces).

Mining IPA relationships



Internal Appeal - Summary

- *All MMI departments need to acknowledge that the IPA will be the main point of contact with potential investors as well as understanding the need for it and its functions and to fully cooperate in establishing it.*
- *Each department needs to designate a senior person as responsible for its communications with regard to the need for and functions of the IPA.*
- *All MMI departments need to acknowledge that in future it will be the IPA that coordinates all promotional activity directed towards securing investment in the Mining Sector.*

3.2 Policy

The policy of the IPA must be clear and agreed by all stakeholders. The policy needs to ensure that the IPA is:

- A focus for the distribution of all information about Mauritania's mining opportunities
- A first point of contact for investors
- Able to provide a professional response to enquiries. (A fast coordinated response with accurate and up to date information are needed.)
- Able to accept the need for the MMI to keep control of investment process throughout
- Aware of the imperative of regular follow up to enquiries from potential investors

There needs also to be a debate concerning policy on investment promotion. It would be wise to invite external practitioners from long established IPAs as well as experts from WAIPA and UNIDO to participate in this debate. It is noted that the EU has also a supporting department for investment in the mining industry. The ultimate goal of foreign investors is to manage large mines. However, although the country also has a desperate need to introduce structure, regulation and investment to its domestic industrial mineral sector for its economic growth, at present this is largely out of control with many small artisanal operations providing mainly construction materials sourced almost at random from the countryside. Often the materials are unsuitable, the mining of them damages the environment and the pits that remain after extraction are used for dumping garbage, compounding the environmental destruction.

A regulated domestic building materials extractive sector is essential to supply good quality materials for infrastructural projects. It could attract investment from local construction companies, civil engineers and entrepreneurs. Therefore, this investment is needed in parallel with the development of metallic minerals and needed for the growth of domestic companies. It would be also result in an

improvement to the quality of building materials, the reduction of environmental damage and an increase in the durability of buildings as well as creation of industries for downstream activities.

Establishing a policy that encourages domestic investment in addition to FDI will involve the participation of the Mauritanian business sector and offer local people an opportunity to benefit from mining activity. The involvement of local businessmen will help to create understanding of the mining sector in the population as a whole and will also improve the capability to solve problems of mining to those communities directly affected by it, especially if they are allowed to derive some benefit from it. Local businesses will also adapt to supply the industry as it grows, benefiting the economy as a whole.

Policy - Summary

- *From its inception, the IPA must consider the need to attract local investment as well as international investment into the mining sector. Failure to do this will alienate the local business community*
- *Each department needs to designate a senior person as responsible for its communications with the IPA*
- *All MMI departments need to realize that in future it will be the IPA that coordinates all promotional activity directed towards securing investment in the Mining Sector.*
- *Over time, the MMI IPA will be able to call on a pool of local investors to provide funding for small scale, but essential, local projects and attract international investors to the larger scale projects. Mechanisms will be needed in the longer term to ensure that local investors may also participate in larger projects.*

Mali with its CNPI and Senegal with its APIX are two developing countries adjacent to Mauritania with experienced IPAs. Oman, with its OCIPED is a petroleum producing country with a more advanced economy, but its IPA may also be considered as a practical example of what is achievable over time.

The UNIDO Investment and Technology Promotion Office Tokyo (ITPO Tokyo) was established in 1980 based on an agreement between UNIDO and the Government of Japan. The basic mandate of this office is to promote direct investment and technical transfer from local investors into developing countries. In accordance with this policy ITPO Tokyo manages several activities such as investment seminars, consulting services, invitations to study for officials from developing countries and sponsorship for investment promotion training programmes in developing countries. The head of this organisation is Mr. Seiji OSHIMA. The ITPO collaborates with a number of other Japanese organisations, including JICA. The following is a full list of ITPO's collaborators:

- ASEAN Centre
- AOTS (The Association for Overseas Technical Scholarship)
- ECFA (Engineering Consulting Firms Association)
- IDCJ (International Development Center of Japan)
- JETRO (Japan External Trade Organization)
- JICA (Japan International Cooperation Agency)
- JAIDO (Japan International Development Organization Ltd.)
- JODC (Japan Overseas Development Corp.)
- JOI (Japan Overseas Investment Information Institute)
- JPC (Japan Productivity Center)

3.3 Funding

Funding the IPA need not be a problem. Mauritania is already close to producing oil and the revenues that will be derived from its sale. A few percents from this revenue will be all that is required to establish and run the Mining Sector IPA. As this will be a 'sales office' to be called, it will have targets and sales objectives and over time this will bring, indirectly, further benefits to the country in the form of mining royalty payments, creation of employment and development of community. Thus funding a professionally managed and competent IPA must be regarded as an investment in the country's future, not as another cost of government.
Furthermore, the pool of talent available to staff the IPA is small and is composed mainly of those departments already reporting to the MMI. Thus, the salary budgets of the very few staff that may be seconded from the MMI departments to man the new IPA can be sequestrated to its budget.
Thus with some external funding from new petroleum revenue and some adjustments to MMI internal budgets funding need not be seen as a problem but as an investment.

Funding - Summary

- *The MMI can adapt its own budgets to fund much of the staffing of the IPA*
- *The MMI can apply for a very small percentage of the oil revenues that will benefit the economy in early 2006.*

3.4 Training

It is evident that very few staff in within the mining sector has any specific experience of IPA management or operation and none have formal training. This is evident from the lack of active research to find investing partners. There is currently no plan or team engaged in this activity.
It will be essential to quickly develop a small professional team that is competent to carry out this work and adopt the IPA best practice guidelines recommended by UNCTAD. An example of this is a project currently underway in Laos, which is at a similar stage of development [as regards its IPA] as Mauritania. This Laos example is very informative and instructive when considering the establishment of the IPA in Mauritania.

Three elements of training need to be considered for the IPA team:

- Formal training overseas by an agency such as WAIPA or UNCTAD.
- Training through exposure to day to day operation of an IPA. This would preferably be a 'mining' or 'mining oriented' IPA but even a regionally located IPA such as those is Senegal or Mali could be suitable.
- Training throughout the IPA planning and commissioning period from an external expert with capability in marketing research, business planning and negotiation. This would be a mix of delivered formal training sessions and 'hands on' training as the team develops.

The cost of training will need to be included within the first year of the operational budget but to a certain extent may be offset by training grants from NGOs.
In Mauritania it will be necessary to provide a comprehensive package of courses that covers all subjects from basic market planning to sophisticated negotiation techniques. A training needs assessment will be required but the training package will most likely need to deliver:

- Time and business planning
- Budgeting, forecasting and financial record keeping

- Performance measurement and benchmarking
- Communications
- Marketing research and the targeting of investors
- Planning of meetings, business travel, promotional and selling visits abroad.
- Organization of investment promotion shows and seminars
- Preparation of promotional literature of all kinds and updating of website
- Notes on foreign cultures.
- Receiving of foreign delegations and visiting investors.
- Organization of presentations, meetings and field trips in Mauritania

The needs assessment will highlight further requirements. Over time the team should be offered further training opportunities to update their skill levels to incorporate the latest techniques and practices used by IPAs.

Training – Summary

- *A training needs assessment of the key staff will be essential. It is unlikely that all of the necessary skill sets are available in Mauritania today.*
- *Three routes are recommended for the training program – formal with an IPA development organization, 'hands on' with a successful functioning IPA, preferably within the same region and culture set and 'reinforced' by an expert marketer during the commissioning stage of the IPA*
- *Training will be needed throughout the life of the IPA, not only during the start -up period.*

4. Establishing the API

4.1 Mission

The Purpose or 'Mission' of the IPA will be to "Promote the Mauritanian Mining Sector to the International and National investment communities in a professional, efficient and cost-effective manner. To maximize interest and investment into this sector."
To explain the functions of this Agency and its relationships with organizations in the Mining sector and also its interface with other administrative areas a short study was prepared and this is attached here. This study is now used as the basis for the design of the IPA together with further information that has been provided during the past 12 months.

4.2 Design Principles.

The design needs to consider the realities of establishing a 'commercial' enterprise in Mauritania. These are:

- The funding of the IPA will be limited during the first stage of its development. Mauritania is not a rich country.
- The staff numbers will need to be kept small during the early stages. Few qualified staff are freely available and funds will not permit the creation of a large organization
- The staff will need expert training in international commercial, language and negotiation techniques. This will take up to one year and external help will be needed.
- The Director will need to have international experience and a sector-related technical education. He will also need to have held senior positions in the Mauritanian mining sector. A short job description and ideal profile will be included in the business plan for the IPA.
- The IPA location needs to be at the heart of Mining sector administration, i.e. close to the centre of the day to day sector management. It will be appropriate to locate the IPA within the Ministry building.

- The offices of the IPA will need furnishing to international standards with suitable communications, publications and visitor facilities. These are 'sales' offices.
- It must be recognized that if the Mining IPA model is successful, it should evolve to bring investment to other industrial sectors in Mauritania.

The relationship of the IPA with other Government departments and Non Governmental Organizations was studied by the JICA team since June 2004, and was also discussed with PRISM. The diagram in the attached study illustrates the logical flow of information and communications between the IPA in its central role as the focus for attraction of investment and as a collector, analyzer and distributor of information to the marketplace. This sheet includes the optimum functional format for the Mauritanian Mining Sector IPA based on the strategic structure.

4.3 Funding the early stages

4.3.1 Assumptions:

Initially, funds must only be provided by Ministry of Mines and Industry. Funds will be limited and thus the scope of operations and focus on investor targets must be aimed at generating the most interest for the least cost.
By keeping staff levels low the need for office facilities is minimized. However, at start up the capital expenditure budget needs to take into consideration the requirement for business furniture, communications and desk-top publishing equipment and software. This will enable the office to operate at the most efficient and effective international level.
The Funding budget needs to consider the expected return on investment over the following three years.

4.4 Staffing

4.4.1 Assumptions

Staff count (including all assistants, tea makers, office attendants etc.) will need to be 6 or less persons initially to keep the operating costs low.

- Director should be a senior, technically qualified official from the mining sector. A person with English skills, international experience and good marketing/diplomatic skills will be required for this work. The Director will have the full responsibility for management of the IPA and implementing Mining Ministry Policy concerning the emphasis for investment attraction. There is likely to be an important travel element to this post, up to 35% of work time when the IPA is fully operational.
- Deputy Director should be capable of replacing the Director when he is not available but be also an efficient administrator. Will also need English skills, international experience and some marketing and diplomatic skills for this work. Some travel will be required in this post.
- Communications Manager. This post will be responsible for all public relations for the IPA including the preparation of the Mauritanian Mining News Briefing and. This will include making meeting arrangements, organizing and booking advertising space and development of external events such as PDAC and Indaba. English skills and marketing experience will be needed for this post.
- Accounts manager. This is essentially a clerical post but some accounting qualification would be preferred as the ability to analyze and measure the effectiveness of promotional activities may be judged by the amount spent on a particular promotion target and the amount subsequently invested by that target. The Accounts manager will be responsible

for providing the financial information that will enable the Director to effectively manage the budget of the IPA and control all costs within that budget.

- Secretary / market researcher. This post will be to support the Director and Deputy Director in their internal roles. It will also be desirable to have a person who knows how to use the internet to look for company information which is essential if the IPA is to build records of potential investors to target.
- Office assistant. to run errands such as document collection and to assist with routine tasks such as photocopying etc.

4.5 Offices and Office Equipment.

The office suite needed by this team will require the following rooms:

- Director's office
- Deputy Director's office
- Communication manager's office (Note, these two offices could)
- Accounts manager's office (be in an 'open plan' area.)
- Secretary's office adjacent to or between Deputy Director and Director.
- Collation / Mail Room / Office assistant location.
- Entrance Lobby (and open plan area).
- Male and Female Toilets
- Conference Room doubling also as a reception facility for visitors.
- Food preparation area (Small kitchen with water cooler, coffee and tea making facility, food storage cupboards and large fridge and washing up facilities)
- Internet communications room
- (Possibly) Video telephone conference room

Equipment must include telephones, overhead projection and screen in conference room,
Five PC's connected to LAN, A3 color printer (e.g. HP 1220 type), Photocopier and adequate filing, paper and publication storage facilities as well as a map table and map storage chest.
The facility will also need to be air-conditioned.

4.6 Cost estimates

4.6.1 The costs for the first year of operation of the unit will be composed of four main elements:

- Salaries
- Establishment costs for the IPA office location including office facilities, furniture and office equipment
- Office rental or capital costs to amortize.
- Promotional and operational costs such as printing publications, participating in investment seminars and phone bills, stationery costs etc.

Where possible estimates for each of these four elements have been provided here below. These will be revised as the business plan is refined.

4.6.2 Salaries

It is estimated that the annual salary bill for these six personnel will be as follows:

Title	Salary US$
Director	12,000.00
Deputy Director	9,000.00

Communications manager	8,000.00
Accounts manager	8,000.00
Secretary	6,000.00
Office assistant	4,000.00
Total Personnel Budget	47,000.00

There may be a concern about this amount but the IPA must be manned by professional people with good language skills who have credibility with foreign people and who are able to travel abroad and 'sell' Mauritania.

4.6.3 Office rental

These estimates are made here based on some idea of the local conditions. Hereafter these costs need to be verified before final budgets are agreed:

Item	Annual Cost US$
Office rental costs	6,000.00
Total	6,000.00

4.6.4 Office equipment costs

Again these costs need to be checked against local conditions

Item	Annual Cost US$
Refurbishment of offices (repaint, carpets,)	3,000.00
Office equipment (computers, projectors and photocopier)	15,000.00
Office Furniture including conference table	10,000.00
Kitchen and Air conditioning	3,000.00
Total	31,000.00

4.6.5 Office operational costs

Item	Annual Cost US$
Maintenance and cleaning	600.00
Power, water and light	2,400.00
Travel Budget (6 overseas missions of two personnel each of two weeks duration)	100,000.00
Publications and printing	12,000.00
Mailing and couriers	5,000.00
Conference fees	5,000.00
Local entertainment	8,000.00
Inwards investment mission expenses	15,000.00
Total	148,000.00

4.6.6 Total cost.

Grand Total 232,000.00

(Note this figure includes US$31,000 for initial set-up investment)

If we allow for an element of contingency at about 10% the total first year cost will be about US$255,000 including the initial investment. This will need further verification and will be influenced most of all by the amount of overseas travel needed to promote the sector.

5 Action Planning

To establish an IPA it is necessary to prepare an implementation plan which considers all of the steps and the main actions needed to achieve a functioning IPA. This planning process is outlined here, with rationales where it is considered necessary. (This planning follows the guidelines set out in The Blue Book on Best Practice in Investment Promotion and Facilitation based on the experience of UNCTAD in setting up IPAs). It is very difficult financially and technically for Mauritania to implement this plan independently without assistance from the donor countries and international organizations. However, establishment of the IPA is vital to economic growth if investment promotion is to be pursued actively.

The plan contains concrete and measurable activities to enable government to achieve best practice in the following three broad areas:

- Regulatory framework for investment and impediments to investment;
- Investment promotion strategy; and
- Institutional development.

The selection of topics and action items are guided by the following key criteria:

- Relevance to foreign investment;
- Actionable within one year;
- Not being covered by other players/donors; and
- With a focus on action and doing – not on planning.

This action planning process also includes provision to monitor the implementation of the IPA. The planning is set out as a series of activities that must be undertaken if a successful IPA is to be achieved within a reasonable time scale, in this case 12 months.

5.1 Activity 1. Production of *official* translations of business-related laws and decrees in English

A critical determinant of investment location is the quality of the business legal and regulatory framework. Before foreign investors can assess the business environment, they must have access to business laws and regulations. Mauritania has a good English translation of the investment law and a few others such as the mining cadastral law and mining regulations, but other laws are difficult to access in terms of availability and reliable English translations.
Also, timely and properly translated laws and regulations are necessary for existing foreign investors to assure greater compliance with the law and to help avoid arbitrariness in law enforcement. Essentially, businesspeople need to have access to clear and understandable written versions of the laws and regulations governing their operations. In Mauritania four languages are in common use, Arabic, Wolof, Pulaar and French. The majority of the legal and regulatory framework is in Arabic and French and “official” English translations are absent, thereby creating uncertainty and reducing transparency.

Because of the absence of official translations of laws and decrees, foreign investors cannot obtain precisely translated information. This results in unreliable information, higher costs for potential investors (both in time and money), and reduces the likelihood that potential investors will seriously consider Mauritania as an investment priority. Official English translated laws are necessary, because the main mining countries are English-speaking and most investment targets are based in English-speaking countries. Large firms and trans-national companies (TNCs) in particular have a tendency to refrain from investing in a location that does not have a clear and transparent set of laws and regulations because they are under close scrutiny by their shareholders and often must adhere to governance standards not only in the host country but from the home country as well.

Activity 1. An Example of Best Practice

Viet Nam's Ministry of Planning and Investment has cooperated with a private law firm since 1992 to produce official translations of laws and decrees related to investment and conducting business in Viet Nam. The law firm translates the laws, gets them approved by the Ministry of Justice, provides copies of the official translations to the government, and has exclusive rights to package and sell these official translations.
The law firm produces and markets the "Foreign Investment Laws of Vietnam Loose-leaf Service," which comprises over 800 laws in 16 volumes. Topics include foreign investment; taxation; banking, finance, and foreign exchange; land and premises; labor; customs and immigration; accounting and auditing; contracts; intellectual property and technology transfer; natural resources and environment; business organizations; civil code and commercial law; and others. Additionally, the firm offers the "Vietnam Legal Update," which is published on a monthly basis and assists business people in keeping up to date on changes in the business legal and regulatory framework. The Government bears no costs as the law firm collects its revenues from sales of the translations.

Activity 1. Implementation

In Mauritania it will not be possible to produce a complete set of official translations of business and mining-related laws and regulations within one year, but this measure is intended to initiate the process of an arrangement similar to the one in the Viet Nam example, and gradually build up a compendium of official legal translations. To formulate and implement a plan to translate Mauritanian laws into official English format will be very effective in gaining investor's confidence. The action plan presented below aims to initiate a long-term cooperative arrangement between an international law firm in Mauritania and the appropriate overseeing ministry or public agency that will produce a priority set of translated laws and decrees within the first year and set targets for the subsequent years. The first step will be to translate laws related to mining investment and this would be practical and desirable to implement within the scope of the PRISM program. The process to achieve this is as follows:

- Preparing the necessary tender documents, including clear terms of reference and qualifying criteria.
- Soliciting proposals from international law firms.
- Using the appropriate committee within the public sector to review and select the law firm with the best proposal meeting the qualifying criteria.
- Preparing a contract that specifies the terms of the arrangement, including deliverables, the approval process, target dates, and length of agreement.
- Signing a contract with the winning bidder.
- Embarking on translating priority laws agreed to in the contract for the first year.

Success of this activity can be measured once a contract is signed with the winning law firm and the first batch of high priority laws are translated. It is important to make these translated laws available by subscription through the website and at seminars.

5.2 Activity 2 Install an investor tracking system

Effective selling requires a good investor leads tracking system which tracks prospects throughout the investment promotion cycle – from inquiry to lead to commitment to investment and beyond. Installing an investor tracking system in the IPA will enable the Agency to more effectively manage its relationship with contacts, potential investors, and established firms. The system will allow staff to input and update contact information, and to produce reports so that the IPA may track progress of investors throughout the investment process and thereafter. This system permits better management of investor portfolios and tracking of investor activity provides a much more effective service to both potential and actual investors. Typical tasks of the IPA will be:

- Investor Targeting and Promotion
- Investment Project Development
- Project Operation
- Account Executive/Investor Tracking System
- Ongoing contact to track needs for infrastructure, manpower & services.
- Information preparation
- Niche market identification
- Company targeting
- Company visits
- Follow-up Investment Decision
- Information provision
- Assistance with contacts
- One-stop-shop services
- Assessment of manpower, infrastructure, service needs
- Follow-up
- Continued “account executive” attention
- Follow-up on manpower, infrastructure, service needs
- “Ombudsman” role and trouble-shooting function
- Project Start-Up

Investor Inquiry, Application Tracking, and Investments Database software is available and the MMI should consider the installation of this for its IPA. Other tracking software systems based on Excel are obtainable. These software systems enable database of tasks mentioned above. The most important points here are to formulate and implement the action plan for solving problems as an official agency after it understands problems investors hold. In Mauritania there are many serious problems for investors such as shortage of infrastructure, lack of engineers, materials procurement from foreign countries, etc. whose solutions are impossible in the short time. Unfortunately Mauritania has not the high rank for investors. It connects with collection of information regarding these problems to carry out what Mauritania can do and disclose a long-term solution program for problems mentioned above. If problems investors hold are neglected, it will be very hard to collect information regarding problems from investors.

Activity 2. Benchmarking

In general, with regard to leads tracking systems, effective IPAs exhibit a:

- Demonstrated use of tracking software, including the follow up and rekindling of leads;

- Good record of success in using the investor tracking system in a sustained and systematic manner; and
- The existence of a complete history of all investor leads and activities available to all staff in the agency.

It is highly recommended that this system be computerized and any effective system will include the following key elements:

- Investment project tracking – to accurately record the nature of the project being proposed and the major characteristics of the proposed investment.
- Contact management – monitoring the types and frequency of the contacts made with the investor to facilitate timely follow up and required actions.
- Work management – tracking the various work elements that the investment promoter needs to carry out in order to progress the investor through the investment promotion cycle. This includes correspondence, assisting with investor visits, etc.
- Investor servicing – recording the types of assistance that the investor requires both from the investment agency and from other agencies such as customs, business consultants, lawyers, etc.
- Permits and authorization tracking – maintaining a comprehensive record of all the permits and licenses that the investor requires and the status of applications for these permits and licenses.
- Management reporting – providing the senior management of the investment promotion agency with accurate and timely information on the processing of an investment proposal, and permitting the monitoring and evaluation of the performance of investment promotion officers.

The feature of this system is to analyze the outcomes of investment projects and to serve as a tool for identifying areas where the investment climate needs improvement.
If this system is used in other fields, it is possible to record and analyze the total impact of an investment in the country, in terms of investment capital expended, annual sales turnover, employment generated, land use, and raw materials and utilities consumed. Finally this could be an effective system for increasing investment, in formulating investment strategy, modifying implementation plans and regulating institutions, etc. ,

Activity 2 Implementation

The basic activity will involve the installation of a software program tailored to MMI requirements, and the provision of a suitable period of sufficient training on its use and application and the development of a full implementation plan. The implementation will be done through advisory services/technical assistance. (UNCTAD and MIGA have provided such services to IPAs in Algeria, Ghana, Republic of Tanzania and Zanzibar.)

An example of an implementation program is as follows:

1. Design specification review (with background project material sent to consultant)
2. Confirm final project specifications (which will take into account MMI's existing computer system) and signs contract agreement with consultants
3. Project review with clients, and installation of system and database design and customization according to country's needs (on site).
4. Training users to operate the new program (on site)
5. Administrators Training, design of templates, reports handover and a site review of the project. This activity includes the development of a complete implementation plan along with expected milestones as MMI implements the investor tracking system.

5.3 Activity 3. Creating a team within the MMI's to focus on building stronger relationships with existing investors in Mauritania

Investment promotion is aimed at getting a potential investor to explore the location in person. Securing the initial investment, keeping it in the location, and possibly expanding the investment later on, however, depend in great part on the quality of services provided to the investor throughout the investment cycle. Facilitation through the site visit and investment registration process, along with continued support and troubleshooting assistance during a company's operations helps to develop satisfied investors who will stay in the location. The MMI needs to create an IPA team that tracks the approval of investment projects, collects data on investment. IPA team staff members will need training as service providers to perform ongoing contact and to provide assistance to investors. Given the limited resources within MMI, it is necessary that existing staff be transferred from their present functions into the IPA to provide investor facilitation and aftercare services and to strengthen relationships with existing investors in Mauritania.

Investment facilitation for new investors is also envisaged within the scope of this function, but for the immediate term the focus will be on more frequent contact and service provision for investors in Tasiast and Akjoujt. By these actions, existing investors are one of the greatest sources of new investment in any particular location, and MMI must ensure that this very limited number of foreign investors in Mauritania remain as satisfied customers.

It is noted that successful IPAs have facilitation and aftercare services identified and prioritized explicitly in their investment promotion strategy. They offer post-location problem-solving services for investor clients and make efforts to 'anchor' the investment to the location.

In order to achieve these features, many IPAs and other agencies have set up investment service centers or a specially trained team to consolidate and facilitate the services offered to investors. Among the general functions performed by investment service centers or teams are providing information and documents to investors, processing investment applications, providing matchmaking services, and helping to rectify the problems of investors with other government agencies. An investment service team should not be designed to assist investors only during the project application phase; rather, a range of services should be offered covering the entire investment cycle.

An investor's service needs change after commencing with the project establishment phase. At this stage, investors require a lot of assistance from the IPA in facilitating the investment approval, getting the maximum incentives offered by the Government for their project, and working through the bureaucracy to complete the registration process and obtain the required permits and licenses. To establish an investment project, the consistency of procedure is important and can be made much easier for the investor with assistance from the IPA's service team. Once the investor's project is operating, the IPA's job in facilitating investors is still not over. Metals mining companies and exploration companies are very sensitive to fluctuations in commodity prices to and will quickly close a mine or put it into care and maintenance if they encounter severe constraints in their operations or the business environment deteriorates. Exploration and development work is sometimes forced to stop. Also, even after starting up, the investment project might have additional or unforeseen needs that the IPA can assist in resolving. In Mauritania this could be further power requirements or additional water supply.

A proactive and service-friendly IPA will maintain periodic contact with the firms after they commence with operations to keep abreast of the developments and address problems early before they get more complicated. Some of the typical types of support activities that an IPA should offer investors in the implementation phase entail ongoing troubleshooting with agencies such as customs and immigration; fostering networking opportunities among investors and with business associations;

and providing value-added services such as identifying new suppliers, potential business partners, and coordination with other types of business service suppliers.
The IPA should be active in following up with firms periodically to identify any problems that they are having that the IPA can resolve, even with firms that have been operating in the location for many years. The periodic follow-up with investors is also useful for anticipating their future needs, and may enable account executives to identify ways to support or convince a firm to expand its operations in that location.

The IPA can expect certain kinds of after-care issues for its clients. There might be needs such as assistance in locating specialized labor or identifying advanced technology suppliers as well as looking for new partners to help them expand their operations or to raise additional capital.

Firms occasionally encounter problems with capital suppliers or partners that require finding replacements quickly and the IPA's database of firms can often be a good source of this information. Also, the IPA can and should play an active advocacy role on behalf of investors to improve the local business environment, such as streamlining local procedures and paperwork. Often, the IPA needs to perform the role of (inter)mediator between the investor and (local) government, and facilitate government-business consultations.

Activity 3 Implementation

- Review the types of services currently offered by MMI that constitute "facilitation" and "aftercare services", and identify priority services to be developed.
- Conduct a training needs assessment of the existing staff, and identify the types of training activities to be implemented.
- Re-train the existing staff to serve as MMI's IPA staff and aftercare services division.
- Provide MMI with a standard "manual" on facilitation and aftercare services to guide existing officers and train future officers.

Monitoring investor activity must be studied so as to adapt the IPA functions, including investor facilitation and aftercare services, to both future requirements and changing scope of delivery.

5.4 Activity 4. Implement a targeted investment promotion strategy. Initial focus on exploration companies with gold and copper interests

An investment promotion strategy that starts with gold and copper exploration is a realistic strategy that takes into account the most attractive metallic prospects in Mauritania. Development of copper ore deposits requires solving infrastructural issues such as constructing ports for large-scale ore deposits. This development strategy shows an orientation and policy for three stages with 5 years at each stage. In the first stage, the emphasis is on gold and copper.

The MMI has not prepared a targeted investment promotion strategy before because of personnel limitations and insufficient financial resources. However, the MMI is aware of the necessity of investor targeting from the seminar held in June 2004 and discussion with PRISM.

Activity 4. Principle for Success

In general, with regard to targeted investment promotion, effective IPAs exhibit a:

- Clear identification of key target sectors and countries;
- Clear identification of key individuals who can help leverage projects; and
- Pro-active approaches to potential investors with proposals.

Investment Target Strategy (ITS) is necessary to attract foreign investment, and the first of the ITS is prioritization of companies for overseas promotion. It is not just likely investor countries, but complete investor profiles based on trends in the international marketplace and in related economic landscapes. The second (and perhaps the most important) output of the ITS is the marketing action plan. This is the framework for implementation of the promotion program. Secondly, the ITS develops marketing plans for investment promotion. The ITS methodology first develops a "long list", or universe of possible activities, consisting of all mining and exploration companies which could be considered as candidates for international investment promotion efforts by the counterpart IPA. Those industries are then screened through three tests: a comparative analysis that compares each company's location requirements with the economy being promoted, a competitive analysis that examines each company's supporting and constraining trends (domestically and internationally), and a policy analysis that prioritizes companies deemed suitable based on MMI investment policy priorities. Note that the comparative and competitive screens are the first screening hurdle, so that a company cannot be included based on its consistency with policy objectives if it has not passed the fundamental economic comparative and competitive analyses. Identified targets are then separated into near-term and medium-term candidates, and marketing plans are tailored to immediately promote near-term candidates for promotion. The marketing strategy acts as the core plan for navigating the IPA management's promotion activities. In general, it outlines the broad approach that IPA management will have to undertake in selling industrial opportunities to prospective investors. And the Marketing Action Plan (MAP) is an outline of the overall program for promoting a particular industry in the host province or country. While the promotion strategy provides the basis for the overall approach to be undertaken by the IPA, the MAP outlines this strategy as a basis to develop company-specific approaches.
A typical MAP contains the following elements:

- Target Investors: the characteristics of ideal investors are described, in order to gain an understanding of who the promotion effort will be targeting. This is done in terms of nationality, type of investor, the motive for potential location in the host province, patterns of local and regional investment, and other information that may be relevant.
- Principal Selling Themes: the promotional emphasis or principal advantages that the host province can highlight in the customized materials and approaches in a single attractive slogan. This may be obtained from a previous benchmarking exercise.
- Promotion Approach: the specific combination of the various investment promotion techniques as determined by the nature of the investor and the characteristics of the mining industry.
- Promotion Materials: the optimal promotional materials are described for the sector, in general terms. In case of Mauritania, new geological maps and GIS are important basic materials. Apart from the standard printed materials, feature videos and CD-ROMs typically form part of such materials. At the least, an information sheet describing the mining industry is indispensable.
- Investment Goals: the specific objectives for the mining sector, in terms of numbers of investments, average size of investment, employment, and other characteristics are noted. Determining investment goals is not easy if not impossible task as it is similar to forecasting the demand. Locating an investment is ultimately a corporate decision, and the factors involved in this decision may not always be transparent to the economic development professional. The frequency of activities towards generating the investment is factored in the assessment of goals as well.

In general, the major activities that need to be carried out include research into potential investors, development of a marketing action plan, preparation of investment promotion materials and marketing documents and marketing strategy implementation including missions to target markets and potential investors.

It is likely that at start up of the MMI's IPA there will need to be provision for technical assistance for the targeted investment promotion activity.

5.5 Activity 5. Produce an Investment Guide

The Investment Guide is intended for the use of foreign investors who are largely unfamiliar with Mauritania. The investment guide is designed to offer overviews of potential locations for investment and pointers to sources of further information. The guide document is intended to offer a balance and objective account of investment conditions. Prepared by an independent 'third party' its principal advantage in drawing the attention of investors to the country is credibility.

Also, the general structure and some of the specific content contained in the investment guide are the result of consultations with the private sector. The MMI has already produced some promotional materials but the lack of budget and expertise has resulted in only a few brochures and guidelines developed by PRISM. The Investment Guide planned by this JICA study intends to give potential investors a clear and concise overview of the mining investment environment, the regulatory framework, investment procedures, opportunities, key contact agencies, and other vital information. Therefore, to explain the Mauritanian opportunities in detail, a formal guidebook should be prepared based on the Investment Guide created during this study.

Activity 5 Implementation Plan

- Formal request from MMI to funders (ex: UNCTAD) for the production of an investment guide;
- Deployment of consultant to undertake fact-finding mission and prepare draft investment guide;

Draft investment guide is reviewed, revised and final production is prepared, but submission of request for an Investment Guide to UNCTAD, fact finding mission and drafting, and vetting of the guide publication targets should be clearly established.

5.6 Activity 6. Train government institutions dealing with investors to be client- oriented

A client charter is a tool that is used by institutions, including IPAs, to set service standards and to improve on these standards in order to satisfy customers. A good set of standards encompassed in a client charter is important for the delivery of quality service as it clearly spells out the IPA's commitment to perform specific tasks within given time frames.

This, and training the IPA staff to the appropriate skills level enables the organization to compare its performance in terms of service delivery with IPAs in other countries. In general, IPA officials with specific understanding of investment issues will provide better customer services to investors. They will be able to comprehend the needs of investors under different situations. The untrained the Government organizations staff interfacing with foreign investors would probably lack the necessary customer orientation and associated skills to be considered service providers as opposed to regulators or administrators.

The Uganda Investment Policy Review carried out by UNCTAD in 1999 contained an action to introduce client charters in public institutions handling foreign investors. The first stage of this process entailed training in customer care for heads of government agencies and the front desk officials. Subsequent stages involved each government agency preparing its own client charter during a workshop. The client charter included the vision and mission statement to ensure that all officers from the top of the organization to the entry-level staff understood and were unified in the IPA's purpose.

The client charter also specified the types of services offered by the IPA, set standards for service delivery time, and clearly delineated the charges for each type of service. Upon completion of the draft client charter, private sector representatives were invited to workshops to discuss the agencies' proposals; the deliberations were then incorporated into the final charters. The IPA and the

government organizations are then expected to display the client charter near the reception desk and also to promote the charter in the media and in their interactions with other government agencies.
Feedback given by the Uganda Investment Authority, the IPA, on the impact of the implementation of the Clients Charter is, "The effect of the Clients Charter was immediately felt. Staff in the organizations recognized and bought into the organization's vision. They had clear services they were responsible for and had clear timelines to beat. It also informed investors on the available services and how long they should take. Staffs were eager to exceed expectations. Networks were created in the process of producing the Clients Charters." Ownership of ideas is a great motivator.
Introduce "Clients Charter" in MMI through a three-day training workshop. (And include two representatives from selected other government agencies such as Customs and Ministry of Finance). The workshop to consist of three modules:

- Module 1. Service improvement training: To allow participants of MMI to review investor service best practices and evaluate their own service delivery.
- Module 2. Developing service standards specific to MMI: To enable participants from MMI to evaluate their existing service delivery methods and standards.
- Module 3. Designing a client charter: To set clear, uniform and transparent service delivery standards for the future.

Build the capacity within MMI to develop the Clients Charter with other public institutions dealing with investors.
At first, the training activities are undergone and a Clients Charter within MMI is adopted. And then, the adoption of Client Charters is facilitated in investor-related departments.

5.7 Activity 7. Fully develop a "network" of contacts across all the ministries dealing with mining business matters

As noted earlier, many countries experience high rates of unrealized project approvals or foreign investment outflows because of complexities and difficulties with government bureaucracy. The IPA must be closely networked with other government agencies to provide investors with a variety of contacts (for information purposes) and to support the IPA's efforts to assist investors in overcoming hurdles and related obstacles regarding investment in MMI and other organizations. For instance, the IPA might be called upon to sort out problems with other government agencies over licenses or permits, customs, and tax matters.
To accomplish this, the MMI should hold periodical meetings with relevant government agencies/ministries in order to resolve mining investment problems. It will need to establish a "Committee for Mining Investment Cooperation and Domestic Investment".
The meetings should focus on two types of issue:

1) approval of investment licenses, and
2) resolving investment-related problems such as contract termination and shareholder disputes.

Another inter-agency issue commonly found in developing countries is the relatively low level of information exchange, particularly when procedural requirements change, leaving the IPA without proper or updated information on matters such as taxation, permits, immigration/visas, and others. Information is generally lacking in Mauritania, and interviews with government officials have revealed that minimal flows of investment or business-related information occurs between ministries and agencies.
Therefore, establishing a "network" of key contact persons in business-related ministries would greatly assist MMI in offering more efficient services to investors and increase the flow of information between MMI and other ministries. The network members should have sufficient decision-making authority to resolve most matters quickly when called upon. (Directors and Directors General of ministerial departments would likely be ideal members for the network.)

Activity 7. Best Practice

One example of an efficient inter-agency arrangement for handling investment matters is found in a state government in India. The Government of Rajasthan created Empowered Committees that are authorized to make inter-departmental decisions that are final and binding on all department and exempt from further examination. The Bureau of Investment Promotion serves as the secretariat for the two Empowered Committees (one for infrastructure development and investment and the other for all other forms of investment).

Other countries or local governments opt to establish one-stop centers that bring together working-level representatives from various ministries or agencies to help process investment applications and issues. The Thailand Board of Investment's One-Stop Service Center is one such arrangement.

Activity 7 Implementation Plan

- Prepare a "concept paper" on the need for the network, participants' roles, and processes.
- Arrange an inter-ministerial meeting to appoint representatives from each relevant ministry or agency.

Enhance information flows between line ministries and MMI:

- MMI to conduct inventory of existing (up-to-date) information from line ministries on procedures for foreign investors related to its IPA.
- IPA prepares guidelines to line ministries on types of information requested (e.g., procedures, sector data, and investment opportunities), including basic documentation formats to be filled in by line ministries.
- Line ministries submit investment-related or sector opportunity information to IPA.
- Update information from all line ministries at least once a year.

In implementing this plan, consensus should be attained by submission of a concept paper to relevant line ministries and appointment of network representatives is important. Also, it is necessary to complete an inventory of existing information and preparation of information formats and to submit relevant information from line ministries to the MMI.

5.8 Activity 8. Initiate pilot program to create relationships between foreign and domestic firms (i.e., business linkages) among MMI, and other agencies for small scale mining of construction materials.

It is necessary to formulate business linkage programs by mining related organizations and companies. It is important to make up a pilot model and orient it to mutual coexistence. Its benefits include:

- a more dynamic and competitive private sector (especially SMEs);
- improved micro-economic environment conducive to the establishment of business linkages;
- more, better quality linkages between TNCs and other foreign firms and local SMEs;
- more quality jobs created and preserved, and creation of industries derived from mining;
- improved competitiveness of local SMEs through technology, know-how and management skills transfer and capital injection;
- TNCs more deeply rooted in the local economy;
- increased capacity to attract FDI; and
- broader and more diversified tax base for government.

This activity is relevant to the proposed program of collaboration between MMI, in its capacity as the Ministry of Industry and other ministries. It opens up the opportunity for domestic firms to be better informed about the demands of foreign firms. Also, such a program can benefit foreign firms by providing information about the feasibility of their investments and/or opportunities to expand their production.
Currently the MMI has no formal linkages programs underway due to a lack of technical personnel and resources, but it is an important task for investment promotion in the future.
Experience shows that business linkages can offer substantial benefits to those foreign affiliates and domestic firms that create and deepen their linked activities.
Foreign affiliates benefit from linkages with domestic firms as they can reduce costs, enhance access to local tangible and intangible assets, increase their specialization and flexibility and adapt technologies and products better and faster to local conditions; and facilitate their local implantation.
Foreign and domestic business linkages can be one of the fastest and most effective ways of upgrading domestic enterprises, facilitating the transfer of technology, knowledge and skills, improving business and management practices, and facilitating access to finance and markets. Strong linkages can promote production efficiency, productivity growth, technological and managerial capabilities and market diversification in local firms. The ability of foreign affiliates' linkage activities to contribute to domestic supplier development depends, to a large extent, on the domestic markets' and local firms' capabilities. However, government interventions are essential to create an environment conducive to sustainable business linkages, through policies and regulations that support the mutual interests of both foreign affiliates and domestic firms.
Parties involved could combine their efforts at supporting the creation and expansion of SMEs through various linkage options, such as seeding, outsourcing and sub-contracting.
There is a model adopted by the Czech Republic. This takes into account the limited presence of foreign firms and the current status of capabilities among domestic firms overall. The IPA of the Czech Republic, CzechInvest, started a practical linkages program called the “Supplier Development Program” (SDP). SDP comprises three main elements:

Collection and distribution of information on the products and capabilities of potential domestic suppliers. This enables foreign firms to short-list and contact potential suppliers. The information on the suppliers is posted on CzechInvest’s website.
a) “Meet the Buyer” events that aim to bring together foreign firms with potential domestic suppliers. The focus is on identifying what components and services new foreign firms are seeking that could be potentially outsourced to domestic suppliers, and this service is offered by CzechInvest;
b) conducting seminars and exhibitions; and
c) matchmaking program of CzechInvest whereby proposals are made to potential foreign investors or, if a foreign investor submits a request for a list of profiles of potential suppliers in the IPA’s database, then CzechInvest provides this information along with a short questionnaire for the foreign investor to complete.
CzechInvest used a pre-defined criteria for selecting domestic supplier companies to participate in an upgrading program. The participating firms developed upgrading plans containing benchmarks that would allow comparisons with competitor firms in the European Union. The upgrading plan involved consultancy and training support from a university in the United Kingdom, covering topics such as utilization of technology, management, marketing, finance, quality assurance, and more. Upon completion of the training program, the supplier firms are presented to banks in order to help them access finance, while banks benefit from finding more reliable customers for loans.
This methodology example of CzechInvest is, however, too early for Mauritania and a task for the future. Mauritanian suppliers for computer associated equipment have experience in importing and parts-procuring from foreign countries and distribution to domestic companies and are improving their services every year. If companies such as these suppliers establish in Mauritania, they could be linked to implementation of the above-mentioned program by using domestic companies for some of the work.

In future, in order to put in place pilot business linkages projects the following general steps need to be taken:

- Identify partner institution to provide training modules and instruction for upgrading suppliers. (To develop organizations such as MAED and Technical Training Center or look for supporting organizations.).
- Define criteria for qualifying suppliers in small scale mining sector. Criteria could include particular sub-sectors with highest potential (as agreed by MMI), production capacity, quality standards, professional management structure, export capability, etc. *
- Collection and distribution of information on potential suppliers' products and capabilities. This activity should be done jointly by MMI, and business associations.
- Posting of immediate potential suppliers' profiles on MMI website in a new section on "suppliers and outsourcing."

In Mauritania, SAMIA, the gypsum miner and processor, might be an ideal candidate for this treatment.

- In order to achieve this step, it is proposed to establish a Business Linkages Task Team based within the IPA comprising a coalition of key Mauritanian stakeholders, respective foreign firms and SMEs in the small scale sector, business development service providers, and potential donors. The task team should then agree on the basic parameters for the business linkage development programs, including: objectives, outputs, organizational framework, roles and responsibilities, and a formal project document can be issued and funds raised to implement the project. At present, investors must look for the possibility of business linkage with Mauritanian companies by themselves. To achieve this business linkage, it is necessary to create a template for potential suppliers' profiles and collect relevant information (based on recommended firms from MMI and others), post profiles on new section of the MMI website and host one "meet the buyer" event.

5.9 Activity 9. Establish a Mauritania Mining Industry Forum for existing investors (in partnership with IFC) and host one investment forum for prospective investors.

Public-private sector partnerships (PPPs) are increasingly used as a vehicle for development. The private sector can be an impetus for economic development, and thus more and more governments are setting up collaborative partnerships with the private sector in order to understand their perspectives and needs and to harness the business community's cooperation in jointly carrying out activities. It is critical for governments to be responsive to the inputs from and issues of concern to the business community if they desire to establish an effective and mutually beneficial partnership with the business sector. The MMI has attended investor events in Burkina Faso (MIGA 2000) South Africa (Indaba 2003, 2004) and Canada (PDAC 2004, 2005) in an effort to engage the mining business community. The new IPA needs to work with the MMI to create an in-country mining investment forum.

International Finance Corporation (World Bank) is also working through PRISM to jointly develop the Mauritanian Mining sector through a program of Institutional reinforcement. JICA is also assisting with the preparation of this Strategy document. These agencies are trying to help the Mauritanian Government's effort to improve the mining business environment by:

- Providing a platform for an effective dialogue process between the business community and the Government; and
- Facilitating information sharing with investors.

Within the scope of the new mining IPA establishing and managing the forum and attending both regional and international mining conferences will be essential and indispensable to the attraction of investment capital to the mining sector.

In order to be effective, the mining sector must organize itself in such a way as to present a coherent position to the Government on the wide range of issues being dealt with. In general, this will often require the increasing mining associated business and the development of practical projects and solutions to business impediments.
The implementation plan for the creation of a Forum needs to be prepared by the IPA for the MMI.
The plan for the investment forum would entail:

- Identification of and commitment from appropriate speakers at the investment forum, including other relevant agencies' representatives, and respected domestic and foreign investors.
- Screening of potential participants and subsequently sending invitation letters.
- Preparation of press releases and press kits.
- Holding the investment forum
- Follow-up with the participants to pursue potential interests in investing in Mauritania

Activity 9 Key Performance Indicators

This will be determined by the MMI and its IPA as the mining investment forum is planned. For preparation of the investment forum, the main performance indicators are:

- Drafting of proposed agenda by end July 2006.
- Identification of speakers.
- Collecting information on potential invitees, screening, and sending invitation letters completed by November 2006.
- Hosting investment forum by April 2007.

6.0 Conclusion

The development of an IPA by the MMI is an essential step if the Mauritanian Government hopes to encourage inward investment to its Mining Sector. However, during the past two years in both formal and informal meetings with counterparts in the Mining Sector the JICA team has discussed some of the many issues that need to be addressed if the IPA is to become successful. Also the JICA team has talked about the IPA issue with PRISM.

In 2006, Mauritania will start to benefit from oil revenues. These revenues must not be allowed to disappear into a few projects, which at this time are unnecessary (for example, new ports or railways). Similarly every member of the Parliament needs to ensure that through its good governance the revenue does not disappear into the accounts of a few powerful families or ministers.

These funds may be used to give the people of Mauritania a very few years, perhaps the time of one generation (25 years), in which those elected to govern can really change the their future. The targets for investment should be to radically improve:

- Healthcare
- Education of both children and adults.
- Sanitation, sewage treatment and disposal and clean water supply, especially in the cities.
- Full employment through a significant effort to encourage inwards investment
- Public transport that is affordable, modern and safe
- Better and safer roads in the cities and linking the cities
- Improved civic management to bring cities and towns to acceptable international standards of management with traffic law enforcement, garbage collection and removal of animals from the streets.
- Clean, safe and quality housing.

Every yen, penny, cent, pound, franc, ougiya and dollar earned from Petroleum production should be committed to achieve improvement in these areas and be accounted for publicly. This alone will lift Mauritania and its people from its yoke of poverty, poor health, lack of education and the spiral of despair and frustration that the great majority of its citizens feel.

If creating an IPA successfully assists in this process the MMI may be sure that it is contributing to the future of this wonderful, beautiful desert country and its people. Remember, once in each lifetime the Gods shine their light of opportunity on all of us. This is the time for Mauritania to wake up and realize that its moment in this brilliant, penetrating and blazing light of opportunity has arrived. Let us pray that it will accept this gift and never return to the darkness again. Inshallah!

1.2 Main Points of the Mauritania Mining Code

1. Prospecting	• 6 months, renewable once for 6 months • Land prospecting/airborne surveys • No exclusive rights
2. Exploration license	• Exclusive right to explore for one group of minerals (7 groups) • Area limit, 1500km2; possession limit, 20 licenses • 3 years; can be renewed twice (each time less than 3 years) • Transferable
3. Exploration fees (annual surface)	• UM 250/km2 (initial period) • UM 500/km2 (1st renewal period), • UM 1000/km2 (2nd renewal period)
4. Promotional zones	• For prospecting/ reconnaissance • 2 zones (<5000km2 each), 2 years • Publicly release all data after 2 years
5. Exploitation license	• Area defined by perimeter of ore deposit for specific group of minerals • Term is 30 years, renewable for 10-year terms many times • License is transferable, can be used as loan security • Technical information can be released to public after license expires • Annual surface fee: UM 2500/km2 • Delivery/transfer/renewal fee: UM 2,500,000
6. Royalties	• Au: 3% revenues • Cu, Pb, Zn, Ag, Ni, Mo, etc.: 1.5-2.5% revenues
7. Taxes	• Corporate tax is 30% on profits • 16% tax for exported dividends • No tax for dividends reinvested in project • Necessary supplies/equipment exempt from customs/import taxes for 5 years; afterwards taxed at 5%
8. Small-scale exploitation license	• <100 employees, <UM 5,000,000 net assets • Perimeter of ore deposit down to –150m • Period is 3 years
9. Surface landowner	• Landowner's consent needed for exploration or exploitation • If consent not granted, Council of Ministers can intervene; license holder pays compensation for use and any mining-related property damage
10. Penalties	• Fines and/or imprisonment for violations of mining code (operating without license, failure to declare mining stopped at expiration of license, not attaining maximum economic recovery of mineral, etc.)

1.3 Tax Regime for Mining Activities in Mauritania

Equipment and materials import duty
• Object of tax: imported equipment, materials, products, fuel, etc. • Tax exemption during exploration and 5 years of production • Rate after 5 years of production: 5% • Fuels, lubricants, spare parts – still remain exempt after 5 years. • Is paid for every import received.
Remunerative fee
• Rates: ▪ Delivery, renewal, transfer of exploration license: UM 400,000 ▪ Delivery, renewal, transfer of exploitation license: UM 2,500,000 ▪ Delivery, renewal of small scale mining license: UM 1,000,000 ▪ Authorization of large scale quarry: UM 1,500,000 • Paid only once in case of the above operations
Surface fee
• Paid annually based on the license area • Rates: ▪ Exploration license: 1st year – UM250/km^2, 2nd year – UM500/km^2, UM1000/km^2 ▪ Exploitation license: UM25,000/km^2
Royalty
• Rate is based on classification of minerals into 7 groups (Mining Code of Mauritania)* • Calculated on gross revenue (selling price of product at last stage of manufacturing in Mauritania) • At the end of financial year, royalty is deducted of taxable result, maximum 7% of turnover realized. • Rates: ▪ Groups 6 & 7 – 3-7% ▪ Gold & groups 3 & 5 outside industrial and ornamental rocks – 3% ▪ Groups 1, 2 & 4 (other than gold) – 1.5-2.5% ▪ Industrial & ornamental rocks – 1-15% ▪ Quarries – 0%
Tax on profit
• Subject to payment during exploitation stage • Rate – 30% • Tax-exempt for three initial years
Withholding tax
• Object of tax: dividends • Rate: 16% for exported dividends • Exemption: if dividends are reinvested into production

1.4 Comparison of Tax Regimes in African Countries

	Country	Mauritania	Botswana	Burkina Faso	Tanzania	Namibia
Exploration	**Duration for approval**	Three years, twice renewable for 3 years each time			Within 4 weeks	Subject to reporting being up to date
	Transfer of concession	Transferable with agreement from ministry of mines	Transferable	Transferable	Transferable, 50% first & second renewal	Transferable
Mining (Exploration)	**Initial term for mining**	30 years	25 years	IMP - 20 years SMP - 10 years AML - 2 years	5 years SML - 25 years ML - 10 years	25 years
	Renewals	10 years	ML - every 25 years	Every 5 years	Every 5 years SML - every 25 years ML - every 10 years	Renewable
	Mining rights transfer	Transferable	Transferable	Transferable	Transferable	Transferable
Fiscal Regime	**Corporate income tax**	30% with 3 year initial tax holiday	25% with variable-rate tax formula which is 70-1500/X where the profitability ratio (X) is the taxable income as a percentage of gross revenue	Exempt at exploration stage	30%	25 to 51%: Tax rate: (>25%)=60-(480/(gross income/taxable income
	Dividend withholding tax	16% on exported dividends	15%	12.50%	10%	10% not deductible
	Royalty	Depends on mineral from 0% (aggregates) to 7% (diamonds); Au 3%, non-ferrous metals 1.5-2.5%	Precious stones - 10%; Precious metals - 5%; others - 3% of gross market value (MMB, Art. 66 (2))	Base metals and other mineral substances - 4% ad valorem; gold and precious metals ad valorem	3.0% of net back value	Precious stone group - 10% of sale; rought or unprocessed mineral o dimension stone group 5%; and other minerals up to 5%
	Import duty	Exempt for five years then 5%	5% plus surcharge rate	Exempt at exploration stage and importation free of customs duties	5% is the cap limit	may exist
	Export duties on minerals	none	none	none	none	None on minerals, 5% on dimension stone blocks, precious stones negotiated
	Value added tax (VAT)	14%	none	Exempt at exploration stage	Exempt where products are for exports	5 to 10% GST
	Tax holiday	3 years	negotiable	none	none	None on minerals, 5% on dimension stone blocks, precious stones negotiated
	Exchange control	yes	yes	none	Minor control for statistical purposes	Some restriction may apply

1.5 The Main Contents of PRISM

a. To improve the Mining Code (1999) and establish mining decrees.
   - To elaborate a new mining law, which would be competitive and meet the sector demands.
   - To establish several decrees necessary for mining development.

b. To enact a necessary type of mining convention (2002)
   - To adopt a law reinforcing the competitiveness of the legal framework in investment sector in mining.

c. To submit the final report describing opportunities for an institutional reinforcement of MMI. (2003)
   The study was realized by a surveying and consulting French Company, and produced the following results:
   - An institutional model that is well understood and subdivided from a theoretical viewpoint.
   - Clear mission and organizational scheme and mobilization procedures.
   - Work procedures ready for implementation.
   - Functional 5-year work plan.
   - Practical use of computers in the work.

d. To establish a mine survey service (2000)
   - To establish a mine survey service to positively influence development of mining.
   - To bring trust to investors in Mauritania.
   - Functioning of the service will bring about a sustainable growth of the cadastral revenues.
   - Coverage of the cadastre is very wide. (Practically, all the territory can be considered as target of potential mineral areas and be registered as license area.)

e. To survey the geological ground-truth in the northern districts (2000)
   - To entrust the work to BRGM.
   - Final report was completed in December, 2003.
   - To make a geological map with a scale of 1/500,000 in the total area and 14 geological maps with a scale of 200,000 in the mineral potential areas.

f. To survey the ground-truth in the central and southern districts (2001)
   - To entrust the work to BGS.
   - To make a geological map with a scale of 1/500,000 in the total area and 12 geological maps with a scale of 200,000 in the mineral potential areas.
   - To submit the final output in June, 2004.

g. To survey the ground-truth in the southernmost districts (2003)
   - To entrust the work BRGM, financed by IBD.
   - To submit the final output in 2005.
   - To make 6.5 geological maps with a scale of 1/200,000.

h. To contract with BGS (2004)
   - To entrust the work to BGS (in the form of a contract with PRISM office for geological ground-truth in the central and southern districts)
   - To make 6.5 geological maps with a scale of 1/200,000 between the first and second districts of the surveys.
   - To start work in March, 2004.

i. To do chemical analyses to confirm the potential mineralization indices.

j. To make potential mineralization indices (2001)
   - ALS Chemex (Canada) considers the results of the chemical analyses to confirm the potential of mineralization of districts covered by the geological ground-truth surveys.

k. To do the geophysical airborne survey in the northern districts (2000)
   - A geophysical airborne survey totaling 371,000km lineaments covering 167,610km^2 with a flight line spacing of 500m and control line at spacing of 5km. Flight lines were directed from the east to the west.
   - To entrust the work to Fugro Airborne Survey.

l. To do a geophysical airborne survey in the southernmost Mauritania (2003)
   - The geophysical airborne survey was financed by IDB.
   - A total of 192,434km lineaments covering 134,703km^2 in the southernmost Mauritania.
   - Sander Airborne Survey (Canada) completed the work in 2003.

m. To do a geophysical airborne survey in the northwestern districts (2003)
   - A geophysical airborne survey totaling 86,846km lineaments covering 60,737km^2 in Choum-Zouerate region.
   - Fugro Airborne Survey completed the work in December, 2003.

n. To increase the institutional capacity for the management of mining environment and operational systems of information and environmental management (SIGE) (2001)
   The goals of this activity are:
   - To develop appropriate methodology for basic studies of environmental conditions.
   - To study the environmental impacts and audit the environment.
   - To understand the socio-economic impacts accompanying mine development and establish an environmental database within the DMG framework.

o. Support program for development initiatives (2004)
   - To participate in co-financing of micro projects to facilitate an active participation of mining communities

and make them responsible for improvement of the conditions of life, labor and revenues as well as the amelioration of socioeconomic impacts on the affected communities.

p. Technical assistance for economic development; framing agency, NGO (2004)
- Main role is to provide a technical assistance to candidates in the preparation of requests for support and execution of project.
- Assistance seekers from the support program wishing to conduct profit-making activities in the Nouadhibou-Zouerate corridor can ask the NGO to assist them to prepare and submit their micro projects.

q. Follow-up and evaluation, investigation of households (initial inquiry) (2004)
- This investigation will serve as reference situation for the social chapter of PRISM 2.
- Based on this investigation, the permanent project impact can be measured.

r. Hydrological studies in Choum-Zouerate. (2004)
- A detailed hydrological study to identify new water resources.
- Applying integrated analytical concept on the information produced by PRISM and the information in the databases of CNRE and SNIM concerning boring in the regions.

s. Hydrological works on water resources evaluation, measurement and tests of water-tables (2006)
- PRISM 2 will finance the evaluation work on the water-table capacity presently being exploited in the Choum-Zouerate region.
- Measurements and tests of newly identified water-tables during the detailed hydrological study.
- Geophysical measurements on the ground or other tests to confirm the presence of deep ground water resources as well as works to stem flowing water.

t. To prepare a management plan for development of the Nouadhibou-Zouerate corridor (2004)
- To make an integrated strategy for the regional development to be established by the authorities and SNIM.
- Short and long term plans to be implemented within the strategy.

u. To do a geophysical airborne study for Zone A (2004)
- This study will cover 160,000km^2 of the Mauritanides range.
- This will complete the coverage of the Mauritanides shield, with the IBD study of PRISM 1.

v. To do a geophysical airborne study for Zone B (2005)
- To make an integrated strategy for the regional development to be established by the authorities and SNIM.
- This study covers the northern edge of the Taoudeni basin and Reguibat shield, a prospective zone for diamond and water resources.

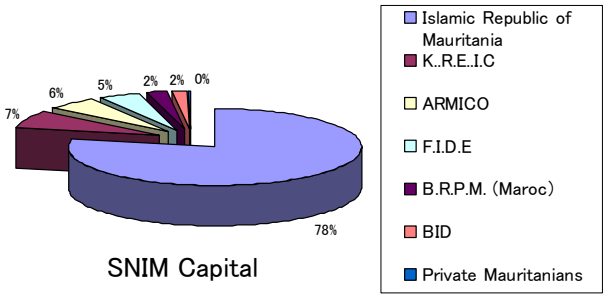
w. To conduct a geological ground-truth study (2004 by WB and 2005 by IDB)
- PRISM 2 will produce 12 geological maps with a scale of 1/200,000 covering the middle and southern districts of Mauritania.
- Four maps will be made by the World Bank financing.
- Eight maps will be made by the IDB financing.

x. To develop the hydro-geological information on Mauritania (2004)
- To compile the geological and geophysical information made by SNIM.
- To compile the database of the hydro-geological boring by CNRE and make a preliminary Mauritanian hydro-geological map with a scale of 1/500,000 in collaboration of CNRE.

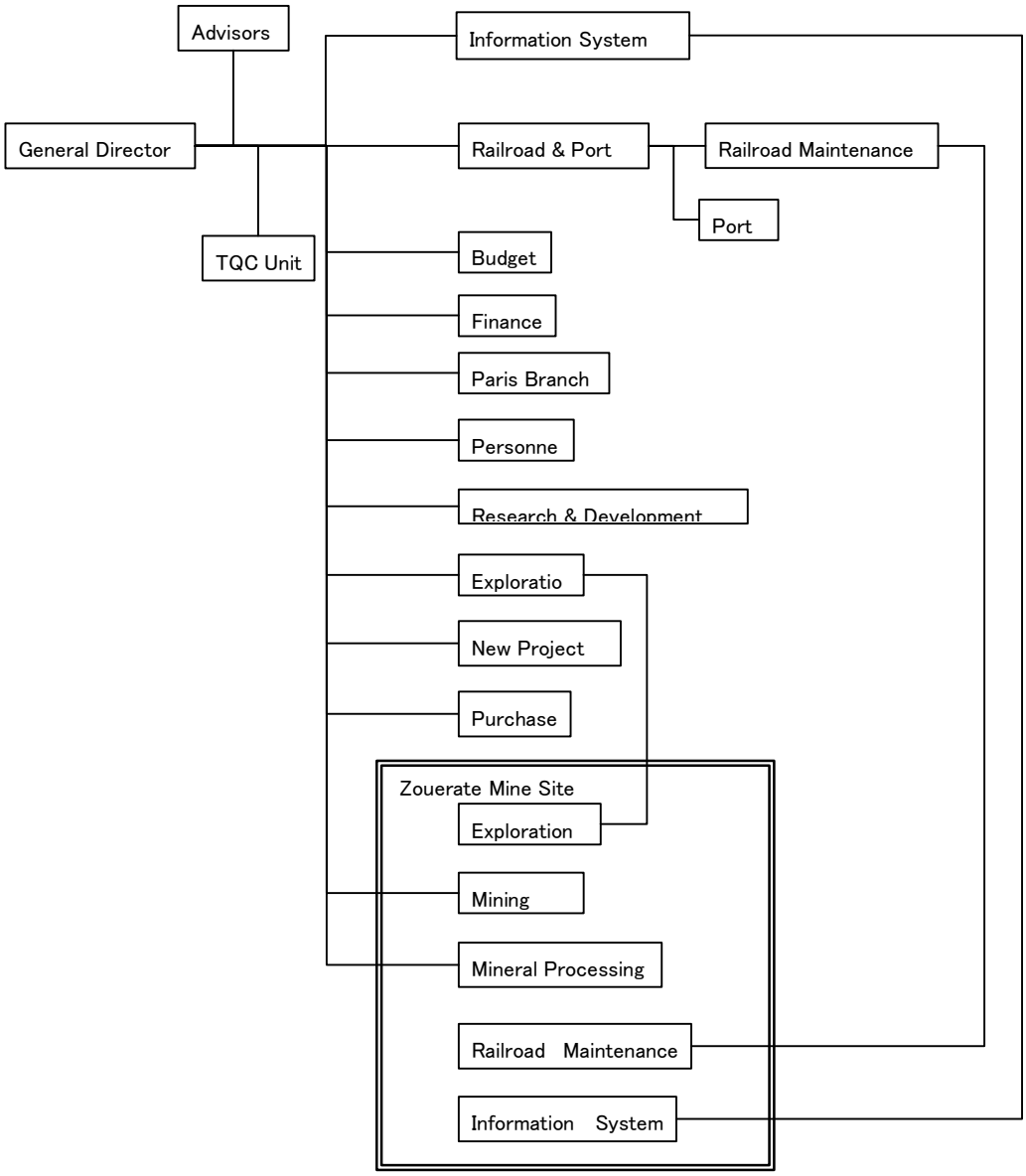
y. Consulting services, evaluation and summary of the mining potential and promotion (2005)
- This includes compiling and interpretation of PRISM 1 result.
- A rough data set is obtained from PRISM 1 results, such as data of the geological samples analyses, which were collected during geologic ground-truth activities and will be available only at the conclusion of PRISM 1.

z. Thematic studies of mineral resources (platinum-palladium study etc.) (2004)
- Summary of information produced during PRISM 1 will be applied in the studies of mineral resources.

1.6 Composition of SNIM's Capital Holders

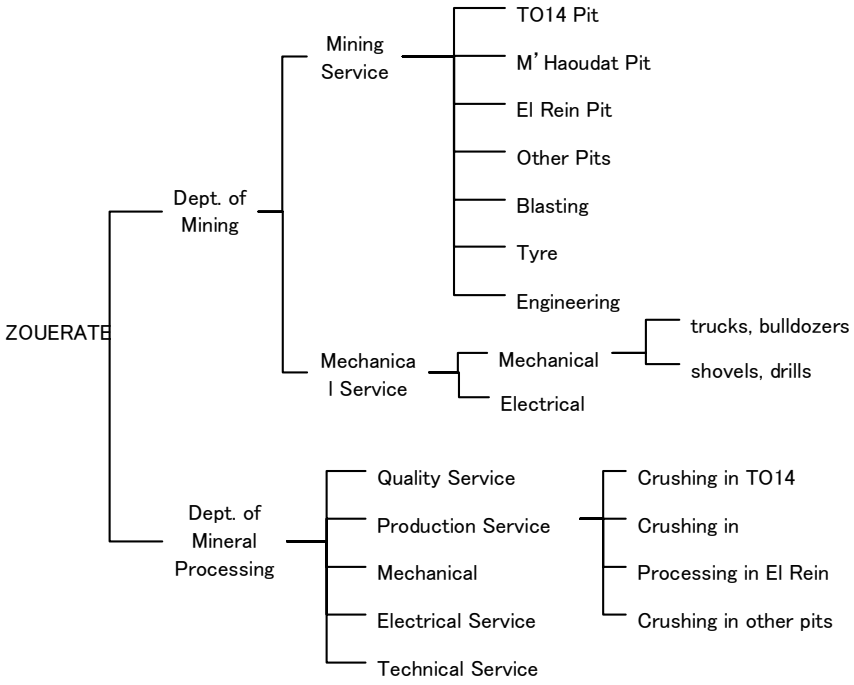


SNIM Capital



SNIM Organization

1.7 Organization Chart of the Zouerate Mine Site and Mining Machines



Zouerate Mine Site Organization Chart

Mining Machines in Main Mines

machines	drill	shovel	loader	truck	bulldozer	grader
TO14	3	2	1	14	5	2
	Buc.	P&H	LET	CAT	KOM.	KOM.
El Rhein	3	3	0	17	6	2
	Buc.	P&H		CAT	CAT	KOM.
M'Haoudat	3	4	2	14	6	1
	Buc.	Buc.	LET	CAT	CAT	KOM.

(NB) Buc: Bucyrus (USA), P&H: (USA), LET: Letourneu (Canada), CAT: Catappillar (USA), KOM: Komatsu (Japan)

2.1 Characteristics of the Ore deposits and manifestations

No.	Name of Prospect	Metal(s)	Locality	Geology	Ore Mineral(s)	Dating Data	History, etc.
1	Catherin	Cu Sn	7˚54'W 25˚49'N Central Yetti Desert. 80km to the ESE of the road running from W. Sahara/Ain Ben Tili to Tindouf.	Pneumatolytic(-Hypothermal) Deposit. The host rock is porphyroid migmatitic granite, which has a distinctive Catherine-type lithofacies near the deposit. The deposit consists of dark and quartz ("Zwitter")-rich greisens that are accompanied by Cu-oxides in joints. The greisenizated zone is 1.2km long in NW-SE and 0.4km wide at the ground-surface level. Sn-minerals were obtained from 2 of 5 drillings (their drilling length is 50 and 85m respectively). Sn-production in the two wells is very limited. In one well, cassiterite occurs only within one a-few-cm-long greisen. In the other well, only one disseminated part, which contains a few granules of cassiterite, exists. Each of the two wells also has a very low grade (0.3-0.6%) Cu-mineralized part, which is a few meters long.	cassiterite, stannite, malachite, malachitechrysocolla, cuprite, covellite, chalcocite, chalcopyrite, sphalerite, , native silver, pyrite, erubescite, panabase, argyrose, apatite, lepidolite, topaz, fluorite		'60, the greisen was discovered. '61-'62, five boreholes were drilled. '71-'72, An UNDP project covered this prospect.
2	Conchita-Florence	Au	8˚32'W 26˚20'N 1.5km to the E of W. Sahara. 3km to the W of the road running from Bir Mogrein to Tindouf.	Vein-type Hydrothermal Deposit. Main host rocks are leptynite and amphibolic migmatite of Hassi el Fogra series (Precambrian C), which are frequently accompanied by felsic pegmatite. They are partly coverd by small and isolated overburdens of propylitized dacite and altered felsic tuff , and are intruded by small dykes of propylitized diorite and relatively-fresh dolerite. The deposit consists of about 40 Au-bearing quartz veins, which are distributed within a 3.2x1.2km area. The veins, generally striking N30˚W and dipping nearly vertically, are 100m long max. and 20 to 100cm (60cm on avg.) wide. Au and Ag graded of grab samples taken from the outcrops of Florence veins (N, E and SE) is as follows: N vein (11g/t, 7g/t), E vein (12.2g/t, 6g/t), SE vein (11g/t, 8g/t). Assuming avg. Au grade of 10g/t, avg. vein width of 60cm, and depth of 10m, total gold content of all the veins is estimated to be 400-500kg.	native gold, pyrite, siderite, limonite, (goethite), galena, chalcopyrite, bornite, covellite, malachite, native copper		
3	Yetti	Pb Zn Cu	8˚18'-8˚37'W 26˚05'-26˚33'N To the NE of Yetti. N. margin of Reguibat schield.	Vein-type Hydrothermal Deposit There is a major N-S fracture zone, in which Aguelt Nebkha metamorphic rock. The E. and W. blocks separated by the fracture zone consist of Yetti granite and Hassi el Fogra migmatite, respectively. The deposit consists of numerous veins distributed along the N-S fracture zone. The mineralized part of the fracture zone reaches 20-30km. In the deposit, both scale and number of veins decline from N to S. Ore minerals predominant in the N. part of the deposit are sphalerite and galena, while those in the S. part are Cu-minerals. The formation age of the deposit was Precambrian (after Precambrian C).	sphalerite, galena, calamine, cerussite, anglesite, chalcopyrite, malachite, chrysocolla, chalcocite, covellite, cuprite, tenorite, pyrite		'61-62, a survey was taken as part of a railroad construction plan.
4	Koedia-Idjill (F'Derik, Seyala, Rouessa, Tazadit)	Fe	12˚27'-12˚42'W 22˚39'-22˚42'N 5-30km to the S of Zouerate city.	Superior-type BIF The four deposits are located within Tazadit unit, which is one of the seven nappes*1 of Proterozoic Idjill Group. The unit consists of itabirite, non-ferruginous quartzite, and schist, which strike roughly E-W and dip moderately to steeply to S. Rocks of the unit suffered from greenschist-facies metamorphism, which finished around 1.8Ga. The deposits exist within the itabirite, either as lenticular concentrates (ca. 65% Fe) of foliated hematite, or as pockets of massive hematite (68% Fe). Fresh hematite ore has a distinctive blue color. On very rare occasions, hematite ore is accompanied by kaolinite. *1 (Remarks regarding other units): La breche unit contains conglomerate beds consisting of subrounded orthoquartzite gravels and black ferruginous matrix. In the W. margin of El Hadej unit, peridotite was found by two drillings. These facts show that Idjill group was originally deposited on an oceanic plate near a continent.	hematite, (martite), (goethite)	1.9Ga? (muscovite, muscovite schist, K-Ar). ---------- Previous studies: 1754±38Ma (biotite), 1850±50Ma (muscovite, muscovite schist, K-Ar).	In the 11th century or earlier, the deposits were discovered. West Africa Geological Survey, Fr. ('37-'39), BRGM, Fr. ('48), Bethlehem Steel, US ('49), and British Steel, Br. ('50) conducted surveys. '52, MIFERMA (Mauritania Iron Mining Company) was established. '63, production began (1.5Mt). '72-73, production was 9Mt. '74, MIFERMA was nationalized and reorganized as SNIM (Mauritania Mining Public Corporation). '74, production reached 12Mt, but that had decreased to 7-8Mt by '82-'83.
	Koedia- Idjill (M'Haoudat)		12˚03'W 22˚57'N 55km to the NE of Zouerate city.	Superior-type BIF The deposit is encompassed by M'Haoudat unit, which is one of the seven nappes comprising Proterozoic Idjill group. The unit consists of itabirite, non-ferruginous-quartzite, and schist. Ore bodies (more than 60% Fe) exist within itabirite, and form foliated-hematite lenticular concentrations and massive hematite pockets. The itabirite, which strikes NW-SE and dips moderately to steeply to NE, is distributed over a 15kmx0.2km area.	hematite		Surveyed as a part of the Guelbs Project conducted by SNIM. '94, this mine was opened. '03, 1.4Mt of 64% Fe and 1.5Mt of 54% Fe were produced.
5	Tiris (El Rhein)	Fe	12˚20'W 22˚53'N 25km to the NE of Zourate city.	Iron Formation The deposit is embedded in Achaean Tiris group, which consists of meta-ferruginous-quartzite, meta-nonferruginous-quartzite, gneiss, leptynite and amphibolite. The host rocks suffered from granulite-facies metamorphism, which finished by 1.5Ga. Clastic materials forming the granulite were suggested to be provided by granitoid of 2.8Ga. The ore mineral is coarse-grained magnetite in a meta-ferruginous-quartzite bed (37% Fe). The ferruginous bed was bent into a complex shape by folding, and is distributed over an area covering 1.5km N-S and 1km E-W.	magnetite, hematite, (martite), (goethite)	1480±40Ma (K-feldspar, leptynite, K-Ar) ---------- Previous studies: 2779±84Ma (granurite, whole rock, Rb-Sr)	MIFERMA conducted an aerial magnetic survey. '72, MIFERMA conducted a geological survey. '80, construction of mine facilities started. '84, electric generators started operation '85, production began (6Mt of 65% Fe ore extracted).
	Tiris (Central El Aouj)		12˚47'W 22˚55'N 40km to the NW of Zoerate city.	Iron Formation The deposit is embedded in Achaean Tiris group, which consists of meta-ferruginous-quartzite, meta-non-ferruginous quartzite, gneiss, leptynite and amphibolite. The host rocks suffered from granulite-facies metamorphism. The ore mineral is coarse-grained magnetite in meta-ferruginous-quartzite (37% Fe). The magnetite-bearing quartzite forms a syncline with a NE-SW aixis, and is distributed over a 4x1km area.	magnetite		MIFERMA conducted an aerial magnetic survey. '82-83, SNIM conducted a geological survey.

No.	Name of Prospect	Metal(s)	Locality	Geology	Ore Mineral(s)	Dating Data	History, etc.
	Tiris (Atomai)		12°45'W 22°43'N 35km to the W of Zouerate city.	Iron Formation Host rock is Achaean Tiris group, which consists of meta-ferruginous-quartzite, meta-non-ferruginous quartzite, and leptynite with a small dyke of pegmatite. The host rocks suffered from granulite-facies metamorphism. The ore mineral is coarse-grained magnetite in meta-ferruginous quartzite (37% Fe). The magnetite-bearing quartzite generally strikes E-W, and dips moderately to steeply to N. The outcrop of the deposit covers a 8km X 0.5km area.	magnetite		MIFERMA conducted an aerial magnetic survey. '80, SNIM conducted a geological survey.
6	Gara Bouya Ali	Fe	11°25'W 25°58'N	Sedimentary Deposit Host rock is upper Cambro-Ordovisian sequence, which consists of a thin bed of conglomerate, a 75m-thick bed of green-micaceous and glauconitic mudstone, and a 50m-thick bed of quartzose sandstone, in ascending order. Iron-ore beds, which are a few meters (15m max.) thick, is intercalated between the conglomerate bed and the mudstone beds. The ore, which contains sedimentary goethite and a large amount of altered glauconite, is low grade (35.5% Fe). For an example, a grab sample of ore shows the following composition: Fe2O3 46.16%, FeO 1.94%, SiO2 38.1%, Al2O3 5.94%, MgO 0.02%, CaO 0.65%, SO3 ND, P2O5 0.75%.	goethite, glauconite, phosphates		
7	F'Derik	Fe	12°42'W 22°40'N	Reclassified into "No.4 Koedia-Idjill" category.			
8	Sfariat	Fe	11°21'W 24°01'N	Algoma-type BIF An Achaean-rock belt runs NW, cutting Achaean-Proterozoic TTG (mainly consisting of tonalite, granodiorite and quartz diorite). The belt consists mainly of migmatitic gneiss, granite, gneiss of volcanic-rock origin, and mylonite of sedimentary-rock origin, and contains two 10-to-30m-thick BIF in a NW-SE shear zone existing within the belt. The BIF is fresh, and did not suffer from any distinct mineralization/alteration. BIF contains both hematite and magnetite in variable proportion. Ore grade is 20-40% Fe. Ore reserve is possibly 30Mt per km of outcrops.	hematite, magnetite		'01-03, OMRG, BGS, etc., conducted a geochemical survey. '03, GSJ and OMRG conducted a field excursion.
	Zednes	Fe	10°37'W 23°47'N	Algoma-type BIF Host rock is a ferruginous quartzite bed, which is 130m thick max. The bed overlays 150m-thick amphibolitic rock, which is accompanied by non-ferruginous quartzite around its top. Ore grade and ore reserve of the deposit are possibly 66-69% Fe and 300Mt, respectively.	hematite		
9	Tourassin-Aneinat	Sn	60km to the S of Bir Mogrein.	Sn-mineralization of this prospect is indicated by only geochemical anomalies (875, 225, 125ppm Sn) in migmatite.			
10	Ghallamane Sebkhas	Cu	350km to the NE of Zoueratecity.	Cu-mineralized of this prospect is indicated by only geochemical anomalies (70, 160, 280ppm Cu) in a volcano-sedimentary complex (Precambrian D, C).			
11	Tasiast (Piment)- Tijirit	Au	15°31'W 20°34'N	Vein-type Hydrothermal Deposit Many narrow lenses of greenstones run roughly N-S, cutiing an Precambrian felsic-rock body (orthogneiss, pegmatit of 2.9Ga, and granodiorite of 2.2Ga). These greenstone lenses consists of mafic schist, amphibolite, peridotite, serpentinite, gabbro, and Algoma-type BIF with local disturbance by oceanic slidings. The greenstones originated from an oceanic plate formed in 3.2Ga and sedimentary rocks on the plate, and suffered from greenstone-to-amphibolite-facies metamorphism, which finished in 1.7Ga. These greenstone lenses with the above-mentioned characters indicates that Tasiast-Tijirit is a suture zone. Mineralization/alteration took place within the Algoma-type BIF after 1.7Ga (possibly in 1.4Ga). Ore reserve of Au is "3g/t Aux12Mt" (measured/indicated base) + "2g/tx12Mt" (inferred base). Mineralization/alteration consisted of the following three stages: <Stage 1>: W-mineralization and silicification. Environment was ca. 280°C, ca. 36% NaCℓ eq., and oxidized. <Stage 2>: Argilization (sericite, kaolinite, dickite, smectite), depletion of Fe and Si, and enrichment of K and Al. Environment was ca. 200°C, neutral to weakly asidic, and reduced. <Stage 3>: Au-mineralization, silicification (including "black quartz" deposition), nontronization, and limonitization. Environment was ca. 150°C and ca. 30% NaCℓ eq.	native gold(?)	2.92-2.91Ga (muscovite, pegmatite, K-Ar), 2.21-2.19Ga (muscovite or hornblende, granodiorite, K-Ar), 3190±80Ma (hornblende, ambiolite, K-Ar), 1.73-1.71Ga (muscovite or hornblende, schist, K-Ar), 1.4Ga? (sericite, argillized BIF, K-Ar)	'93-96, OMRG and BRGM discovered the Au mineralization. '03, Defiance Mining acquired the property from Normandy LaSource. In September 2004, Rio Narcea Mines acquired the property from the Defiance Mining. Tasiast Mauritanie Ltd, a subsidary of Rio Narcea Mines, started construction of a gold mine in November 2005 in order to product gold bullion for mid-2007.
12	Amsaga (EL Foulet)	Cr	13°29'W 20°34'N To the W of Atar.	Orthomagmatic Deposit There is a complex of anorthite and ultramafic rocks (Precambrian D). Serpentine in the complex is accompanied by ore minerals. Lenses of a few to a few hundred square meters form agglomerations, and those agglomerations comprise the two ore belts of El Foulet (4x0.3km extending from NNE-SSW) and El Heirich (10x0.5km, extending from NE-SW). Ore grade is as follows: Cr2O3 30～36%, Cr/Fe<2, Al2O3<3%.	chromite, magnetite		'64, 38 boreholes were drilled.
	Amsaga (El Heirich)		13°35'W 20°20'N To the W of Atar.				28 test boreholes were drilled.
13	Chegga	Cu	5°05'W 25°00'N	The deposit is embedded in Precambrian fine-grained ferruginous sandstone. Ore grade is 0.21-0.82% Cu.	malachite, cuprite, covellite		
14	Tabrinkout	Au (W?)	14°04'W 19°43'N 35km to the E of Akjoujt.	Vein-type Hydrothermal deposit Chlorite schist is distributed widely with small blocks of carbonate rock. Carbonate rocks were mineralized, and 5-to-20cm-wide quartz veins were deposited. Au exceeds 1g/t in a few local places, but overall the mineralized rocks are low grade. No W-bearing minerals (wolframite, etc) were found either in outcrops or trench/drilling wastes. and W grade of rocks and veins is less than 31ppm. By the mineralization, many elements (Au, Ag, Bi, Cu, Pb, Sb, Se, Sn, and Te) were enriched. The mineralization environment is 250℃, 34% NaCℓ eq.	native gold, malachite, wolframite(?), scheelite(?), bismuthinite(?)		Surveyed by BRGM and OMRG.
15	Akka Danach	Fe	12°40'W 19°33'N	Sedimentary Deposit The deposit is hematite concentrates in upper Ordovician sandstone and mudstone.	hematite		
16	Bathat Ergil	P	12°42'W 20°34'N	Sedimentary Deposit Host rock is basal quartzose sandstone of Precambrian Atar group.	phosphates		

No.	Name of Prospect	Metal(s)	Locality	Geology	Ore Mineral(s)	Dating Data	History, etc.
17	Inchiri （Guelb Moghrein）	Cu Au Co	14˚26'W 19˚45'N 4km to the W of Akjoujt.	Carbonate Replacing Hydrothermal Deposit Basalt, dolerite, and intermediate-to-asidic volcanic rocks are widely distributed with being accompanied by carbonate rock, chert, and BIF. Moreover, Those rocks suffered from greenschist-to-amphibolite-facies metamorphism, which finished in 393Ma. To the W of Guelb Moghrein, Hajar Dekhen granite moved by thrust covers the rocks . Below the W. hill of Guelb Moghrein, there is a magnesian carbonate lens (50-100m thick, 500m long along dip), which strikes NW-SE, dips 30˚SW around the peneplain level, and dips horizontally 150-200m below the peneplain. The deposit consists of ore (mainly Cu-minerals) replacing the carbonate lens. The lens is rich in black spots of coarse-grained magnetite, and partly contains a-few-cm-diameter white spots of magnesite-aggregate. In the lens and their vicinity, there exist magnesian skarns (anthophyllite, talc). From a part of the top of the lens to the surface, a hematite-schist block developed in the shape of a mushroom opening toward the surface, cutting surrounding chlorite schist. Around the bottom of the block, sulphate minerals were deposited. These field data suggest that hot O2-rich fluid flowed up with changing chlorite to hematite. rocks . The deposit consists of an oxidized zone above the peneplain and a sulphide zone below the peneplain. Malachite and azurite are predominant in the former, and chalcopyrite is predominant in the latter. Cu-minerals are also disseminated within the 1-to-15m-thick silicious gossan on the summit of the W hill deposit. Cu grades of the gossan, the oxidized zone and the sulphide zone are 0.5%, 2.7% and 0.4-9%, respectively. By the mineralization, many metal elements (Au,Ag,As,Bi,Co,Cu,Ge,In, Ni,Se,Sn,Te,Zn) were enriched, while Cr was leached out. The assemblage of enriched elements in this deposit is similiar to that in Tabrinkout. Mineralization tool place after the metamorphism, which finished 393 Ma. Possibly around 300Ma, namely just before formation of Pangea. Mineralization environment is 250-300℃, 35%NaCℓ eq., with oxidation occurring in the upper part of the deposit. In Masse I, II, and III to the SW of the Guelb Moghrein, there are martite-bearing magnesian carbonate rocks (several meters thick, 100-200m long), in which malachite is disseminated.	Oxidized Zone: gossan, malachite, chrysocolla, covellite, azurite, hematite, goethite, limonite, magnetite, dioptase, cuprite, tenorite, native copper, chalcocite Suphide Zone: chalcopyrite, pyrrhotite, cubanite, mackinawite, pentlandite, chalcocite, (sylvanite, melonite), molybdenite, Ni-Co-mineral, native gold	393±10Ma (muscovite, muscovite schist, K-Ar)	46, discovered by boring. BUMIFOM ('52) and PENARROYA ('53) conducted surveys. '57, MICUMA attempted development using the oxygen penetration method, but there was too much carbonate so too much oxygen was consumed, and desirable results were not obtained. '67, SOMIMA（Anglo-American）adopted the segregation method (TORCO process), and reevaluated the project. '71, an open pit Cu mine was opened that had an annual production of 25,000t of Cu. Ore reserve of Cu: in the oxidized zone (Cu 8Mtx2.7%, Au 2.5g/t), in the sulfide zone: Cu 15Mtx1.8% Au 1.3g/t. '78, almost all ore in the oxidized zone had been excavated, and production was stopped. '94, General Gold International acquired the deposit. After a boring survey, he planed to mine the sulfide zone. In June 2004, Mauritanian Copper Mines (MCM), a subsidary of First Quantum Minerals Ltd, aquired a 80% of interest the coper and gold project. MCM has started construction of an open-pit mine and a factory of extraction of copper and gold at the end of
18	Kadiar	Cu	12˚40'W 16˚53'N 16km to the N of Arere	Dissemination Deposit There are serpentinite and Gadel series, which strikes N-S and dips 30-60˚W, primarily composed of prasinite, chlorite schist, and mica schist, with thin siliceous/ferruginous/carbonaceous beds. At the surface, a siliceous gossan, which strikes NNW-SSE and dips 60˚W, is 30-60m thick and 350-500m long. From the depth of 2-5m to the depth of 30m there is mainly powdery ferruginous gossan. From the depth of 30m to the depth of 90m, there exists a carbonate rock consisting of magnesite and siderite. The oxidized zone in the powdery ferruginous gossan is 30m wide, 20m thick, and 350m long, with grade of 1.5% Cu. The primary zone in the carbonate rock is at-least-10m-thick with grade of 0.8% Cu. The powdery ferruginous gossan also contains 0.7% of Zn, and trace amounts of Ag and Co. '03, SNIM found a very trace amount of native gold by drilling.	Oxidized Zone: gossan, malachite(chalcopyrite, pyrite) Sulphide Zone: pyrite, chalcopyrite, (pentlandite, bravoite, millerite, chromite, native gold)		Three boreholes were drilled. 9,500t Cu in the oxidized zone, and 2,500t Cu in the primary zone in the carbonate rock were estimated. '03, SNIM conducted some drillings.
19	Indice 78	Cu Au	12˚44'W 16˚43'N 12km to the S of Arere.	Vein-type Hydrothermal Deposit Host rock is metamorphosed andesitic rocks, namely lava and tuff. Au grade is 0.2-29g/t, and Cu grade is <35.5%. Only 5 of 472 quartz-vein samples taken by GGI's detailed survey exceed 0.02g/t Au. Max. was 0.7g/t Au. GGI evaluate this prospect as "disappointing".	malachite, covellite, native gold		93-95, BRGM and OMRG conducted surveys. '96, General Gold International conducted a detailed survey.
20	Oudelemgil	Cu Au	12˚11'W 16˚55'N	Host rock is meta-gabbro, meta-basalt, agglomerate, quartzite, schist. Cu grade of Cu and Au are 35.5% and 40ppb, respectively. Ore reserve is 138kt (3% Cu).	malachite, chalcopyrite		
21	M'Bout	Cu Au	12˚32'W 16˚01'N				
22	Diaguili	Cu	12˚21'W 14˚53'N。	Dissemination Deposit There are chlorite schist, jaspilite and siltstone of Gadel series with lenses of serpentinite. Chlorite schist and jaspilite strikes N20˚E, and near their contact area they form alteration. These rocks are covered by a less-than-1m-thick bed of clay and sand. Ore minerals are disseminated in the chlorite schist and jaspilite. There are two outcrops (the N and S hills), which strike NE-SW and are 300-400m long and 100m wide, In the outcrops, malachite and chrysocolla are disseminated Cu grade in high-grade zone is 12.73% at a 5m-long trench, and 3.83% at a 2m-long trench. Above the depth of 40m, there is a oxidized zone, which is 10-20 wide and 400m long. Cu grade is 1-2% (1.5% on avg.). Below the depth of 40m, there is a primary zone, not much is known about them because satisfactory boring has not been done there yet. Ore reserve of Cu in the oxidized zone of the N hill deposit is 7kt. Cu grade of the primary zone is 2.08% on avg. (max. 6.74% at the depth of 69-69.6m).	Outcrop/Oxidized Zone: malachite, chrysocolla (chalcocite, covellite, chalcopyrite, bornite) Sulphide Zone: pyrite, chalcopyrite, bornite, , chalcocite		74, more than 17 boreholes were drilled at the N hill. Some borehole were drilled (drilling length is 50m) at the S hill. ろ。The ore condition of the primary zone is not well known because boring has not reached there. '75, there were plans to make borings down to a depth of 200m at the S hill.
23	Guidimaka	Cr	12˚03'-12˚23'W 14˚50'-15˚14'N	Orthomagmatic podiform-type deposit It consists of massive chromite deposit in sepentinite in the Mauritanides, which are 10-40m long and up to 15m thick. Main mineral of chromite consists of magnesiochromite, and Cr2O3 grade is low ranging 22-33%. The present survey confirmed the existence of PGM that indicates a Pt grade of 0.07-0.1 ppm. Sulfide minerals of PGM are comfirmed by EPMA.	chromite, ferro-magnesiochromite, osmium, irarsite, laurite, erlichmanite, cuproiridsite, pentlandite and millerite		

No.	Name of Prospect	Metal(s)	Locality	Geology	Ore Mineral(s)	Dating Data	History, etc.
24	Bou Naga	Y Th	13˚15'W 18˚55'N	Orthomagmatic Deposit The host rock is syenite of Bou Naga hypabyssal-plutonic alkali complex of Precambrian C. The deposit in SW of the W body consists of xenotime-bearing veins, each of which is several tens to 1,500(+) meters long and a few to two cm wide. Ore grade and ore reserve of Y_2O_3 are 4.4% and 510t, respectively. Grade of Th is less than 1%. Moreover, grades of Th, CeO_2, and Y_2O_3 in outcrop of Guelb Zellaga are 0.1-0.9%, less than 3%, less than 0.2%.	xenotime, thorite, synchysite, doverite, bastnasite, zircon, rutile, pyromorphite, fluorite, Mn-oxide, Fe-oxide, barite, malachite		'70, exploitation started at SW of the W body. '71exploitation stopped with the collapse of Y price.
25	Kaedi-Aleg-Bogue	P	13˚41'-14˚05'W 16˚11'-16˚35'N	Concealed Sedimentary Deposit Phosphate-mineral-bearing beds, which have a total thickness of less than 3.5m and are 22% P_2O_5, are intercalated in Eocene dolostone and limestone.	phosphates		
26	Jreida-Lemsid	Ti	15˚58'-16˚04'W 18˚12'-18˚39'N	Concealed Placer Deposit The deposit exists in recent coastal sands along the Atlantic coast. Deposit thickness is 0.3-1.5m. Grade is 2-10% TiO_2.	ilmenite		
27	Nouakchott	gypsum	15˚35-15˚47'W 18˚24-18˚39'N	Concealed Evaporite Deposit 17.5Mt of ore exists with clay 0.3-3m below the surface.	gypsum		
28	Aftout es Saheli	halite	16˚06-16˚16'W 17˚04'-16˚44'N	Evaporite Deposit Ore reserve is 150kt. The deposits were formed when sea water that had flooded the lowlands behind the sand dunes evaporated during the dry period. In small-scale deposits (e.g., Lemzewid, El Bokaria), each bed is 5cm (max. 25cm) thick. In large-scale deposits (e.g., N'Teret, Twidermi), each bed is 14-40cm thick. The N'Teret deposit is 590X630m in aerial extent. It consists of 8 halite beds exist, which intercalate clayey beds. Ore reserve is 150kt. The Twidermi deposit is 490X390m in aerial extent. Above the depth of 75 cm, 2 halite beds exist with intercalating a mudstone bed. Ore reserve of Twidermi is said to be a few tens of thousands of tons.	halite		45, Mining of the N'Teret deposit began as hand-excavating mining. '34-'60, at least 125,000t of halite were excavated with annual production rate of 6,000-9,000t/year. As the excavation became deeper, permeating water made it difficult to continue excavating. '70, the MMI adopted modern excavation methods, and produced 600t.

2.2 List of collected samples

	Sample	Lat. (N)		Lon. (W)		Description
		°	'	°	'	
Oudelemguil (Ragel)	BTH003	16	04.206	12	08.795	
Oudelemguil (Ragel)	BTH004	16	04.202	12	08.793	
Oudelemguil (Ragel)	BTH007					
Oudelemguil (Ragel)	BTH008					
Oudelemguil (Ragel)	BTH011					
Oudelemguil (Ragel)	BTH012					
Oudelemguil (Ragel)	BTH013					
Oudelemguil (Ragel)	BTH014					
Oudelemguil (Ragel)	BTH015	16	03.760	12	08.836	strongly-silicified, strongly to mediumly hematized rock
Oudelemguil (Ragel)	BTH016	16	03.769	12	08.838	strongly-silicified, strongly to mediumly hematized rock
Oudelemguil (Ragel)	BTH017	16	03.788	12	08.831	strongly-silicified, mediumly hematized rock
Oudelemguil (Ragel)	BTH018	16	03.801	12	08.831	strongly-silicified, strongly to mediumly hematized rock
Oudelemguil (Ragel)	BTH019	16	03.805	12	08.831	strongly-silicified, strongly to mediumly hematized rock
Oudelemguil (Ragel)	BTH020	16	03.814	12	08.826	strongly-silicified, strongly hematized rock
Oudelemguil (Ragel)	BTH021	16	03.818	12	08.832	strongly-silicified, strongly hematized rock
Oudelemguil (Ragel)	BTH022	16	03.827	12	08.830	strongly-silicified, strongly hematized rock
Oudelemguil (Ragel)	BTH023	16	03.832	12	08.845	mediumly-silicified meta-basalt
Oudelemguil (Ragel)	BTH001	16	04.204	12	08.788	malachite bearing green copper ore (baslt? Origin)
Oudelemguil (Ragel)	BTH002	16	04.202	12	08.793	malachite ore,standard
Oudelemguil (Ragel)	BTH003	16	04.194	12	08.799	sheared zone,clayey
Oudelemguil (Ragel)	BTH004	16	04.211	12	08.759	sheared basalt w/malachite impregnation
Oudelemguil (Ragel)	BTH005	16	04.135	12	08.773	quartz vein,N10E,49W,w=3cm
Oudelemguil (Ragel)	BTH006	16	04.104	12	08.539	weathered schistose quarzite
Oudelemguil (Ragel)	BTM007	16	03.906	12	08.854	No.2 ore body, malachite vein
Oudelemguil (Ragel)	BTM008	16	03.907	12	08.849	siliceous limonitized quartzite
Oudelemguil (Ragel)	BTM009	16	03.898	12	08.850	malachite imp. chlorite basalt
Oudelemguil (Ragel)	BTB001	16	03.810	12	08.810	greenish-gray very-fine-grained quartzite or mediumly-silicified meta-basalt
Kadiar	KDB001	16	53.425	12	-40.210	gree Cu-bearing gossan
Kadiar	KDB002	16	53.468	12	-40.249	gree Cu-bearing gossan
Kadiar	KDH001	16	53.400	12	-39.964	muscovite schist
Kadiar	KDH002	16	53.404	12	-39.967	quartz vein, 30cm wide
Kadiar	KDH003	16	53.351	12	-40.027	muscovite quartzose schist
Kadiar	KDH004	16	53.335	12	-40.144	siliceous gossan with trace amount of green Cu
Kadiar	KDH005	16	53.322	12	-40.142	siliceous gossan with trace amount of green Cu
Kadiar	KDH006	16	53.315	12	-40.137	hematite-rich gossan, weakly siliceous
Kadiar	KDH007	16	53.304	12	-40.134	siliceous gossan, rich in yellow mineral
Kadiar	KDH008	16	53.289	12	-40.129	siliceous gossan
Kadiar	KDH009	16	53.278	12	-40.113	siliceous gossan
Kadiar	KDH010	16	53.263	12	-40.104	siliceous gossan
Kadiar	KDH011	16	53.243	12	-40.097	siliceous gossan
Kadiar	KDH012	16	53.231	12	-40.091	siliceous gossan
Kadiar	KDH013	16	53.212	12	-40.103	muscovite-bearing quartzose schist
Kadiar	KDH014	16	53.182	12	-40.132	muscovite schist
Kadiar	KDH015	16	53.173	12	-40.142	chlorite schist
Kadiar	KDH016	16	53.161	12	-40.156	strongly silicified rock with Fe-oxides
Kadiar	KDH017	16	53.146	12	-40.158	strongly silicified rock with Fe-oxides
Kadiar	KDH018	16	53.140	12	-40.167	strongly silicified rock with Fe-oxides
Kadiar	KDH019	16	53.149	12	-40.176	strongly-mediumly silicified muscovite schist
Kadiar	KDH020	16	53.164	12	-40.192	strongly silicified rock
Kadiar	KDH021	16	53.165	12	-40.201	strongly silicified rock with brown/red/black Fe-oxides with quatz veinlets
Kadiar	KDH022	16	53.183	12	-40.198	strongly silicified muscovite schist with Fe-oxides and quartz veinlets
Kadiar	KDH023	16	53.207	12	-40.206	chlorite schist, hornblende-bearing??
Kadiar	KDH024	16	53.211	12	-40.206	serpentinite with asbest
Kadiar	KDH025	16	53.233	12	-40.222	serpentinite
Kadiar	KDH026	16	53.245	12	-40.198	massive green chlorite rock, hornblende-bearing??
Kadiar	KDH027	16	53.260	12	-40.178	muscovite quartzose schist
Kadiar	KDH028	16	53.263	12	-40.216	serpentinite
Kadiar	KDH029	16	53.291	12	-40.182	massive muscovite-chlorite schist
Kadiar	KDH030	16	53.347	12	-40.151	siliceous gossan with trace amount of green Cu
Kadiar	KDH031	16	53.359	12	-40.152	siliceous gossan with trace amount of green Cu
Kadiar	KDH032	16	53.359	12	-40.163	serpentinite
Kadiar	KDH033	16	53.367	12	-40.166	chlorite schist
Kadiar	KDH034	16	53.376	12	-40.170	serpentinite
Kadiar	KDH035	16	53.384	12	-40.173	chlorite schist
Kadiar	KDH036	16	53.385	12	-40.178	specularite-rich gossan
Kadiar	KDH037	16	53.386	12	-40.180	talc chlorite schist
Kadiar	KDH038	16	53.387	12	-40.180	weakly Fe-disseminated schist, talc-bearing
Kadiar	KDH039	16	53.438	12	-40.212	green schist
Kadiar	KDH040	16	53.450	12	-40.220	siliceous gossan with relicts of muscovite chlorite schist
Kadiar	KDH041	16	53.457	12	-40.218	chlorite schist
Kadiar	KDH042	16	53.469	12	-40.256	strongly silicified rock with drusy quartz, surrounded by siliceous gossan
Kadiar	KDH043	16	53.485	12	-40.266	strongly silicified rock with quartz veins
Kadiar	KDH044	16	53.499	12	-40.278	siliceous gossan with quartz veinlets along schistosity
Kadiar	KDH045	16	53.516	12	-40.277	weakly siliceous gossan with trace amount of green Cu
Kadiar	KDH046	16	53.535	12	-40.290	siliceous gossan
Kadiar	KDH047	16	53.565	12	-40.289	mediumly-strongly silicified muscovite schist
Kadiar	KDH048	16	53.531	12	-40.328	massive chlorite rock
Kadiar	KDH049	16	53.551	12	-40.265	muscovite chlorite schist
Kadiar	KDH050	16	53.509	12	-40.232	chlorite schist
Kadiar	KDH051	16	53.432	12	-40.162	biotite muscovite chlorite quartzose schist
Kadiar	KDM001	16	53.332	12	-40.144	siliceous gossan with malachite
Kadiar	KDM002	16	53.205	12	-40.110	sericite schist
Kadiar	KDM003	16	53.160	12	-40.185	siliceous gossan with quartz veinlet
Kadiar	KDM004	16	53.189	12	-40.207	brecciated siliceous gossan originated from schist
Kadiar	KDM005	16	53.174	12	-40.246	silicified serpentinite with chromite
Kadiar	KDM006	16	53.182	12	-40.236	siliceous gossan originated from schist
Kadiar	KDM007	16	53.203	12	-40.243	silicified serpentinite with chromite
Kadiar	KDM008	16	53.222	12	-40.263	pale blue brecciated rock
Kadiar	KDM009	16	53.391	12	-40.182	
Kadiar	KDM010	16	53.408	12	-40.198	
Kadiar	KDM011	16	53.460	12	-40.245	
Kadiar	KDM012	16	53.556	12	-40.330	
Indice78	IDH040	16	43.629	12	44.128	massive muscovite-chlorite green rock
Indice78	IDH041	16	43.628	12	44.101	muscovite chlorite schist
Indice78	IDH042	16	43.621	12	44.341	muscovite chlorite schist
Indice78	IDH043	16	43.950	12	44.326	muscovite chlorite schist, weakly epidotized, weakly silicified, with green Cu along schistosity
Indice78	IDH044	16	43.949	12	44.324	massive epidote chlorite weakly silicified green rock with trace amount of green Cu
Indice78	IDH045	16	43.953	12	44.284	weakly silicified muscovite chlorite schist with trace amount of green Cu along schistosity

2.2 List of collected samples

	Sample	Lat. (N)		Lon. (W)		Description
		°	'	°	'	
Indice78	IDH046	16	43.869	12	44.255	massive epidote chlorite weakly silicified green rock
Indice78	IDH047	16	43.883	12	44.242	muscovite chlorite schist
Indice78	IDH048	16	43.898	12	44.289	muscovite chlorite schist, weakly epidotized, weakly silicified
Indice78	IDH049	16	43.853	12	44.231	massive epidote chlorite green rock
Indice78	IDH050	16	43.787	12	44.211	massive epidote chlorite weakly silicified green rock
Indice78	IDH051	16	43.916	12	44.297	massive epidote chlorite weakly silicified green rock with trace amount of green Cu
Indice78	IDH052	16	43.939	12	44.253	massive epidote chlorite weakly silicified green rock
Indice78	IDH053	16	43.774	12	44.183	muscovite chlorite schist
Indice78	IDH054	16	43.761	12	44.200	massive epidote chlorite weakly silicified green rock
Indice78	IDH055	16	43.721	12	44.213	quartz vein, max 37cm-wide, 6m-long
Indice78	IDH056	16	43.740	12	44.299	muscovite chlorite schist
Indice78	IDH057	16	43.748	12	44.238	quartz vein with specularite and green Cu along grain boundary/crack
Indice78	IDH058	16	43.747	12	44.238	quartz vein
Indice78	IDH059	16	43.747	12	44.238	muscovite chlorite schist with green Cu along schistosity
Indice78	IDH060	16	43.731	12	44.242	muscovite chlorite schist
Indice78	IDH061	16	43.741	12	44.224	chlorite muscovite schist
Indice78	IDH062	16	43.744	12	44.218	massive epidote chlorite weakly silicified green rock
Indice78	IDH063	16	43.739	12	44.225	chlorite muscovite schist with green Cu along schistosity
Indice 78	IDM001	16	43.699	12	44.200	malachite ore containing chalcocite
Indice 78	IDM002	16	43.781	12	44.235	quartz vein containing chlorite film
Indice 78	IDM003	16	43.796	12	44.247	quartz vein
Indice 78	IDM004	16	43.799	12	44.251	quartz vein
Indice 78	IDM005	16	43.799	12	44.233	epidotizated quartz vein in epidote andesitic schist
Indice 78	IDM006	16	43.870	12	44.250	chlorite andesite
Indice 78	IDM007	16	43.877	12	44.235	quartz vein
Indice 78	IDM008	16	43.799	12	44.117	quartz vein
Indice 78	IDM009	16	43.814	12	44.122	quartz vein
Indice 78	IDM010	16	43.717	12	44.197	milky quartz vein containing sericite
Indice 78	IDM011	16	43.707	12	44.199	translucent quartz vein with malachite films
Indice 78	IDM012	16	43.635	12	44.140	milky quartz vein containing epidote and chlorite
Zourate	KEH001	22	38.802	12	26.833	kaolinite accompanied by blue hematite ore
Zourate	KEH002	22	38.802	12	26.833	blue banded high-grade hematite ore
Zourate	KEH003	22	41.629	12	28.720	itabirite
Zourate	KEH004	22	37.531	12	27.938	magnetite-bearing hematite ore including rounded gravels of quartzite
Zourate	TZM001	22	39.922	12	28.205	muscovite schist
Zourate	TZM002	22	37.532	12	27.936	breccia
Zourate	TZM003	22	39.507	12	27.975	quartzite
Zourate	KDM001	22	41.380	12	28.430	latabirite (hematite & quartzite bands), N60W, 55 s
Zourate	KMD002	22	38.480	12	26.490	banded specularite ore (Blue hematite)
Zourate	KDM003	22	38.450	12	26.510	blue hematite ore with lamina (blue hematite part and silicate-rich part)
Zourate	SYM001	22	40.821	12	34.889	quartz sichist
Zourate	SYH001	22	40.799	12	34.923	yellow-green chlorite muscovite schist
Zourate	SKM007	22	41.340	12	42.500	banded magnetite quartzite (Itabirite)
Zourate	KEH006	22	43.211	12	30.958	chlorite-muscovite schist
Zourate	LMM001	22	43.216	12	30.961	limestone, reddish brown, bedding of N55W strike and 68 s dipping (For Dr.Murakami)
Zourate	MHH001	22	57.138	12	3.102	blue banded high-grade hematite ore
Zourate	MHH002	22	57.149	12	3.101	kaolinite-muscovite schist
Zourate	MHM003	22	57.166	12	3.110	hematite-ore block in quartz vein (float in a cutting face)
Zourate	MHM001	22	57.160	12	3.122	banded hematite ore
Zourate	MHM002	22	57.163	12	3.112	muscovite shear zone
Zourate	RHH001	22	52.210	12	18.185	magnetite concentrate just before shipment to Nouadhibou
Zourate	RHH002	22	52.974	12	19.838	Fe-oxie-rich meta-tonalite? with very small amounts of pyrite
Zourate	RHH003	22	52.976	12	19.834	biotite-bearing green chlorite rock (meta-amphibolite?)
Zourate	RHH004	22	52.976	12	19.834	high-grade magnetite ore
Zourate	RHH005	22	52.976	12	19.834	dark green amphibolite
Zourate	RHH006	22	52.776	12	19.658	"leptynite" (reddish-brown-feldspar-bearing granitoid)
Zourate	AOH001	22	54.852	12	46.884	hematite-bearing meta-quartzite (debris after mountain-top collapse)
Zourate	EAM001	22	54.899	12	46.758	garnet leptinite
Zourate	EAM002	22	54.903	12	46.832	banded coarse-grained cummingtonite-bearing meta-ferruginous sandstone
Zourate	ATH001	22	42.572	12	45.174	muscovite-biotite-bearing psammitic schist
Zourate	ATM001	22	42.573	12	45.136	Fe-oxide-bearing banded fine-grained meta-quartzite
Zourate	ATM002	22	42.584	12	45.190	tourmarine bearing felsic rock
Zourate	SKM001	22	52.530	12	41.370	rock salt
Zourate	SKM002	22	53.040	12	49.150	coarse leptinite
Zourate	SKM003	22	53.040	12	49.150	magnetite-quartz vein cutting leptinite, 10-15cm width
Zourate	SKM004	22	53.040	12	49.150	coarse grained biotite hornblende leptinite
Zourate	SKM006	22	52.160	12	51.590	crystal gypsum developed on rock salt
Zourate	GAM001	22	33.342	12	24.901	dolomite (P2), pale blue, bedding of N10W strike and 4 E dipping (for Dr.Murakami)
El Rhein	RHH101	22	52.983	12	19.441	magnetite-poor amphibolite
El Rhein	RHH102	22	52.983	12	19.441	magnetite-rich amphibolite
M'Haoudat	MHH101	22	56.608	12	02.634	muscovite-chlorite schist
M'Haoudat	MHH102	22	56.608	12	02.634	weekly-shistose green rock bearing quartz veinlets&hematite
M'Haoudat	MHH103	22	57.488	12	03.345	muscovite-chlorite schist
Sfariat	SFH001	24	06.128	11	34.112	weekly-sheared amphibolite, N51W60N
Sfariat	SFH002	24	07.502	11	34.566	coarse-grained BIF, looking like sandstone
Sfariat	SFH003	24	07.509	11	34.563	BIF
Sfariat	SFH004	23	58.683	11	20.584	BIF, N24W80S
Sfariat	SFH005	23	58.670	11	20.855	epidote skarn containing hornblende&pink feldspar
Sfariat	SFH006	23	58.634	11	20.776	sheared granite bearing pink-feldspar
Sfariat	SFH007	24	10.591	11	40.100	pyroxene skarn
Sfariat	SFH008	24	10.504	11	39.773	BIF, N58W68N
Sfariat	SFM001	24	05.935	11	34.271	BIF
Sfariat	SFM002	24	07.480	11	34.559	limestone, N58W, 74N
Sfariat	SFM003	24	07.496	11	34.555	magnetite bearing BIF, N30W, 45N
Sfariat	SFM004	23	58.629	11	20.768	pink feldspar rich granite, foliation distinct N30W, 80S
Sfariat	SFM005	23	58.723	11	20.713	weathered white granite
Sfariat	SFM006	23	58.877	11	20.716	magnetite bearing BIF, N70W, 30N
Sfariat	SFM007	23	58.903	11	20.733	milky quartz vein in sheared magnetite BIF, N55W, 54N
Sfariat	SFM008	23	59.012	11	21.566	quartz vein in BIF, N2W, 72S
Sfariat	SFM009	24	10.585	11	40.108	pyroxene skarn
Sfariat	SFM010	24	10.796	11	40.033	brownish goethite BIF, N45W, 50N

2.2 List of collected samples

	Sample	Lat. (N)		Lon. (W)		Description
		°	'	°	'	
Sfariat	SFM011	24	10.724	11	39.910	brownish goethite BIF, N15W, 82N
Sfariat	SFM012	24	10.752	11	39.960	brownish goethite BIF, N60W, 88S
Tasiast	TSH001	20	34.148	15	30.890	hematitic BIF partially with quartz-layers brecciated (1-10cmφ), bedding=N10˚E60˚SE
Tasiast	TSH002	20	34.150	15	30.884	white strongly-argillized(sericite,dicite) schist, "metafelsite" (trench)
Tasiast	TSH003	20	34.149	15	30.819	white argillized(dicite,sericite,gypsum) rock with small amount of calcite (trench)
Tasiast	TSH004	20	34.129	15	30.803	white argillized (dicite,gypsum>sericite,calcite) BIF (trench)
Tasiast	TSH005	20	34.150	15	30.774	silicifized BIF (trench)
Tasiast	TSH006	20	34.148	15	30.765	silicifized BIF bearing magnetite (trench)
Tasiast	TSH007	20	34.148	15	30.765	amphibolite, silicifized, partially "nontronized" (trench)
Tasiast	TSH008	20	34.149	15	30.731	BIF bearing magnetite (trench)
Tasiast	TSH009	20	34.148	15	30.706	quartz vein, black quartz, limonite film (trench)
Tasiast	TSH010	20	34.148	15	30.681	BIF "nontronized", along schistosity (trench)
Tasiast	TSH011	20	34.148	15	30.466	BIF bearing magnetite, bedding=N-S80˚E
Tasiast	TSH012	20	38.419	15	30.741	quartz vein, black quartz, strike=N10˚E, 6-7m thick (waste from trench)
Tasiast	TSH013	20	38.404	15	30.823	white/light green limestone, bedding=N18˚E with unclear dip
Tasiast	TSH014	20	38.441	15	31.107	BIF bearing magnetite (waste from trench)
Tasiast	TSH015	20	38.441	15	31.100	quartz vein, <15cm thick, with small amount of limonite (waste from trench)
Tasiast	TSH017	20	39.214	15	31.711	white quartzite (psammitic schist), bedding=N2˚E78˚SE
Tasiast	TSH018	20	41.198	15	24.284	fresh amphibolite with unclear schistosity
Tasiast	TSH019	20	47.262	15	33.879	fresh granodiorite (gneiss?) bearing muscovite &biotite
Tasiast	TSH020	20	47.568	15	34.357	lightly-greenish muscovite (from pegmatite) (waste from trench)
Tasiast	TSH021	20	30.116	15	34.138	basalt
Tasiast	TSH022	20	28.904	15	35.134	brown laterite with brecciated texture, bearing quartzite grains
Tasiast	TSH023	20	28.908	15	35.251	fresh peridotite
Tasiast	TSH024	20	34.310	15	30.798	BIF (trench)
Tasiast	TSH025	20	34.311	15	30.795	yellow-altered (anthophyllite>goethite,sericite,) BIF (trench)
Tasiast	TSH026	20	34.311	15	30.792	BIF, limonitized (trench)
Tasiast	TSH027	20	34.311	15	30.792	argillied (anthophyllite) BIF? with supergene calcite (trench)
Tasiast	TSH028	20	34.311	15	30.789	kaolinite-bearing muscovite schist (trench)
Tasiast	TSH029	20	34.311	15	30.788	muscovite schist partially smectized(& kaolinized) (trench)
Tasiast	TSH030	20	34.311	15	30.788	silicified BIF (black quartz) (trench)
Tasiast	TSH031	20	34.311	15	30.785	BIF weakly "nontronized" along bedding plane (trench)
Tasiast	TSH032	20	34.311	15	30.779	dolerite (basalt?) (dike?) (trench)
Tasiast	TSH033	20	34.311	15	30.776	silicified BIF (trench)
Tasiast	TSH034	20	34.311	15	30.773	BIF with limonite/hematite on its surface (trench)
Tasiast	TSH035	20	34.311	15	30.767	BIF weakly "nontronized" along bedding plane (trench)
Tasiast	TSH036	20	34.311	15	30.764	fresh BIF (trench)
Tasiast	TSH037	20	34.311	15	30.760	strongly silicified BIF (black quartz) (trench)
Tasiast	TSH038	20	34.311	15	30.756	BIF, relatively fresh (trench)
Tasiast	TSH039	20	34.311	15	30.753	silicified rock, including coarse-grained quartz in fine-grained quartz matrix (trench)
Tasiast	TSH040	20	34.311	15	30.753	muscovite (& ser/smec) schist (trench)
Tasiast	TSH041	20	34.311	15	30.751	fresh BIF (trench)
Tasiast	TSH042	20	34.311	15	30.748	sheared rock, whitely argillized (calcite>semctite) BIF (trench)
Tasiast	TSH043	20	34.311	15	30.745	"nontronized" BIF (trench)
Tasiast	TSH044	20	34.311	15	30.741	BIF with "nontronite" veinlets (trench)
Tasiast	TSH045	20	34.311	15	30.738	BIF weakly "nontronized" along bedding plane (trench)
Tasiast	TSH046	20	34.312	15	30.734	weakly "nontronized" BIF (trench)
Tasiast	TSH047	20	34.312	15	30.728	weakly "nontronized" BIF (trench)
Tasiast	TSH048	20	34.312	15	30.724	strongly silicified BIF (black quartz) (trench)
Tasiast	TSH049	20	34.312	15	30.722	weakly "nontronized" BIF (trench)
Tasiast	TSH050	20	34.312	15	30.717	mediumly "nontronized" BIF (trench)
Tasiast	TSH051	20	34.312	15	30.712	very-weakly "nontronized" BIF (trench)
Tasiast	TSH052	20	34.312	15	30.709	mediumly-"nontronized" BIF (trench)
Tasiast	TSH053	20	34.312	15	30.705	strongly silicified BIF (black quartz) (trench)
Tasiast	TSH054	20	34.312	15	30.704	chlorite schist (trench)
Tasiast	TSH055	20	34.312	15	30.698	chlorite schist (trench)
Tasiast	TSH056	20	34.312	15	30.689	chlorite schist, spotted (trench)
Tasiast	TSH057	20	34.312	15	30.683	chlorite schist, spotted (trench)
Tasiast	TSH058	20	34.316	15	30.738	mediumly nontronized (& anthophyllite) BIF (trench)
Tasiast	TSH059	20	34.315	15	30.738	black quartz vein (silicified BIF?) (trench)
Tasiast	TSH060	20	34.321	15	30.738	mediumly hematitized BIF, weakly yellow-altered (goethite), weakly silicifized (trench)
Tasiast	TSH061	20	34.323	15	30.738	mediumly hematitized BIF, weakly "nontronized", showing bandding structre (trench)
Tasiast	TSH062	20	34.327	15	30.738	mediumly silicified BIF (black quartz?) (trench)
Tasiast	TSH063	20	34.330	15	30.739	mediumly to strongly silicified BIF (black quartz?) (trench)
Tasiast	TSH064	20	34.331	15	30.739	weakly to mediumly "nontronized" BIF (trench)
Tasiast	TSH065	20	34.334	15	30.739	mediumly to strongly silicifized BIF, hematitized (trench)
Tasiast	TSH066	20	34.337	15	30.739	mediumly silicifized, mediumly to wealy "nontronized" BIF, weakly hematitized (trench)
Tasiast	TSH067	20	34.341	15	30.739	greenish gray chlorite-garnet-muscovite-biotite schist, weekly smectized (trench)
Tasiast	TSH068	20	34.347	15	30.740	sheared altered rock, strongly calcitized, nontronized, smec/ser (trench)
Tasiast	TSH069	20	34.351	15	30.740	sheared altered rock, strongly calcitized, sericized, semctized (trench)
Tasiast	TSH070	20	34.364	15	30.735	sheared, medium-weakly hematitized BIF, weakly "nontronized", very weakly silicifized (trench)
Tasiast	TSH071	20	34.364	15	30.730	silicified BIF? cutted by "nontronite" veinlets (trench)
Tasiast	TSH072	20	34.364	15	30.723	chlorite schist, spotted (trench)
Tasiast	TSH073	20	34.364	15	30.707	chlorite schist, spotted (trench)
Tasiast	TSH074	20	44.955	15	34.872	granodiorite
Tasiast	TSH075	20	46.663	15	35.281	muscovite from 40cm-wide pegmatite cutting light-gray gneiss
Tasiast	TSH076	20	34.364	15	30.738	mediumly hematitized BIF, weakly "nontronized", weakly silicifized (trench)
Tasiast	TSH077	20	34.364	15	30.744	mediumly hematitized BIF, weakly "nontronized", weakly silicifized (trench)
Tasiast	TSH078	20	34.364	15	30.751	mediumly silicified BIF, weakly "nontronized", weakly hematitized (trench)
Tasiast	TSH079	20	34.364	15	30.757	medium-strongly nontronized, medium-weakly goethized BIF, weaky silicifized (trench)
Tasiast	TSH080	20	34.364	15	30.763	strongly silicified BIF (black quartz), weakly hematitized, showing bedding texture (trench)
Tasiast	TSH081	20	34.364	15	30.769	extremely sheared and strongly nontronized rock (trench)
Tasiast	TSH082	20	34.364	15	30.774	strongly to mediumly silicifized BIF, choritizated (trench)
Tasiast	TSH083	20	34.364	15	30.780	mediumly green-actinized BIF, weakly silisified (trench)
Tasiast	TSH084	20	34.364	15	30.786	muscovite schist bearing smectite (trench)
Tasiast	TSH085	20	34.364	15	30.786	strongly silicified BIF (black quartz) (trench)
Tasiast	TSH086	20	34.364	15	30.786	nontronized rock with anthophyllite (trench)
Tasiast	TSH087	20	34.364	15	30.786	schist strongly white-argillized (sericite,smectite,calcite) (trench)
Tasiast	TSH088	20	34.364	15	30.790	strongly silicified BIF (black quartz) (trench)
Tasiast	TSH089	20	34.364	15	30.794	strongly silicified BIF (black quartz) in green BIF (trench)

2.2 List of collected samples

	Sample	Lat. (N)		Lon. (W)		Description
		°	'	°	'	
Tasiast	TSH090	20	34.364	15	30.800	mediumly "nontronized" BIF, mediumly to weakly silicified (trench)
Tasiast	TSH091	20	34.364	15	30.806	meta-basic rock (trench)
Tasiast	TSH092	20	34.364	15	30.812	mediumly to strongly silicified BIF, weakly "nontronized" (trench)
Tasiast	TSH093	20	34.364	15	30.818	mediumly to strongly silicified BIF (trench)
Tasiast	TSH094	20	34.364	15	30.823	strongly to mediumly silicified BIF (trench)
Tasiast	TSH095	20	34.364	15	30.829	reddish-white clay (calcite>rutiel>kaolinite,smectite) in BIF (trench)
Tasiast	TSH096	20	34.365	15	30.832	mediumly to strongly silicified BIF (trench)
Tasiast	TSH097	20	34.365	15	30.835	muscovite schist mediumly white-argillized (sericite,smectite,kaolinite) (trench)
Tasiast	TSH098	20	34.365	15	30.841	strongly white-argillized (calcite>smectite>sericite,kaolinite) schist? (trench)
Tasiast	TSH099	20	34.365	15	30.847	white mediumly kaolinized/smectized muscovite schist, "metafelsite" (trench)
Tasiast	TSH100	20	34.365	15	30.852	mediumly to strongly silicified BIF (black quartz) (trench)
Tasiast	TSH101	20	26.952	15	30.597	muscovite-bearing pegmatite vein 50cm wide (waste from trench)
Tasiast	TSH102	20	26.958	15	30.599	quartz vein <10cm wide
Tasiast	TSH103	20	25.912	15	29.560	Black quartz in reddish white clay with calcite
Tasiast	TSM001	20	34.161	15	30.769	amphibolite
Tasiast	TSM002	20	34.160	15	30.643	BIF, magnetite bearing
Tasiast	TSM003	20	38.448	15	30.770	quartzite
Tasiast	TSM004	20	41.202	15	24.283	carbonatized amphibolite schist, malachite disseminated
Tasiast	TSM005	20	28.876	15	35.283	serpentinite (peridotite origin)
Tasiast	TSM006	20	28.872	15	35.289	birbirite (laterited ultrabasic rock)
Tasiast	TSM007	20	34.332	15	30.722	sulphide dissminated garnet-bearing amphibole schist from sr460 hole (bore)
Tasiast	TSM008	20	34.342	15	30.722	sulphide dissminated amphibole schist from sr423 hole (bore)
Tasiast	TSM009	20	34.383	15	30.722	amphibole schist from s274 hole (bore)
Tasiast	TSM010	20	44.956	15	30.868	granodiorite
Tasiast	TSM011	20	45.465	15	35.318	birbirite (laterited ultrabasic rock)
Tasiast	TSM012	20	26.758	15	30.489	black quartz from the trench T45
Tasiast	TSH201	20	34.286	15	30.725	BIF, weakly-nontronized, weakly-silicified, moderately-limonized
Tasiast	TSH208	20	34.315	15	30.741	black-quartz vein
Tasiast	TSH209	20	34.318	15	30.738	black-quartz vein with limonite&nontronite along grain boundary
Tasiast	TSH210	20	34.325	15	30.741	black-quartz vein with limonite along grain boundary
Tasiast	TSH211	20	34.327	15	30.739	black-quartz vein with limonite&nontronite along grain boundary
Tasiast	TSH212	20	34.331	15	30.739	black-quartz vein with limonite along grain boundary
Tasiast	TSH213	20	34.336	15	30.738	black-quartz vein with limonite&nontronite along grain boundary
Tasiast	TSH214	20	34.339	15	30.738	black-quartz vein with limonite&nontronite along grain boundary
Tasiast	TSH215	20	34.323	15	30.735	black-quartz vein with limonite&nontronite along grain boundary
Tasiast	TSM101	20	34.331	15	30.740	brownish red goethite BIF
Tasiast	TSM102	20	34.329	15	30.740	brownish red goethite BIF
Tasiast	TSM103	20	34.146	15	30.686	BIF, standard
Tasiast	TSM104	20	34.147	15	30.693	yellowish brown BIF, standard
Tasiast	TSM105	20	34.140	15	30.704	yellowish brown Silicified BIF, standard
Tasiast	TSM106	20	34.150	15	30.734	yellowish brown silicified BIF with native gold, standard
Guelb Moghrein	AKH001	19	44.993	14	25.575	Cu-carbonate-Fe-oxide ore
Guelb Moghrein	AKH004	19	44.929	14	25.486	light brown carbonate rock including magnetite-epidote-limonite
Guelb Moghrein	AKH005	19	44.935	14	25.494	sheared chlorite schist including epidote
Guelb Moghrein	AKH006	19	44.942	14	25.493	limonite vein
Guelb Moghrein	AKH007	19	44.947	14	25.496	malachite-epidote-bearing limonite vein
Guelb Moghrein	AKH008	19	44.950	14	25.504	epidote-bearing carbonate vein
Guelb Moghrein	AKH009	19	44.962	14	25.508	limonite-bearing milky quartz vein
Guelb Moghrein	AKH010	19	44.960	14	25.634	malachite-bearing goethite hematite ore
Guelb Moghrein	AKH011	19	44.961	14	25.622	malachite-magnetite-limonite-bearing siderite rock
Guelb Moghrein	AKH012	19	44.904	14	25.511	malachite-goethite-bearing carbonate rock with white magnesite-spots
Guelb Moghrein	AKH013	19	44.841	14	25.454	muscovite schist
Guelb Moghrein	AKH014	19	44.856	14	25.429	malachite-magnetite-limonite-bearing siderite rock
Guelb Moghrein	AKM001	19	44.991	14	25.568	malachite-chrysocolla bearing chlorite schist
Guelb Moghrein	AKM002	19	44.991	14	25.568	azurite-malachite carbonate rock
Guelb Moghrein	AKM003	19	44.990	14	25.549	quartz vein in chlorite schist
Guelb Moghrein	AKM004	19	44.971	14	25.525	calcite vein in chlorite schist
Guelb Moghrein	AKM005	19	44.980	14	25.527	jarosite-ser/smec-amphibole chlorite vein
Guelb Moghrein	AKM006	19	44.990	14	25.544	quartz calcite vein
Guelb Moghrein	AKM007	19	45.004	14	25.575	chlorite epidote-malachite vein
Guelb Moghrein	AKM008	19	45.004	14	25.575	smectite chlorite vein bearing malachite,antlerite,pyrite and geothite
Guelb Moghrein	AKM009	19	45.010	14	25.586	azurite-bearing anthophyllite rock
Guelb Moghrein	AKM010	19	45.010	14	25.586	malachite,goethite,covellite,pyrite and Cu-sulphate vein
Guelb Moghrein	AKM011	19	45.012	14	25.596	quartz vein in malachite-bearing Fe-oxide ore
Guelb Moghrein	AKM012	19	45.022	14	25.608	massive chlorite schist
Guelb Moghrein	AKM013	19	45.040	14	25.622	quartz vein in chlorite schist
Guelb Moghrein	AKM014	19	44.961	14	25.627	magnesite hematite goethite magnetite ore with anthophyllite malachite
Guelb Moghrein	AKM015	19	44.963	14	25.627	nontronite-talc-bearing anthophyllite rock
Guelb Moghrein	AKM016	19	44.933	14	25.592	nontronite-talc-bearing anthophyllite rock
Guelb Moghrein	AKM017	19	44.933	14	25.592	magnetite bearing carbonate ore
Guelb Moghrein	AKM018	19	44.944	14	25.562	talc anthopyllite vein in goethite-bearing magnesite rock
Guelb Moghrein	AKM019	19	44.945	14	25.566	malachite disseminated Fe-oxide ore
Guelb Moghrein	AKM020	19	44.950	14	25.554	malachite disseminated sheared carbonate ore
Guelb Moghrein	AKM021	19	44.927	14	25.547	malachite disseminated magnetite carbonate ore
Guelb Moghrein	AKM022	19	44.916	14	25.534	magnetite carbonate ore
Guelb Moghrein	AKM023	19	44.911	14	25.518	malachite rich magnetite carbonate ore
Guelb Moghrein	AKM024	19	44.896	14	25.486	chrysocolla disseminated anthophyllite vein
Guelb Moghrein	AKM025	19	44.896	14	25.475	malachite disseminated magnetite carbonate ore
Guelb Moghrein	AKM026	19	44.893	14	25.474	cummingtonite biotite schist with malachite
Guelb Moghrein	AKM027	19	44.890	14	25.459	chlorite schist
Guelb Moghrein	AKM028	19	44.870	14	25.454	chlorite schist
Guelb Moghrein	AKM029	19	44.870	14	25.454	malachite-magnetite carbonate with limonite
Guelb Moghrein	AKM030	19	44.963	14	25.627	carbonate ore (wall ore in AKM015)
Akjoujt	AKH201	19	45.001	14	25.577	nontronite and anthophyllite
Akjoujt	AKH202	19	45.001	14	25.578	malachite, azurite and nontronite
Akjoujt	AKH203	19	45.013	14	25.573	limonized chlorite schist with anthophyllite relict
Akjoujt	AKH204	19	45.023	14	25.569	limonized chlorite schist
Akjoujt	AKH205	19	45.018	14	25.561	sulphate 5-10cm wide along a fracture plane
Akjoujt	AKH206	19	45.018	14	25.560	nontronized chlorite schist
Akjoujt	AKH207	*1		*1		RCGM66 152.37-152.39m calcarious green stone

2.2 List of collected samples

	Sample	Lat. (N)		Lon. (W)		Description
		°	'	°	'	
Akjoujt	AKH208	*1		*1		RCGM66 121.50-121.60m chalcopyrite&magnetite-bearing carbonate
Akjoujt	AKH209	19	44.938	14	25.562	nontronite along a joint
Akjoujt	AKH210	19	44.940	14	25.564	anthophyllite along a joint
Akjoujt	AKM101	19	44.924	14	25.552	chysocolla-rich limonitizatied magnetite ore
Akjoujt	AKM102	19	44.898	14	25.509	malachite disseminated magnetite ore
Akjoujt	AKM103	19	44.892	14	25.491	coarse- grained magnetite ore, standard
Akjoujt	AKM104	19	44.771	14	25.395	malachite chysocolla disseminated magnetite ore, standard
Akjoujt	AKM105	19	42.081	14	26.262	magnetite ore with malachite
El Khader	AKH002	19	38.559	14	15.255	ferruginous sandstone
El Khader	AKH003	19	38.632	14	15.259	ferruginous sandstone
Tabrinkout	TBH001	19	43.050	14	4.18	malachite-hematite-bearing quartz vein
Tabrinkout	TBH002	19	43.047	14	4.18	malachite-hematite-bearing quartz vein
Tabrinkout	TBH003	19	43.040	14	4.182	limonite-bearing quartz vein
Tabrinkout	TBH004	19	43.007	14	4.191	limonite-bearing quartz vein
Tabrinkout	TBH005	19	42.985	14	4.199	tourmaline-bearing silicified black to dark brown carbonate with quartz veinlet
Tabrinkout	TBH006	19	42.957	14	4.213	waste after trenching (limonite-bearing quartz vein)
Tabrinkout	TBH007	19	42.937	14	4.185	malachite-limonite-bearing quartz vein
Tabrinkout	TBH008	19	42.939	14	4.197	malachite-limonite-bearing quartz vein
Tabrinkout	TBH009	19	42.939	14	4.189	malachite-limonite-bearing quartz vein
Tabrinkout	TBH010	19	42.918	14	4.171	dark gray limonite-rich silicified siderite rock
Tabrinkout	TBH011	19	42.957	14	4.175	malachite-limonite-bearing quartz vein
Tabrinkout	TBH012	19	42.961	14	4.167	malachite-limonite-bearing quartz vein
Tabrinkout	TBH013	19	43.000	14	4.153	limonite-bearing white carbonate rock
Tabrinkout	TBH014	19	43.012	14	4.146	green chlorite schist
Tijirit	222TS21	20	51.437	14	22.627	malachite bearing quartz vein, w=30cm, N36W, vertical
Tijirit	222TS22	20	51.450	14	22.636	malachite partly chalcopyrite bearing quartz vein, w=25cm, N36W, vertical
Tijirit	TJH001	20	51.300	14	22.721	hornblende-bearing (meta)andesite
Tijirit	TJH002	20	51.211	14	22.735	meta-andesite
Tijirit	TJH003	20	51.210	14	22.739	ophicalcite
Tijirit	TJH004	20	51.219	14	22.761	meta-andesite
Tijirit	TJH005	20	51.216	14	22.772	ophicalcite
Tijirit	TJH006	20	50.414	14	22.319	biotite-bearing alkali granite
Tijirit	TJH007	20	51.244	14	22.771	meta-andesite
Tijirit	TJH008	20	51.171	14	22.710	meta-andesite
Tijirit	TJH009	20	51.217	14	22.689	ophicalcite
Tijirit	TJH010	20	51.246	14	22.693	quartz vein
Tijirit	TJH011	20	51.271	14	22.691	carbonated metaandesite
Tijirit	TJH012	20	51.300	14	22.721	hornblende-bearing (meta)andesite
Tijirit	TJH013	20	51.312	14	22.701	ophicalcite
Tijirit	TJH014	20	51.356	14	22.729	meta-andesite
Tijirit	TJH015	20	51.362	14	22.697	malachite-bearing quartz vein
Tijirit	TJH016	20	51.408	14	22.668	weakly-silicified meta-andesite
Tijirit	TJH017	20	51.393	14	22.680	ophicalcite
Tijirit	TJM001	20	51.470	14	22.744	brownish quartz vein (ATOR) w/ malachite and native gold
Tijirit	TJM002	20	51.473	14	22.736	basalt
Tijirit	TJM003	20	51.450	14	22.746	quartz vein (ATOR) containing hematite, chlorite
Tijirit	TJM004	20	51.452	14	22.715	gabbro
Tijirit	TJM005	20	51.473	14	22.785	quartz vein w/ malachite, N8E, dip?
Tijirit	TJM006	20	50.429	14	22.305	sodalite syenite
Tijirit	TJM007	20	52.669	14	23.056	milky quartz vein partly containning malachite-native gold dipN20W?
Tijirit	TJM008	20	52.589	14	23.050	quartz vein (trench)
Tijirit	TJM009	20	47.468	14	23.871	milky quartz vein
Tijirit	TJM010	20	47.468	14	23.871	quartz vein
Tijirit	TJM011	20	51.419	14	22.748	quartz vein w/ malachite, N20, dip? w=60cm
Tijirit	TJM012	20	51.414	14	22.749	quartz vein w/ malachite, w=30cm
Tijirit	TJM013	20	51.396	14	22.744	chalcedony quartz vein with malachite
Tijirit	TJM014	20	51.315	14	22.813	quartz vein, N-S, vertical w=110cm
Guidimaka	DGH013	14	51.381	12	20.863	massive chromite ore debris
Guidimaka	DGH014	14	51.381	12	20.863	hematite schist (N30E65S)
Guidimaka	DGH015	14	51.380	12	20.858	chlorite schist, muscovite-bearing?, trench waste
Guidimaka	DGH016	14	51.372	12	20.844	weakly-serpentinized ultramafic rock, trench waste
Guidimaka	DGH017	14	51.373	12	20.845	massive chromite ore debris
Guidimaka	DGH018	14	51.363	12	20.823	<4cm-wide quartz vein cutting serpentinite
Guidimaka	DGH019	14	51.412	12	20.853	ophicalcite
Guidimaka	DGH020	14	51.417	12	20.853	chromite ore
Guidimaka	DGH021	14	51.446	12	20.866	weakly-serpentinized ultramafic rock
Guidimaka	DGH022	14	51.470	12	20.886	silicified black schist
Guidimaka	DGH023	14	51.441	12	20.838	massive chlorite rock, hornblende-bearing???
Guidimaka	DGH024	14	51.344	12	20.855	weakly-serpentinized ultramafic rock
Guidimaka	DGH025	14	51.344	12	20.862	massive chromite ore debris
Guidimaka	DGM006	14	51.129	12	20.791	siliceous slate
Guidimaka	DGM007	14	51.020	12	21.045	(float) massive chromite ore, standard
Guidimaka	DGM008	14	51.157	12	20.857	(float) massive chromite ore
Guidimaka	DGM009	14	51.157	12	20.857	(float) dunite?
Guidimaka	DGM010	14	51.157	12	20.857	(float) dunite?
Guidimaka	DGM011	14	51.370	12	20.842	serpentinite
Guidimaka	DGM012	14	51.367	12	20.838	massive chromite ore, standard
Guidimaka	DGM013	14	51.467	12	20.878	sheared rock near boundary between serpentine and slate
Guidimaka	DGM014	14	51.379	12	20.857	massive chromite ore
Guidimaka	DGM015	14	51.378	12	20.855	serpentinite
Guidimaka	DGM016	14	51.370	12	20.838	massive chromite ore
Guidimaka	DGM017	14	51.341	12	20.786	siliceous slate
Guidimaka	DGM018	14	51.424	12	20.835	chlorite schist, N70E, 80W
Guidimaka	DGM019	14	51.409	12	20.814	serpentinite
Guidimaka		14	50.821	12	20.917	siliceous slate, N10E, 44W
Guidimaka		14	51.478	12	20.890	siliceous slate, N20E, 60W
Guidimaka	DGM101	14	51.707	12	19.927	massive chromite
Guidimaka	DGM102	14	51.314	12	20.842	massive chromite
Guidimaka	DGM103	14	51.377	12	20.841	massive chromite
Guidimaka	DGM104	14	51.378	12	20.843	massive chromite

2.2 List of collected samples

	Sample	Lat. (N)		Lon. (W)		Description
		°	'	°	'	
Guidimaka	DGM105	14	51.376	12	20.845	massive chromite
Guidimaka	DGM106	14	51.379	12	20.854	massive chromite
Guidimaka	DGM107	14	51.387	12	20.846	massive chromite
Guidimaka	DGM108	14	51.384	12	20.848	massive chromite
Guidimaka	DGM109	14	51.383	12	20.850	massive chromite
Guidimaka	DGM110	14	51.378	12	20.856	massive chromite
Guidimaka	DGM111	14	51.384	12	20.857	massive chromite
Guidimaka	DGM112	14	51.382	12	20.839	massive chromite
Guidimaka	DGM113	14	51.379	12	20.837	massive chromite
Guidimaka	DGM114	14	51.384	12	20.836	massive chromite
Guidimaka	DGM115	14	51.386	12	20.837	massive chromite
Guidimaka	DGM116	14	51.385	12	20.841	massive chromite
Guidimaka	DGM117	14	51.387	12	20.846	massive chromite near serpentinite
Guidimaka	DGM118	14	51.389	12	20.845	massive chromite
Guidimaka	DGM119	14	51.390	12	20.844	massive chromite
Guidimaka	DGM120	14	51.391	12	20.845	massive chromite
Guidimaka	DGM121	14	51.390	12	20.848	massive chromite
Guidimaka	DGM122	14	51.395	12	20.840	massive chromite
Guidimaka	DGM123	14	51.396	12	20.840	massive chromite (chromite:metallic luster)
Guidimaka	DGM124	14	51.397	12	20.840	massive chromite
Guidimaka	DGM125	14	51.398	12	20.841	massive chromite
Guidimaka	DGM126	14	51.402	12	20.850	massive chromite
Guidimaka	DGM127	14	51.407	12	20.850	massive chromite
Guidimaka	DGM128	14	51.410	12	20.850	massive chromite
Guidimaka	DGM129	14	51.411	12	20.853	massive chromite
Guidimaka	DGM130	14	52.513	12	22.336	massive chromite
Guidimaka	DGM131	14	52.516	12	22.346	massive chromite (chromite:metallic luster)
Guidimaka	DGM132	14	52.518	12	22.352	massive chromite
Guidimaka	DGM133	14	52.505	12	22.353	massive chromite (chromite:metallic luster)
Guidimaka	DGM134	14	52.523	12	22.337	massive chromite
Guidimaka	DGB101	14	51.708	12	19.928	massive chromite
Guidimaka	DGT001	14	51.490	12	19.956	silicified peritic schist
Guidimaka	DGT002	14	51.708	12	19.926	massive chromite
Guidimaka	DGT003	14	51.708	12	19.927	massive chromite
Guidimaka	DGT004	14	51.672	12	19.933	serpentines
Guidimaka	DGT005	14	51.768	12	19.895	serpentines
Guidimaka	DGT006	14	51.775	12	19.910	serpentines w/limonaite
Guidimaka	DGT007	14	50.779	12	20.412	serpentines
Guidimaka	DGT008	14	51.378	12	28.850	massive chromite
Guidimaka	DGT009	14	51.372	12	20.851	massive chromite
Guidimaka	DGT010	14	51.368	12	20.849	massive chromite
Guidimaka	DGT011	14	51.360	12	20.847	massive chromite
Guidimaka	DGT012	14	51.362	12	20.850	massive chromite
Guidimaka	DGT013	14	51.367	12	20.851	massive chromite
Guidimaka	DGT014	14	51.376	12	20.850	massive chromite
Guidimaka	DGT015	14	51.374	12	20.862	massive chromite
Guidimaka	DGT016	14	51.367	12	20.864	massive chromite
Guidimaka	DGT017	14	51.363	12	20.864	massive chromite
Guidimaka	DGT018	14	51.337	12	20.863	massive chromite
Guidimaka	DGT019	14	51.327	12	20.858	massive chromite
Guidimaka	DGT020	14	51.330	12	20.851	massive chromite
Guidimaka	DGT021	14	51.330	12	20.856	massive chromite
Guidimaka	DGT023	14	51.326	12	20.853	massive chromite
Guidimaka	DGT024	14	51.324	12	20.847	massive chromite, serpentine
Guidimaka	DGT025	14	51.316	12	20.846	massive chromite
Guidimaka	DGT026	14	51.317	12	20.860	massive chromite
Guidimaka	DGT027	14	51.301	12	20.848	massive chromite
Guidimaka	DGT028	14	51.300	12	20.846	massive chromite
Guidimaka	DGT029	14	51.297	12	20.844	massive chromite
Guidimaka	DGT030	14	51.297	12	20.843	massive chromite
Guidimaka	DGT031	14	51.297	12	20.842	massive chromite
Guidimaka	DGT032	14	51.295	12	20.848	massive chromite
Guidimaka	DGT033	14	51.424	12	20.843	massive chromite
Guidimaka	DGT034	14	51.417	12	20.845	massive chromite
Guidimaka	DGT035	14	51.419	12	20.850	massive chromite
Guidimaka	DGT036	14	52.508	12	22.329	massive chromite
Guidimaka	DGT037	14	52.504	12	22.333	massive chromite
Guidimaka	DGT038	14	52.500	12	22.339	massive chromite
Guidimaka	DGT039	14	52.454	12	22.333	massive chromite
Guidimaka	DGT040	14	52.497	12	22.324	massive chromite
Diaguili	DGH001	14	52.939	12	20.969	gray carbonaceous quartzite
Diaguili	DGH003	14	52.943	12	20.970	gray carbonaceous quartzite with quartz network
Diaguili	DGH004	14	52.962	12	20.952	gray carbonaceous quartzite with quartz network
Diaguili	DGH005	14	52.983	12	20.930	gray carbonaceous quartzite with quartz network
Diaguili	DGH006	14	53.014	12	20.894	siliceous gossan and quartz vein
Diaguili	DGH007	14	53.037	12	20.865	gray calcaropus quartzite with 5cm-wide quartz vein bearing gossan
Diaguili	DGH009	14	53.091	12	20.849	specularite-bearing 10cm-wide quartz vein (N40E85W) in conglomerate
Diaguili	DGH010	14	52.942	12	21.010	black schist (N40E85W)
Diaguili	DGM001	14	52.827	12	21.064	gray quartzite
Diaguili	DGM002	14	52.915	12	21.047	muscovite schist, N50E, 75W
Diaguili	DGM003	14	52.934	12	21.042	muscovite schist, N50E, 55W
Diaguili	DGM004	14	52.958	12	21.048	milky quartz vein, w=70cm, N20E, 70W
Diaguili	DGM005	14	53.039	12	20.861	gray quartzite with quartz network, standard
Diaguili						quartz vein N80W, 70S, w=0.5cm
Diaguili						quartz vein, N42E, 34SE, w=1cm
Diaguili		14	52.887	12	21.036	gray siltstone, bedding N35E, 80W
Diaguili		14	52.898	12	21.038	red weathered siltstone, bedding N30E, 80W
Diaguili		14	52.905	12	21.041	reddish siltstone, bedding N42E, 80W
Diaguili		14	52.916	12	21.047	conglomerate, bedding N50E, 45W, thick 2m
Diaguili		14	52.958	12	21.004	conglomerate
	THS301					DDH SC049 25.30-25.60m white clay
	THS3032					DDH SC049 36.30-36.60m white clay

2.3 List of Microscopic Observation

	Sample no	Locality	Rock name	Texture	Px	Cpx	Amp	Hb	Bi	Mus	Chl	Gar	Srp	Tc	Ep	Pl	Kf	Q	To	Fl	Au	Ap	Az	Mal	Cc	Ilm	Mt	Ht	Goe	Py	Po	Pnt	Bis	Hm	Ru	Chy	Mcr	Mil	Cr	Os	Ir	Lau	Erli	Cuir	Mn	Gn	Goe	Ht	Cov	Cpy	Others
1	AKH001	Guelb Moghrein	Azulite-malachite-limonite rock	Botryoidal				△										+					○	○	○			△	◎	+	+																			+		
2	AKH012	Guelb Moghrein	Malachite-limonite-magnesite rock	Botryoidal									△					+						○				△	○																							◎magnesite
3	AKM009	Guelb Moghrein	Anthophyllite-talc schist with azurite vein	Schistose			△				△		○	◎									○	△					△																							
4	AKM011	Guelb Moghrein	Malachite-limonite-quartz rodk	Boxwork														◎						○				△	○																							
5	AKM014	Guelb Moghrein	Malachite-limonite rock	Boxwork														○						○			◎		◎																						+	+	○magnesite
6	AKM019	Guelb Moghrein	Malachite-anthophyllite-limonite rock	Foliated						△								○						△	+			+	◎																							
7	AKM026	Guelb Moghrein	Chlorite schist with malachite vein	Schistose			+		○?		◎		+					◎	+					○		+			○																							◎smectite; ○phlogopite?
8	TBH005	Tabrinkout	Tourmaline bearing quartz-limonite rock	Seriate														◎	◎	+									◎																							
9	AOH001	El Aouj (Central)	Magnetite-Quartz rock	Seriate, xenoblastic														◎		+							△	○	○																							
10	ATM001	Atomai	Hematite-quartz rock	Hypidioblastic			○								+			◎	+	○		+						◎	△		+																						+smectite
11	EAM002	El Aouji	Pyroxene bearing hematite-quartz rock	Xenoblastic	△			○										◎									○	○																								△smectite
12	RHH002	El Rhein	Pyroxene bearing hematite-quartz rock	Hypidioblastic	○			○										◎									△	◎		+																					+	+	△aegirineaugite
13	KDM003	Zouerate, T014	Hematite-quartz rock	Banded														◎		+							+	○																							
14	KEH004	near TO14	Hematite-quartz rock	Banded and brecciated														◎							+		+	△	+																							+smectite; +silica
15	MHM003	Mhaoudat	Hematite-quartz rock	Banded			+*											◎	+								+	○	○	+	+																						
16	TSH001	Tasiast, piment	Quart limonite rock	Boxwork, brecciated														◎	+	+									○	+	+																						
17	TSH005	Tasiast, piment	Quartzite breccia with limonite vein	Boxwork, colloform						+								◎	△								+	△	+																						
18	TSH009	Tasiast, piment	Quartzite with limonite vein	Seriate														◎		+					+			△																							+silica
19	TSH018	Ndaouds	Epidote amphibolite	Nematoblastic				◎							△	◎			+			+			+	+					+																						+titanite;
20	TSH019	Khneifissat	Biotite-epidote-amphibole gneiss	Weakly foliated				○	○		○				△	△		◎				+			△																												+titanite
21	TSH021	Inkebden	Amphibolite	Massive and fine-grained				◎							+	○										+					+																					+	+titanite
22	TSH022	Inkebden SW	Quartz-limonite rock	Boxwork														△											◎																							+smectite; +silica
23	TSH023	Inkebden SW	Uralite gabbro	Massive, medium grained	◎*			◎			△				△	◎																																				◎uralite
24	TSH025-1	Piment TR40	hematite-chlorite-amphibole rock	Banded, foliated			◎		+		◎	△														+			△	○		+																				△smectite
25	TSH025-2	Piment TR40	Hematite-amphibole-quartz rock	Banded			○											◎							△		+	◎	△																							+silica
26	TSH032	Piment TR40	Amphibole-quartz rock	Banded			△	◎	+									◎		+							+	+	+																							+smectite
27	TSH037	Piment TR40	Quartzite with biotite vein	Seriate					+		+							◎		+					+																											
28	TSH039	Piment TR40	Quartzite	Seriate							+							◎		+																																+smectite; +ka
29	TSH040	Piment TR40	Phlogopite-muscovite schist	Schistose					○	◎								◎	+	+																																
30	TSH044	Piment TR40	Hematite-amphibole-quartz rock	Banded			△						△							△					+			○	△																							△silica, △smectite
31	TSH057	Piment TR40	Biotite-muscovite psamitic schist	Weakly schistose					○	○						○		◎	+									+			+																						
32	TSH058	Piment TR41	Hematite-amphibole-quartz rock	Banded			○						○							+								◎	○																							△silica
33	TSH059	Piment TR41	Quartzite with calcite-goethite vein	Seriate														◎		+					+		△	△	+		+																						+smectite
34	TSH060-1	Piment TR41	Quartzite with hematite and amphibole	Seriate			+						△							+					△			+	△		+																						
35	TSH060-2	Piment TR41	Amphibol-hematite-quartz rock	Banded			○					+						○		△							△	△	◎		+																						△smectite, +silica
36	TSH066	Piment TR41	Quartzite with amphibole-limonite vein	Seriate			△				○							◎		○									○		+																							△smectite, △silica
37	TSH067	Piment TR41	Garnet-biotite-muscovite schist	Schistose					○	◎		△						○	+																																			+native bismuth?
38	TSH071	Piment TR32	Quartzite with serpentine-goethite band	Weakly banded			△		△				◎					○		△							+	○	○																							△silica
39	TSH074	North of Ntalfa	Biotite granodiorite	Hypidiomorphic				+	○	+					△	○	○	○				+				+																											△myrmekite
40	TSH080	Piment TR32	Quartzite with ankerite-goethite vein	Seriate			+											◎		△					+				△																							+smectite
41	TSH083	Piment TR32	Hematite-amphibole-quartz rock	Banded			◎						△					◎										○	+																							
42	TSH091	Piment TR32	Garnet amphibolite	Hypidioblastic			◎		+				○					◎										+			+																						
43	TSH099	Piment TR32	Andalusite-muscovite gneiss	Foliated					+	○								◎	+							△																											○andalusite
44	TSH101	Tasiast south	Pegmatite	Micrograhic						◎						◎		○		+		△																															
45	TSM005	Inkebden SW	Silicified serpentinite	Foliated							○		○							△									○																							○silica, ○smectite
46	TSM006	Imkebden SW	Limonitized serpentinite	Hypidiomorphic	◎*								◎	◎				△											△	△																							◎*olivine pseud., +chromite
47	TSM007	Piment	Garnet-biotite amphibole rock	Nematoblastic			◎	○	△		△	△						△		+					○		○			△	+																					+	△stilpnomerane
48	TSM008	Piment	Biotite-amphibolite	Banded			◎	◎	◎							○		○													+	+																						
49	TSM009	Piment	Biotite-magnetite amphibole rock	Banded			◎	△								◎				+					△		○				△																							
50	AKH013	Guelb Moghrein	Biotite-muscovite schist	Schistose						+	○							◎				+				○																											
51	AKH014	Guelb Moghrein	Malachite-limonite rock						△									△						◎			○		◎																							△Si
52	AKM001	Guelb Moghrein	Tourmaline bearing chlorite schist	Xenoblastic								◎						◎	+			+		△		+																						△				
53	AKM002	Guelb Moghrein	Azurite-malachite limonite rock						△			△											△	△	△				◎	+																							
54	AKM012	Guelb Moghrein	Chlorite schist	Poikiloblastic								◎				◎		○				+				△																											

2.3 List of Microscopic Observation

	Sample no	Locality	Rock name	Texture	Px	Cpx	Amp	Hb	Bi	Mus	Chl	Gar	Srp	Tc	Ep	Pl	Kf	Q	To	Fl	Au	Ap	Az	Mal	Cc	Ilm	Mt	Ht	Goe	Py	Po	Pnt	Bis	Hm	Ru	Chy	Mcr	Mil	Cr	Os	Ir	Lau	Erli	Cuir	Mn	Gn	Goe	Ht	Cov	Cpy	Others
55	AKM017	Guelb Moghrein	Magnetite-limonite rock															○							○		○		◎																							
56	AKM028	Guelb Moghrein	Chlorite schist	Xenoblastic								◎										+				△			+																							＋Stp
57	TBH002	Tabrinkout	Malachite bearing quartz rock	Seriate														◎						+				+																							
58	TBH014	Tabrinkout	Chlorite schist	Porphyroclastic								◎						◎				+																													＋Stp+;'+Ti
59	ATH001	Atomai	Biotite gneiss	Xenoblastic						○						△	◎	○	△			+						+																							
60	ATM002	Atomai	Tourmaline bearing granitic gneiss	Hypidioblastic												◎	○	◎	△			+																													
61	EAM001	El Aouj	Garnet bearing granitic gneiss	Hypidioblastic						+						◎	○	◎									+	+																							△Gar;+Zr+
62	KEH002	TO14	Banded iron ore	Banded														◎										○																							
63	KEH003	near T1	Banded iron ore	Banded														◎								△	○																							△Cst
64	KEH006	G. El Hamariat	Garnet-biotite-muscovite schist	Lepidoblastic						○	◎		+					◎	+			+																													△Carb
65	MHH001	M'Haoudat	Banded iron ore	Banded														◎									+	◎																							
66	MHH002	M'Haoudat	Kaolin ore	Laminar														△	△																															◎Ka
67	RHH003	El Rhein	Garnet-biotite amphibole gneiss	Hypidioblastic		△			○	△			△														△			△																				
68	RHH005	El Rhein	Pyroxene amphibolite	Nematoblastic		○		○		+						◎						+			+																									
69	RHH006	El Rhein	Biotite granite	Hypidiomorphic						△						△	◎	○	+									+									+												
70	SKM003	Sebkha	Clinopyroxene-biotite granitoids	Heterogranular		+				△						△		◎				+				△	△																							+Zr;+Ep
71	SKM004	Sebkha	Clinopyroxene granitoids	Heterogranular		○										◎		◎							+		+																							+Ep
72	SYH001	Seyala	Biotite-muscovite schist	Lepidoblastic						△	○							◎	+						+																								△Mnt
73	SYM001	Kedia Seyal	Banded iron ore	Banded														◎									+	○																							△Mnt
74	TZM001	Tazadit	Biotite-muscovite schist	Lepidoblastic						△	◎	+						◎	+									+	+																						△Mnt
75	TZM003	Tazadit	Orthoquartzite	Blastopsammitic						+								◎								+																								
76	TSH002	Piment	Kaolin ore	Laminar														○	+																															◎Ka;+Ti
77	TSH007	Piment	Garnet amphibolite	Nematoblastic				○	○				○					◎										△																							
78	TSH012	Tasiast north	Tourmaline-quartz rock	Seriate							+							◎	+																															
79	TSH017	Tasiast north	Biotite-muscovite schist	Porphyroblastic						+	△	+				◎		◎							+																									
80	DGH005	Diaguili	Quartzite with quartz vein	Banded														◎	+																		+												+Zr
81	DGM001	Diaguili	Quartzite	Weakly schistose						+								◎										+									+												+Zr
82	DGM003	Diaguili	Biotite-muscoite gneiss	Gneissic					+	◎								◎	+										△									+												
83	DGH013	Guidimaka	Massive chromite ore	Xenomorphic/fracture replacement							◎																○																							◎		+Cor
84	DGH016	Guidimaka	Massive chromite ore	Xenomorphic/fracture replacement							◎																○																							◎		
85	DGH017	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							◎																○																							◎		
86	DGH020	Guidimaka	Massive chromite ore	Fracture replacement							◎																○																							◎		
87	DGM006	Guidimaka	Silicified serpentinite	Xenomorphic														◎									+	△	△																				+		
88	DGM011	Guidimaka	Serpentinite	Mesh replacement									◎	+													+	+																						+		
89	DGM012	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							◎																+	△																						◎		
90	DGM015	Guidimaka	Chlorite rock	Xenomorphic	△*						◎				+											△	+										+													
91	DGM018	Guidimaka	Chlorite schist	Weakly schistose							◎																+	+	+																						
92	BTH004	Oudelemguil (Prin.)	Gossan with malachaite vein	Sphelical/botryoidal							○							△							◎			△	○								+												
93	BTH010	Oudelemguil (Prin.)	Gossan with malachaite vein	Botryoidal/fracture replacement							○				△										◎				◎					+														+		+Chc
94	BTH011	Oudelemguil (Prin.)	Epidote chlorite rock with malachite vein	Fracture replacement							○				+										◎				◎					+														+		+Chc
95	BTM001	Oudelemguil (Prin.)	Chlorite rock with malachite vein	Xenomorphic							◎							+							+				△																					○Lex-Ru
96	BTM006	Oudelemguil (Prin.)	Psamitic schist	Weakly schistose						◎							△*	◎	+									+	+																					+Zr
97	BTM007	Oudelemguil (Ragel)	Chlorite schist with malachite vein	Schistose							◎							○							+	+			+									○												+Smc, +Lex
98	BTM009	Oudelemguil (Ragel)	Chlorite schist, weathered	Xenomorphic							◎							○									○*	○																							○Lex-Ru, +Zr
99	BTM010	Oudelemguil (Prin.)	Epidote chlorite rock, weathered	Xenomorphic/colloform							◎					◎		○								△				△								△												
100	KDH015	Kadiar	Chlorite schist	Weakly schistose							◎																+		+																						+Zr
101	KDH023	Kadiar	Magnetite chlorite rock	Weakly schistose							◎																+	△																						+		+Ap
102	KDH036	Kadiar	Quartz muscovite rock, weathered	Colloform						◎								△											△																						
103	KDH040	Kadiar	Silicified gossan including muscovite	Boxwork, colloform						△	△							◎											○																						
104	KDM001-1	Kadiar	Gossan with malachite vein	Boxwork, colloform														○							○			△	◎								△												
105	KDM001-2	Kadiar	Gossan with malachite vein	Boxwork, colloform						+								◎							△			△	◎								+												
106	IDH051	Indice 78	Chlorite epidote quartz rock	Weakly schistose						+	+					◎	+	◎							+	△	+		+					△														+		+Ag, +Chc, +Bo
107	IDH063	Indice 78	Chlorite epidote quartz schist	Weakly schistose						△	△					○		◎							△				○								+	+										+		△Lex-Ru, +Fl
108	IDM001	Indice 78	Quartzite with malachite vein	Xenomorphic						+	+							◎			+				△					△																		+		△Chc

2.3 List of Microscopic Observation

	Sample no	Locality	Rock name	Texture	Px	Cpx	Amp	Hb	Bi	Mus	Chl	Gar	Srp	Tc	Ep	Pl	Kf	Q	To	Fl	Au	Ap	Az	Mal	Cc	Ilm	Mt	Ht	Goe	Py	Po	Pnt	Bis	Hm	Ru	Chy	Mcr	Mil	Cr	Os	Ir	Lau	Erli	Cuir	Mn	Gn	Goe	Ht	Cov	Cpy	Others
109	IDM005	Indice 78	Epidote quartz rock	Hypidiomorphic, medium-grained						△					◎			◎							+			+																							
110	IDM006	Indice 78	Epidote quartz rock	Xenomorphic, fine-grained						△	△				◎			◎								+									+																△Ru-Lex, △Act
111	IDM011	Indice 78	Sericite bearing quartzite with malachite vein	Xenomprphic, equigranular						△								◎						+				△								+													+		+Chc, +Bo
112	RHH101	El Rhein	Amphibolite, quartz bearing	xenomorphic					○		○					◎		◎									+			+			+																		
113	MHH101	M'Haoudat	Biotite gneiss	gneissose							◎					◎*		◎				+											○*																		
114	MHH102	M'Haoudat	Muscovite gneiss	gneissose						△	◎					○	△	◎											△																						Chl replacing Pl
115	MHH103	M'Haoudat	Biotite muscovite schist	schistose						◎	△							◎				+							△				△*																		
116	SFH001	Sfariat	Amphibolite, biotite bearing	nematoblastic				◎								◎		△				+				△			+				+																		
117	SFH002	Sfariat	BIF	banded, sheared														◎				+						◎					+																		
118	SFH003	Sfariat	BIF	banded, sheared														◎				+					◎*	○	△																						Goe replacing Mt
119	SFH005	Sfariat	Epidote quartz rock with prehnite	xenomorphic				+			+				◎			◎				+				△									+																○Prehnite vein
120	SFH006	Sfariat	Orthogneiss	gneissose						+						◎	◎	◎															+																	
121	SFH007	Sfariat	Epidote-chlorite-quartz rock	hypidiomorphic							△				△			◎											+						+																△Ep mostly zoisite
122	SFM002	Sfariat	Carbonate rock	replacement						+	△							+							◎																										+Garnet
123	SFM006	Sfariat	BIF	banded						+								◎				+					△	◎							+																+Pyroxene
124	AKH203	G.Moghrein	Limonitized rock, amphibole bearing	porous & schistose (relic)				+										△				+							◎	+					+																
125	AKH204	G.Moghrein	Biotite schist	schistose							◎							◎								+							◎*																			Chl replacing Bi
126	TJH001	Tijirit	Epidote amphibolite, quartz bearing	weakly schistose					◎		○				○	+		○							+										△																
127	TJH002	Tijirit	Epidote amphibolite, quartz bearing	weakly schistose					◎		○				◎	△		△							△				+						△																
128	TJH006	Tijirit	Nepheline syenite	porphyritic						△					+	◎										△	△	△	△				△		+																△Nepheline, △Sodalite, '+Allanite
129	TJM001	Tijirit	Malachite bearing quartz rock	xenomorphic & boxwork														◎						△					○						+															+	
130	TJM002	Tijirit	Chlorite epidote amphibole rock	intersertal (relic)					◎		△				○	○		+									△	△							○																
131	TJM004	Tijirit	Chlorite-epidote-amphibole rock	ophitic (relic)					◎		△				◎	○		△																	△																
132	TJM007	Tijirit	Chalcopyrite bearing quartz rock	xenomorphic, granoblastic						+								◎						+	+				+	+																			△	△	
133	TJM011	Tijirit	Malachite bearing quartz rock	xenomorphic, granoblastic														◎						○	+																										
134	TSM301	Tasiast	Amphibolite, po-mt bearing	Banded			○	△										◎							△		○				△																				
135	TSM302a	Tasiast	Garnet amphibolite , cp-py vein	Banded, porous			△	○	△		△	○						◎							+		+			○	△					△														+	△Ank?
136	TSM302b	Tasiast	Garnet amphibolite, po-pnt-mt bearing	Banded, porous			○	△	△		+	△						◎				+			+		○			+	+					+														+	+Pnt?, '+Ank?
137	DGM102	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							○																								+		◎	+	△												
138	DGM104	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							○																								+		◎	+	△												
139	DGM111	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							○																								+		◎		△	+	+	+	+	+	+						
140	DGM120	Guidimaka	Chromite	Xenomorphic/fracture replacement							○																								+		◎	+	△											+	
141	DGT002	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							○																					+		+			◎		+											
142	DGT005	Guidimaka	Chromite ore	Xenomorphic/fracture replacement									◎														△										△		+							+	+	△			
143	DGT014	Guidimaka	Chromite	Xenomorphic/fracture replacement									○																						+		◎		△												
144	DGT015	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							△		○																						+															+	
145	DGT020	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							○																					+			+		◎		△								△				
146	DGT033	Guidimaka	Chromite ore	Xenomorphic/fracture replacement							○																					+		+	+		○		◎												

Amounts (%):

◎ Dominant (>30)

○ Major (10-30)

△ Minor (3-10)

+ Trace (<3)

*: Pseudomorph

Abbreviation : Mineral name

Ab : Albite	Chl : Chlorite	Gar : Garnet	Mil : Millerite	Q : Quartz
Act : Actinolite	Chy : Chrysocolla	Gn : Galena	Mn : Mangan Oxide	Ru : Rutile
Ag : Acanthite (Argentite)	Cly : Clay mineral	Goe : Goethite	Mnt : Montmorillonite	Ser : Sericite
Amp : Amphibole	Cor : Corundum (sapphire)	Hb : Hornblende	Ms : Magnesite	Si : Silica mineral
Ank : Ankerite	Cov : Covellite	Ht : Hematite	Mt : Magnetite	Smc : Smectite
Ap : Apatite	Cpx : Clinopyroxene	Ilm : Ilmenite	Mus : Muscovite	Srp : Serpentine
Au : Native gold	Cpy : Chalcopyrite	Ir : Irarsite	Oq : Opaque mineral	Stp : Stilpnomelane
Az : Azulite	Cr : Chromite	Ka : Kaolin mineral	Os : Osmium	Tc : Talc
Bi : Biotite	Cst : Cristobalite	Kf : K-feldspar	Pl : Plagioclase	Ti : Titanite (sphene
Bis : Bismuthinite	Cuir : Cuproiridsite	Lau : Laurite	Pnt : Pentlandite	To : Tourmaline
Bo : Bornite	Ep : Epidote	Lex : Leucoxene	Po : Pyrrhotite	Zr : Zircon
Cc : Calcite	Erli : Erlichmanite	Mal : Malachite	Px : Pyroxene	
Chc : Chalcocite	Fl : Fluorite	Mcr : Magnesiochoromite	Py : Pyrite	

2.4 X-ray diffraction analysis(1)

No.			Silicate minerals																																					Carbonate minerals					Sulfate minerals		Sulfides		Oxideds and hydroxides									
			Silica		Clay minerals										Zeolite	Others																																														
			Cristobalite	Quartz	Smectite(Montmorillonite)	Muscovite (Sericite)	Ser/Smc.interstratified(mixed-layer)	Kaolinite	Dicite	Chlorite	Serpentine	Talc	Holloysite	Laumontite	Plagioclase	Amphibole	Potassium feldspar	Tourmaline	Andalusite	Calsite	Epidote	Prehnite	Talc	Biotite	Anthophyllite	Cumming tonite	Chrysotile	Lizardite	Wuestite	Microcline	Magnesite	Siderite	Dolomite (Ca,Mg)CO_3	Malachite	Ankerite	Alunite	Gypsum	Pyrite	Sphalerite	Rutile TiO_2	Goethite α-FeO(OH)	Azurite	Brochantite	Magnetite	Hematite Fe_2O_3	Ilmenite	Chromite	Magnesiochromite
Oudelemguil (Ragel)		BTH001		◎		◎							・																																												
		BTH002		・		・				◎																																														
		BTH003		○		・				◎																																													
		BTH003		◎		◎	・																																															
		BTH004		・						◎																																													
		BTH007		△						◎																																													
		BTH008		・						◎																																													
		BTH011								◎																																													
		BTH012		△						◎									○		○																																	
		BTH012		・						◎									○																																			
		BTH015		◎				○																																														
		BTH025								◎																																													
		BTM003		◎						◎																																												
		BTM007		○						◎																																												
		BTM009		△						◎																																												
Kadiar		KDH004		◎										・						○																																	
		KDH006		○																◎																																	
		KDH007		◎																○																																	
		KDH013		◎		△		・																																													
		KDH023								◎																																													
		KDH024																									◎	◎																										
		KDH026								◎																																												
		KDH036		・								◎												◎																													
		KDH037								◎		◎												◎																													
		KDH038										◎												◎																													
		KDH042		◎								△												△																													
		KDH013		◎		△																																														
		KDH019		◎																																																
		KDH023		◎																		・																													
		KDH026								◎												・																													
		KDH013		・								◎												◎																													
Indice 78		IDH006		△		・				◎						・				◎		○																													
		IDH010		◎		・									・																																					
		IDH051		◎		・				△							・			△	・	◎																													
		IDH061		◎		◎						△												△																													
		IDH062		△						△										◎		◎																													
		IDH063		◎		◎				・												△																													
		IDM001(S同位体)		◎																														◎																	
Zouerate	242	KEH001		△				◎																																	△									
	245	SYH001		◎		◎				○																																									
	244	MHH002		◎		◎		◎									○																																	
	243	RHH001		◎								▪					▪														▪		▪						▪									
		RHH101		◎						○						・	◎																																◎			
Sfariat		SFH001		△				・								◎			◎																															
		SFH005		◎												△	◎				◎	○																													
		SFH006		◎													◎			◎																															
		SFH007		◎						◎							◎			・																															
		SFH002		◎																												◎		・															
		SFH004	・	◎												△																																	
		SFH007		◎						◎																					◎																	

2.4 X-ray diffraction analysis(1)

Area	No.	Sample	Silicate minerals: Silica: Cristobalite	Silica: Quartz	Clay minerals: Smectite(Montmorillonite)	Clay minerals: Muscovite (Sericite)	Clay minerals: Ser/Smc.interstratified(mixed-layer)	Clay minerals: Kaolinite	Clay minerals: Dicite	Clay minerals: Chlorite	Clay minerals: Serpentine	Clay minerals: Talc	Clay minerals: Holloysite	Zeolite: Laumontite	Others: Plagioclase	Others: Amphibole	Others: Potassium feldspar	Others: Tourmaline	Others: Andalusite	Others: Calsite	Others: Epidote	Others: Prehnite	Others: Talc	Others: Biotite	Others: Anthophyllite	Others: Cumming tonite	Others: Chrysotile	Others: Lizardite	Others: Wuestite	Others: Microcline
Tasiast	1	TSH002		◎		◎			◎																					
Tasiast	2	TSH003		◎		◎			◎																					
Tasiast	3	TSH004		◎		○			◎																					
Tasiast	4	TSH005		◎															△											
Tasiast	5	TSH025				○											◎anth													
Tasiast	6	TSH027		◎													△													
Tasiast	7	TSH028		◎		◎		△																						
Tasiast	8	TSH029		◎	△	◎		▪							▪															
Tasiast	**9	TSH040		◎		○	◎	▪																						
Tasiast	10	TSH042		△	△																									
Tasiast	11	TSH058		◎	△												△													
Tasiast	12	TSH059		◎																										
Tasiast	13	TSH060		◎																										
Tasiast	14	TSH067		◎	△	◎				▪																				
Tasiast	15	TSH068		○	○		△																							
Tasiast	16	TSH069		◎	△	△																								
Tasiast	17	TSH079		△	○												▪													
Tasiast	18	TSH081		△	◎										○															
Tasiast	19	TSH083		◎													◎act													
Tasiast	20	TSH084		◎	○	◎											△													
Tasiast	21	TSH086		◎	◎			▪									○anth													
Tasiast	22	TSH087		◎	◎	◎																								
Tasiast	23	TSH095		△	▪			▪																						
Tasiast	24	TSH097		◎	△	◎		△							◎					○										
Tasiast	25	TSH098		◎	△	▪		▪																						
Tasiast	26	TSH099		◎	△	◎		△							◎					○										
Tasiast	27	TSM005	○	◎						◎																				
Tasiast	28	TSM006		◎	△					△		○																		
Tasiast		TSH201		○	○															·										
Tasiast		TSH301		◎			·	◎																						
Tasiast		TSH302		◎		◎		◎																						
Guelb Moghrein	129	AKH010										▪																		
Guelb Moghrein	130	AKH012		△								▪																		
Guelb Moghrein		AKH012(white)																												
Guelb Moghrein	131	AKH013		◎		△									◎															
Guelb Moghrein	133	AKM005		◎			△			◎					◎		○													
Guelb Moghrein	134	AKM008			△					△																				
Guelb Moghrein	135	AKM010		○																										
Guelb Moghrein	136	AKM014		▪								▪					△anth													
Guelb Moghrein	137	AKM015			△							△					◎anth													
Guelb Moghrein	138	AKM016			△							○					◎anth													
Guelb Moghrein	139	AKM018		▪								◎					◎anth													
Guelb Moghrein	140	AKM024															◎anth													
Guelb Moghrein	141	AKM027		◎						◎																				

Area	No.	Sample	Carbonate minerals: Magnesite	Carbonate minerals: Siderite	Carbonate minerals: Dolomite $(Ca,Mg)CO_3$	Carbonate minerals: Malachite	Carbonate minerals: Ankerite	Sulfate minerals: Alunite	Sulfate minerals: Gypsum	Sulfides: Pyrite	Sulfides: Sphalerite	Oxideds and hydroxides: Rutile TiO_2	Oxideds and hydroxides: Goethite α-FeO(OH)	Oxideds and hydroxides: Azurite	Oxideds and hydroxides: Brochantite	Oxideds and hydroxides: Magnetite	Oxideds and hydroxides: Hematite Fe_2O_3	Oxideds and hydroxides: Ilmenite	Oxideds and hydroxides: Chromite	Oxideds and hydroxides: Magnesiochromite
Tasiast	1	TSH002	▪																	
Tasiast	2	TSH003						◎												
Tasiast	3	TSH004	○					◎												
Tasiast	4	TSH005										△								
Tasiast	5	TSH025																		
Tasiast	6	TSH027										▪								
Tasiast	7	TSH028																		
Tasiast	8	TSH029	◎																	
Tasiast	**9	TSH040																		
Tasiast	10	TSH042	◎									▪								
Tasiast	11	TSH058										○								
Tasiast	12	TSH059																		
Tasiast	13	TSH060										△								
Tasiast	14	TSH067																		
Tasiast	15	TSH068	◎																	
Tasiast	16	TSH069	◎																	
Tasiast	17	TSH079																		
Tasiast	18	TSH081	◎																	
Tasiast	19	TSH083																		
Tasiast	20	TSH084																		
Tasiast	21	TSH086	○				▪													
Tasiast	22	TSH087	◎																	
Tasiast	23	TSH095	◎											△						
Tasiast	24	TSH097						▪												
Tasiast	25	TSH098	◎																	
Tasiast	26	TSH099																		
Tasiast	27	TSM005																		
Tasiast	28	TSM006																		
Tasiast		TSH201											◎				○			
Tasiast		TSH301											○				○			
Tasiast		TSH302											○							
Guelb Moghrein	129	AKH010										◎								
Guelb Moghrein	130	AKH012		◎																
Guelb Moghrein		AKH012(white)		◎																
Guelb Moghrein	131	AKH013																		
Guelb Moghrein	133	AKM005							△				▪	△						
Guelb Moghrein	134	AKM008								▪							△			
Guelb Moghrein	135	AKM010								○							○			
Guelb Moghrein	136	AKM014		△			▪			▪		○								
Guelb Moghrein	137	AKM015																		
Guelb Moghrein	138	AKM016																		
Guelb Moghrein	139	AKM018		△																
Guelb Moghrein	140	AKM024													◎					
Guelb Moghrein	141	AKM027																		

2.4 X-ray diffraction analysis(1)

			Silicate minerals																																					Carbonate minerals					Sulfate minerals		Sulfides		Oxideds and hydroxides									
			Silica		Clay minerals											Zeolite	Others																																													
			Cristobalite	Quartz	Smectite(Montmorillonite)	Muscovite (Sericite)	Ser./Smc.interstratified(mixed-layer)	Kaolinite	Dicite	Chlorite	Serpentine	Talc	Holloysite	Laumontite	Plagioclase	Amphibole	Potassium feldspar	Tourmaline	Andalusite	Calsite	Epidote	Prehnite	Talc	Biotite	Anthophyllite	Cumming tonite	Chrysotile	Lizardite	Wuestite	Microcline	Magnesite	Siderite	Dolomite (Ca,Mg)CO_3	Malachite	Ankerite	Alunite	Gypsum	Pyrite	Sphalerite	Rutile TiO_2	Goethite α-FeO(OH)	Azurite	Brochantite	Magnetite	Hematite Fe_2O_3	Ilmenite	Chromite	Magnesiochromite
		AKH201								△		○												○																															
		AKH202								◎																																													
Akjoujt		AKH203		◎	○								・																											・	◎													
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		AKH207																								◎												・																
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		TJH002		△						◎					◎					△																																		
		TJH003		△						○										◎																・																	
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		DGM102								○																																						△	◎	
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		DGM111								○																																						△	◎	
		DGM120								○	△																																				△	◎	
		DGT002								○																																					△	△		△	◎	
		DGT005									◎																																						△	△	
		DGT014									○																																						△	◎	
		DGT015								△	○																																						△	○	
		DGT020								○																																						△	◎	
		DGT033								○																																						○	△	

Amounts

◎ Dominant
○ Major
△ Minor
・Trace

2.5 Chemical Assay1

	Sample	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Pd	Pt	Rb	Re	S	Sb	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Cr2o3
		ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Guelb Moghrein	AKH001	3.84	9.91	0.02	2730	10	0.07	12.35	5.38	0.03	111.5	1030	<1	0.05	76,700	33.6	1.63	0.61	0.1	5.83	0.01	57.6	1.3	2.45	1850	2.53	0.02	0.4	879	130	6.1	<0.001	<0.005	0.4	0.004	0.28	0.87	10	54.3	105.5	<0.05	6.20	1.0	<0.005	<0.02	0.8	46	24.3	37.1	21	1.6	
Guelb Moghrein	AKH004	0.515	0.82	0.23	128.0	30	<0.05	0.62	16.2	0.14	17.55	131.5	2	0.08	4,450	15.35	2.83	0.22	0.1	0.201	0.02	26.3	1.2	4.47	5690	1.22	0.01	0.2	58.3	90	2.9	<0.001	<0.005	0.7	0.002	1.64	0.14	3	0.5	67.7	<0.05	0.26	0.4	0.011	0.03	1.3	202	28.0	13.6	<2	2.1	
Guelb Moghrein	AKH005	0.100	0.13	7.28	1860	10	0.88	0.23	0.88	<0.02	138.5	210	6	0.42	1,755	8.49	18.25	0.18	0.4	0.134	0.07	74.5	2.8	1.02	1600	1.60	4.89	5.7	35.0	1160	2.0	<0.001	<0.005	4.2	0.003	0.03	0.11	2	2.0	23.3	0.09	0.25	10.8	0.722	0.03	3.2	203	125.5	18.6	4	14.2	
Guelb Moghrein	AKH006	0.095	0.10	0.43	811	70	0.19	0.46	5.42	0.08	14.5	216	3	0.30	1,655	23.6	3.54	0.30	0.2	0.12	0.05	16.7	6.9	0.59	4340	0.74	0.05	0.6	53.1	50	1.3	<0.001	<0.005	3.2	<0.002	0.01	0.25	2	0.9	66.6	<0.05	0.28	0.7	0.032	0.03	1.4	94	17.5	30.1	4	4.6	
Guelb Moghrein	AKH007	4.63	0.47	6	85.7	20	0.86	2.79	0.45	0.02	20.6	91.3	<1	0.81	19,900	9.82	17.25	0.15	1.4	1.22	0.14	13.7	3.2	0.92	1195	1.95	3.51	3.1	53.3	390	3.4	<0.001	<0.005	9.6	0.002	<0.01	0.22	2	4.0	22.8	0.16	2.87	2.1	0.310	0.04	2.4	206	62.7	8.4	9	41.8	
Guelb Moghrein	AKH008	0.324	0.03	0.59	457	20	0.33	0.67	6.49	0.12	12.6	212	8	0.30	572	22.7	5.71	0.31	0.3	0.065	0.06	20.0	2.5	2.78	2880	0.68	0.03	0.6	103.5	60	3.9	<0.001	<0.005	3.2	0.002	0.01	0.80	2	1.4	45.5	0.05	0.22	1.1	0.034	<0.02	13.1	117	29.3	56	6	5.5	
Guelb Moghrein	AKH009	0.006	0.18	0.75	8.7	10	0.21	0.05	0.42	<0.02	2.09	4.6	18	0.07	50	1.68	2.13	<0.05	0.5	0.011	0.02	1.4	1.2	0.16	336	3.56	0.31	0.9	4.2	80	0.7	<0.001	<0.005	0.8	<0.002	<0.01	0.20	1	0.4	7.0	<0.05	<0.05	0.6	0.083	<0.02	0.4	52	8.4	3.6	3	13.2	
Guelb Moghrein	AKH010	5.41	6.10	0.01	1615	<10	<0.05	21.2	2.38	0.42	0.72	516	<1	<0.05	80,300	44.1	1.10	0.61	<0.1	4.40	<0.01	<0.5	0.6	1.46	6740	2.07	0.01	0.2	527	150	1.7	<0.001	<0.005	0.1	0.003	0.12	0.57	15	51.4	26.0	<0.05	6.34	<0.2	<0.005	<0.02	0.9	38	1.4	5.8	30	<0.5	
Guelb Moghrein	AKH011	7.40	5.01	0.01	2580	<10	0.14	39.5	0.21	<0.02	9.51	263	<1	<0.05	70,400	45.3	0.79	0.55	<0.1	2.78	0.01	4.7	0.4	0.52	1165	1.87	0.03	0.3	371	1180	0.9	<0.001	<0.005	0.1	<0.002	0.06	0.43	13	20.7	7.7	<0.05	9.38	<0.2	<0.005	<0.02	0.5	94	22.3	5.0	15	0.8	
Guelb Moghrein	AKH014	6.87	4.18	0.3	1950	10	0.23	12.85	0.02	0.14	34.2	86.4	<1	0.32	148,000	40.5	3.03	0.62	0.2	3.13	0.01	22.4	0.4	0.24	1235	4.36	<0.01	0.6	211	250	5.8	0.001	<0.005	1.4	<0.002	0.13	0.32	18	9.8	4.9	<0.05	3.57	0.9	0.044	<0.02	7.9	72	29.1	19.4	14	7.2	
Guelb Moghrein	AKM003	0.002	0.07	0.41	26.6	20	0.14	0.51	0.10	<0.02	4.27	3.4	25	0.62	141	1.64	1.78	<0.05	0.1	0.006	0.15	3.2	4.4	0.19	102	3.27	0.01	0.4	6.7	60	0.6	<0.001	<0.005	11.0	<0.002	<0.01	0.12	2	0.9	1.3	<0.05	<0.05	<0.2	0.027	0.03	0.1	35	7.8	1.2	<2	3.1	
Guelb Moghrein	AKM004	0.003	0.02	0.74	<0.2	10	0.09	0.49	>25	<0.02	3.77	8.5	2	0.25	43	1.8	2.59	<0.05	0.2	0.025	0.06	2.9	2.5	0.38	1965	0.48	0.19	0.7	<0.2	40	1.9	<0.001	<0.005	3.3	<0.002	<0.01	0.06	2	0.3	103.5	<0.05	<0.05	0.6	0.058	<0.02	0.3	43	1.6	9.0	2	7.2	
Guelb Moghrein	AKM005	0.021	0.16	5.29	8.6	20	0.50	0.67	0.81	0.05	47.1	202	11	1.54	3,540	12.7	21.7	0.21	3.4	0.036	0.24	20.4	9.6	2.67	893	4.39	1.92	6.2	134.5	470	2.5	<0.001	<0.005	22.1	0.003	3.54	0.16	2	1.4	12.8	0.47	0.09	5.8	0.586	0.05	2.1	340	1.2	10.1	4	103	
Guelb Moghrein	AKM006	0.007	<0.01	1.66	<0.2	20	0.44	0.40	16.8	<0.02	7.46	10.6	13	0.28	70	2.95	5.05	0.05	0.7	0.026	0.05	3.9	2.8	0.57	1605	1.33	0.65	1.5	2.7	200	1.9	<0.001	<0.005	2.9	<0.002	0.05	0.17	1	0.7	74.5	<0.05	<0.05	1.3	0.163	<0.02	0.5	115	2.9	16.0	2	21.9	
Guelb Moghrein	AKM007	0.566	14.10	2.63	6340	10	0.41	7.42	7.25	0.12	54	1215	<1	0.13	111,500	19.25	8.90	0.42	1.9	3.43	0.04	26.7	1.6	0.86	1540	3.81	0.01	3.2	827	100	1.9	<0.001	<0.005	1.8	<0.002	>10	0.93	20	46.5	278.0	0.28	5.71	3.5	0.318	0.02	2.4	191	68.5	30.1	31	63.8	
Guelb Moghrein	AKM008	0.749	6.36	4.12	3970	40	1.38	6.00	0.47	0.19	97.2	664	<1	0.56	60,700	29.6	16.55	0.48	2.8	3.92	0.15	48.5	3.1	1.37	976	4.50	0.04	5.7	378	320	3.9	<0.001	<0.005	8.1	0.004	3.04	0.68	14	34.4	34.0	0.42	3.45	5.6	0.539	0.10	4.1	290	294	34.7	30	87.9	
Guelb Moghrein	AKM009	0.302	5.56	3.52	1680	50	1.85	3.53	1.16	0.61	116	1075	<1	2.74	215,000	15.5	14.35	0.35	2.5	1.76	0.16	59.2	1.7	1.59	1750	5.31	0.01	5.1	874	270	1.2	0.001	<0.005	23.1	<0.002	0.79	0.67	8	16.6	42.0	0.39	2.17	5.8	0.476	0.07	2.5	465	64.4	38.0	227	74.1	
Guelb Moghrein	AKM011	5.42	8.70	0.12	18.7	<10	0.19	3.22	0.08	0.04	2.94	26.7	29	0.06	11,800	4.34	0.55	0.09	0.1	0.212	0.01	1.6	0.3	0.03	239	5.91	<0.01	0.1	30.2	60	0.6	<0.001	<0.005	0.6	0.002	0.10	0.18	2	1.3	2.4	<0.05	0.66	<0.2	0.005	<0.02	0.2	27	10.2	0.9	6	2.0	
Guelb Moghrein	AKM013	0.007	0.06	0.4	10.9	10	1.43	0.29	0.06	<0.02	35	8.4	24	0.08	477	1.04	1.50	0.05	0.1	0.013	0.01	15.4	1.9	0.41	126	3.11	<0.01	0.2	7.3	210	1.3	<0.001	<0.005	0.6	<0.002	0.01	0.27	1	0.4	1.1	<0.05	<0.05	0.3	0.018	<0.02	0.1	27	20.1	10.2	3	3.4	
Guelb Moghrein	AKM014	1.18	1.98	0.02	890	<10	0.16	4.14	0.41	0.19	68.9	498	4	<0.05	16,600	48.9	1.34	0.66	<0.1	0.993	0.02	37.2	0.7	2.00	>10000	1.46	0.15	0.4	186	600	<0.5	<0.001	<0.005	0.3	0.002	0.11	0.61	3	10.8	33.3	<0.05	1.25	<0.2	<0.005	<0.02	0.5	108	4.2	9.8	18	0.7	
Guelb Moghrein	AKM015	0.040	0.60	0.02	183.0	10	0.10	0.10	0.09	0.09	1.2	135	<1	0.17	1,215	18.7	0.57	0.34	<0.1	0.033	0.02	0.6	2.1	8.01	7190	0.12	0.11	0.3	96.5	20	2.0	<0.001	<0.005	0.4	<0.002	0.03	0.59	1	1.5	34.6	<0.05	0.05	<0.2	<0.005	<0.02	0.1	7	0.7	1.7	15	0.5	
Guelb Moghrein	AKM016	0.068	0.24	0.06	74.2	<10	0.09	0.51	0.09	<0.02	0.33	59.2	<1	<0.05	3,050	18.85	0.45	0.37	<0.1	0.091	0.01	<0.5	1.7	7.29	3000	0.20	0.01	0.3	82.8	<10	0.7	<0.001	<0.005	0.2	<0.002	0.01	0.72	1	2.6	13.0	<0.05	0.15	<0.2	<0.005	<0.02	0.1	8	4.4	0.5	9	<0.5	
Guelb Moghrein	AKM017	0.317	0.88	0.01	713	<10	0.07	2.65	1.12	<0.02	0.4	92.6	4	<0.05	11,400	37.8	0.96	0.58	<0.1	0.932	0.01	<0.5	0.5	6.64	>10000	0.80	0.01	0.4	81.9	80	<0.5	<0.001	<0.005	0.1	<0.002	0.02	0.21	1	7.4	44.7	<0.05	1.17	<0.2	<0.005	<0.02	0.6	57	73.9	4.3	11	<0.5	
Guelb Moghrein	AKM018	9.89	2.37	0.02	163.0	<10	0.11	13.55	0.26	0.19	8.06	74.3	<1	<0.05	6,810	32.3	0.94	0.59	<0.1	0.329	0.01	4.3	1.4	6.38	>10000	0.53	0.01	0.4	125	250	0.5	<0.001	<0.005	0.3	<0.002	0.03	0.87	15	4.5	10.0	<0.05	1.84	<0.2	<0.005	<0.02	0.6	16	16.2	2.1	25	0.5	
Guelb Moghrein	AKM019	1.52	18.15	0.02	250	<10	<0.05	23.9	0.03	<0.02	32.1	94.2	<1	<0.05	231,000	27.8	2.55	0.68	0.1	8	<0.01	17.6	1.3	0.45	1110	3.88	<0.01	0.4	218	340	2.0	0.001	0.005	0.3	<0.002	1.14	0.39	8	68.6	3.0	<0.05	11.45	0.2	<0.005	<0.02	1.0	39	205	20.1	35	0.7	
Guelb Moghrein	AKM020	1.07	3.58	0.02	1060	<10	0.06	5.67	0.59	0.11	110.5	131	<1	<0.05	31,700	54.9	1.36	0.96	0.1	1.64	0.01	60.8	0.4	1.53	6420	1.05	0.02	0.6	230	1020	<0.5	<0.001	<0.005	0.2	<0.002	0.11	0.23	5	11.4	29.7	<0.05	1.79	0.5	<0.005	<0.02	0.7	72	27.7	17.0	24	<0.5	
Guelb Moghrein	AKM021	1.22	2.22	0.02	796	<10	<0.05	10.75	2.79	0.11	0.79	210	<1	<0.05	41,100	47.5	0.78	0.72	<0.1	2.97	0.01	<0.5	0.4	1.82	5300	1.09	0.01	0.6	129	290	0.5	<0.001	0.01	0.2	<0.002	0.19	0.30	3	20.5	41.3	<0.05	3.87	<0.2	<0.005	<0.02	0.1	90	24.8	4.2	21	<0.5	
Guelb Moghrein	AKM022	0.319	0.66	0.01	504	<10	<0.05	1.77	0.87	<0.02	9.14	49.3	2	<0.05	12,500	52.46	0.77	0.75	<0.1	0.512	0.01	5.0	0.4	2.95	6190	0.71	<0.01	0.6	51.8	140	<0.5	<0.001	<0.005	0.1	<0.002	0.06	0.15	1	5.9	25.8	<0.05	0.54	<0.2	<0.005	<0.02	0.2	104	71.8	6.3	10	<0.5	
Guelb Moghrein	AKM023	3.23	5.13	0.01	2920	<10	0.07	21.2	0.38	<0.02	16.75	134	<1	<0.05	144,000	40.8	1.60	0.66	<0.1	4.32	<0.01	8.7	2.1	0.35	1630	3.35	<0.01	0.4	241	570	1.3	0.003	<0.005	0.1	<0.002	0.11	0.33	13	32.5	8.0	<0.05	4.71	<0.2	<0.005	<0.02	1.5	57	78.6	20.5	21	<0.5	
Guelb Moghrein	AKM024	0.333	3.99	0.17	3850	<10	0.08	4.50	3.16	0.02	3.4	186	<1	<0.05	81,000	9.42	1.81	0.31	0.1	1.275	0.01	1.5	1.5	1.94	1505	2.60	0.02	0.4	86.0	60	2.1	<0.001	<0.005	0.1	<0.002	0.01	0.66	4	16.8	46.1	<0.05	2.70	0.3	0.007	<0.02	1.2	66	4.2	29.4	5	0.5	
Guelb Moghrein	AKM025	8.50	0.81	0.07	3200	20	0.19	27.4	0.06	0.07	7.47	312	<1	<0.05	37,500	47.0	0.91	0.77	0.1	1.145	0.01	5.2	0.4	0.16	3720	4.18	0.01	0.5	995	340	0.8	<0.001	<0.005	0.2	<0.002	0.09	0.35	5	3.4	11.4	<0.05	5.34	<0.2	0.005	<0.02	7.9	240	39.6	17.5	20	1.1	
Guelb Moghrein	AKM026	0.12	1.08	4.12	205	100	0.88	0.68	0.22	0.02	62.5	163	<1	4.63	131,500	13.15	15.05	0.44	1.6	0.061	0.36	37.7	8.8	1.82	4390	3.88	0.20	3.0	517	230	6.1	0.002	0.005	54.0	<0.002	0.01	0.14	2	0.9	24.9	<0.05	0.23	7.1	0.571	<0.02	20.3	329	11.2	19.5	85	56.3	
Guelb Moghrein	AKM029	4.50	3.73	0.65	1380	20	0.09	26.3	0.08	0.04	44	160.5	<1	<0.05	130,000	42.0	3.98	0.72	0.2	4.98	0.01	24.8	1.4	0.51	3810	4.21	0.02	1.0	272	460	5.5	0.001	<0.005	0.4	<0.002	0.14	0.45	8	37.7	13.9	0.06	8.66	1.7	0.024	<0.02	28.2	112	159	4.2	58	8.7	
Guelb Moghrein	AKM030	0.575	2.74	0.02	518	<10	<0.05	3.82	0.93	0.03	2.53	124	<1	<0.05	31,000	42.4	0.71	0.64	<0.1	1.96	<0.01	1.4	0.5	5.41	6030	0.89	0.01	0.4	101	40	<0.5	<0.001	<0.005	0.1	<0.002	0.08	0.27	1	19.6	4.8	<0.05	1.66	<0.2	<0.005	<0.02	0.2	95	2.0	6.8	8	<0.5	
ground truth	AKH002	0.005	0.06	1.06	35.3	50	0.32	0.09	0.17	0.03	8.53	123.5	31	<0.05	174	26.9	6.08	0.40	0.2	0.053	0.04	6.9	3.1	0.05	526	1.96	0.02	0.8	23.9	190	1.3	<0.001	<0.005	1.7	<0.002	0.06	0.90	2	1.3	10.8	0.08	<0.05	1.8	0.030	<0.02	0.5	27	4.6	2.9	<2	7.4	
ground truth	AKH003	0.048	0.12	5.61	382	40	1.12	1.44	0.10	<0.02	5.11	8.9	108	0.24	617	18.1	16.25	0.26	1.5	0.085	0.32	3.0	20.2	0.07	83	1.16	0.06	4.1	27.8	70	1.9	0.002	<0.005	18.0	<0.002	0.04	0.27	1	1.4	7.9	0.31	0.10	8.8	0.161	0.04	2.8	91	5.7	8.1	<2	46.5	
Tabrinkout	TBH001	21.2	2.42	0.02	127.5	50	0.06	0.07	2.64	0.06	0.39	10.7	11	<0.05	7,240	14.7	0.44	0.17	<0.1	0.156	0.01	<0.5	0.3	0.31	3820	6.01	0.02	0.1	38.3	780	2.1	0.002	<0.005	0.2	<0.002	0.07	0.91	2	0.4	32.1	<0.05	<0.05	<0.2	<0.005	<0.02	2.4	47	15.3	2.2	<2	0.6	
Tabrinkout	TBH002	0.522	1.99	0.29	44.6	40	0.11	0.10	0.20	0.03	2.13	9.8	20	0.05	11,900	6.77	0.93	0.09	0.1	0.271	0.12	1.0	0.3	0.05	382	4.66	0.01	0.1	64.9	200	1.6	<0.001	<0.005	3.9	<0.002	0.03	0.91	3	1.7	6.0	<0.05	<0.05	0.2	0.007	<0.02	0.7	22	6.5	1.4	3	3.5	
Tabrinkout	TBH003	0.014	0.10	0.05	62.6	320	0.13	0.07	0.61	0.08	1.74	10.2	22	<0.05	516	11.35	0.65	0.13	<0.1	0.094	0.01	1.5	0.6	0.18	2980	2.93	0.01	0.1	25.0	180	1.8	<0.001	<0.005	0.2	<0.002	0.03	1.12	1	0.2	20.5	<0.05	<0.05	<0.2	<0.005	0.04	0.8	55	30.3	2.1	6	1.7	
Tabrinkout	TBH004	0.003	0.04	0.06	96.3	60	<0.05	0.07	0.19	0.02	1.12	6.2	22	<0.05	75	4.82	0.40	0.07	<0.1	0.046	0.02	0.7	0.4	0.06	899	4.08	0.01	0.1	14.8	60	1.4	<0.001	<0.005	0.6	<0.002	0.01	0.64	2	0.3	7.7	<0.05	<0.05	<0.2	<0.005	<0.02	0.4	19	25.9	0.7	4	1.7	
Tabrinkout	TBH005	0.001	0.03	3.35	203	360	0.75	0.87	0.58	0.04	43.4	44.5	62	<0.05	112	14.3	8.72	0.20	0.3	0.116	0.04	24.1	1.4	0.94	4320	2.60	0.32	0.3	45.3	510	1.7	<0.001	<0.005	1.0	0.002	0.06	0.45	1	1.2	49.2	<0.05	<0.05	1.6	0.130	0.03	1.4	211	21.1	8.2	5	8.8	
Tabrinkout	TBH006	0.010	0.05	0.05	456	230	0.09	0.35	0.03	0.02	1.74	4.3	17	<0.05	67	9.81	0.50	0.13	<0.1	0.133	0.01	1.2	0.4	0.14	2640	2.85	0.01	0.1	11.6	30	1.2	<0.001	<0.005	0.4	<0.002	<0.01	0.88	1	0.2	6.6	<0.05	<0.05	<0.2	<0.005	0.02	0.6	62	7.7	2.0	4	0.9	
Tabrinkout	TBH007	0.029	0.03	0.02	175.0	60	<0.05	0.04	0.31	<0.02	0.31	2	18	<0.05	56	4.42	0.18	0.07	<0.1	0.082	0.01	<0.5	0.3	0.07	1275	3.66	0.02	0.1	6.0	130	1.6	<0.001	<0.005	0.2	<0.002	0.02	0.88	2	0.2	8.7	<0.05	<0.05	<0.2	<0.005	<0.02	0.2	3	4.1	4.7	3	0.8	
Tabrinkout	TBH008	0.002	0.02	0.01	11.1	10	<0.05	0.18	0.10	0.02	0.22	1.2	22	0.06	35	0.9	0.11	<0.05	<0.1	<0.005	<0.01	<0.5	0.2	0.04	154	5.06	0.02	0.1	4.5	20	1.4	<0.001	<0.005	0.2	<0.002	<0.01	0.88	2	0.4	4.9	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	1	7.2	0.1	2	1.0	
Tabrinkout	TBH009	0.634	0.20	0.01	2020	40	<0.05	1.04	2.14	<0.02	0.29	3.1	16	<0.05	1,845	12.05	0.24	0.18	<0.1	0.289	0.01	<0.5	0.2	0.21	3420	2.72	0.01	0.1	14.2	30	1.6	0.001	<0.005	0.1	<0.002	0.05	1.34	2	3.4	31.9	<0.05	<0.05	<0.2	<0.005	<0.02	0.6	38	3.6	1.6	2	0.5	
Tabrinkout	TBH010	25.4	3.69	0.02	6240	20	0.06	>10000	0.99	<0.02	0.46	42.3	5	<0.05	29,500	12.6	0.89	0.23	<0.1	0.761	0.01	<0.5	0.6	0.06	1625	2.85	0.01	0.1	45.4	40	113.5	<0.001	<0.005	0.2	<0.002	0.05	136	6	12.8	11.8	<0.05	0.78	<0.2	<0.005	<0.02	1.0	8	2.5	1.6	<2	0.8	
Tabrinkout	TBH011	0.036	0.03	0.02	44.5	30	<0.05	66.1	0.88	<0.02	0.26	2.1	24	<0.05	215	4.68	0.19	0.06	<0.1	0.059	0.01	<0.5	0.2	0.15	1305	4.06	0.01	0.1	8.7	90	1.8	<0.001	<0.005	0.3	<0.002	0.04	1.8	2	0.4	21.3	<0.05	<0.05	<0.2	<0.005	<0.02	0.1	2	4.8	1.5	3	0.8	
Tabrinkout	TBH012	1.535	0.38	0.01	135.5	20	<0.05	322	0.44	<0.02	0.13	124	23	<0.05	2,190	10.8	0.18	0.18	<0.1	0.378	<0.01	<0.5	0.2	0.06	957	3.71	0.01	0.1	65.4	50	3.8	0.002	<0.005	0.1	<0.002	0.07	2.3	13	1.2	8.8	<0.05	0.30	<0.2	<0.005	<0.02	0.3	19	6.1	0.8	<2	0.6	
Tabrinkout	TBH013	0.012	<0.01	0.04	7.0	10	0.16	3.62	17.1	0.02	14.65	9.3	2	0.06	20	7.44	0.34	0.12	<0.1	0.150	0.01	5.1	1.1	8.81	3570	0.34	0.02	0.1	11.6	20	1.4	<0.001	<0.005	0.2	<0.002	0.03	0.28	2	<0.2	82.1	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	9	0.7	23.3	<2	<0.5	
Tabrinkout	TBH014	0.002	<0.01	5.48	36.9	30	0.51	1.25	0.43	<0.02	18.8	47.8	30	<0.05	70	9.18	20.1	0.14	0.1	0.060	0.02	8.7	16.8	5.42	317	0.54	<0.01	0.8	55.6	1470	<0.5	<0.001	<0.005	0.7	<0.002	0.01	0.17	2	1.0	4.7	<0.05	<0.05	3.0	0.239	<0.02	1.1	241	0.5	10.8	12	2.9	
		0.033	1.69	0.09	55	110	<0.05	1.52	0.45	23.1	0.46	27.9	30	<0.05	4910	1.8	0.35	0.07	<0.1	0.559	0.01	<0.5	0.4	0.04	211	4.95	0.01	0.1	19.8	20	91	<0.001	<0.005	0.4	<0.002	0.02	0.2	10	0.4	5.4	<0.05	2.03	<0.2	<0.005	<0.02	0.3	12	7.1	0.9	2400	1.5	
	222TS22	0.005	0.05	0.05	16.8	140	<0.05	0.01	0.1	6.64	0.45	7.1	26	<0.05	877	0.98	0.15	<0.05	<0.1	0.14	0.01	0.5	0.4	0.01	109	4.98	0.01	0.1	6.5	20	5.1	<0.001	<0.005	0.2	<0.002	0.01	0.14	3	0.4	2.4	<0.05	0.07	<0.2	<0.005	<0.02	<0.1	5	8.3	0.3	174	1.9	
Akjoujt	AKM104	0.739	3.46	0.18	2180	120	4.67	0.07	0.04	0.03	7.05	22	<1	<0.05	141500	40	1.76	0.86	0.1	0.047	0.01	20.7	0.5	0.01	140	4.33	0.01	0.5	87.9	1060	1.1	<0.001	<0.005	0.4	<0.002	0.01	1.4	19	0.4	4	<0.05	<0.05	0.3	0.006	<0.02	13.6	61	50.7	42.3	3	3.2	
Akjoujt	AKM105	0.408	1.8	0.03	6990	20	0.08	9.32	0.89	0.56	6.6	275	<1	<0.05	59400	46.7	0.73	0.71	<0.1	2.18	0.01	3.9	0.3	0.17	2060	4.28	0.01	0.4	108.5	240	1.4	<0.001	<0.005	<0.1	<0.002	0.13	2.45	5	3.7	17.1	<0.05	1.67	<0.2	<0.005	<0.02	8.3	198	62.9	4.6	48	<0.5	
Sfariat	SFH002	<0.001	0.04	0.07	1.1	20	<0.05	<0.01	0.09	<0.02	4.63	0.9	29	<0.05	17.2	29.6	0.42	0.43	<0.1	<0.005	0.01	2.9	2.9	0.01	65	3.98	0.01	0.4	6.1	100	<0.5	<0.001	<0.005	0.3	<0.002	0.01	0.26	2	0.3	8	<0.05	<0.05	<0.2	<0.005	<0.02	0.2	7	7.6	2.1	3	2.6	
Sfariat	SFH003	<0.001	0.05	0.04	3.7	70	0.79	<0.01	0.2	0.04	3.41	2	31	<0.05	12.4	28.6	0.3	0.41	<0.1	<0.005	0.01	2.2	1.1	0.02	285	3.57	0.02	0.3	15.1	450	0.6	<0.001	<0.005	0.2	<0.002	0.05	0.18	2	0.3	7.5	<0.05	<0.05	<0.2	<0.005	0.03	0.2	4	5.2	5.1	16	1.5	
Sfariat	SFH004	<0.001	0.04	0.03	1.2	20	0.17	<0.01	0.07	<0.02	3.45	0.5	32	<0.05	7.8	26.7	0.32	0.4	<0.1	<0.005	<0.01	1.9	0.3	<0.01	83	3.81	<0.01	0.4	4.4	370	0.6	<0.001	<0.005	<0.1	<0.002	0.01	0.21	2	0.3	12.9	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	4	6.2	3.6	3	1.6	
Sfariat	SFH007	<0.001	<0.01	3.97	1	270	0.81	0.01	0.96	<0.02	64.2	12.7	30	<0.05	4.9	3.87	20.6	0.13	2	0.028	1.98	41	33.2	2.28	616	2.35	0.05	5.8	42	400	12.1	<0.001	<0.005	49.6	<0.002	0.04	0.06	2	1.2	235	0.3	<0.05	11.2	0.173	0.17	1.2	72	3.4	8.6	75	74.4	
Sfariat	SFH008	0.007	0.04	0.03	2.6	20	0.1	<0.01	0.11	<0.02	2.82	0.9	28	<0.05	6.5	32.1	0.45	0.5	<0.1	<0.005	0.01	1.8	0.6	0.05	75	4.19	0.01	0.4	8.4	430	0.6	<0.001	<0.005	0.4	<0.002	0.01	0.34	2	0.3	5.3	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	3	6	4.2	2	2.2	
Sfariat	SFM001	0.003	0.04	0.07	4.6	50	<0.05	<0.01	0.12	<0.02	2.65	0.4	27	<0.05	4.4	28.3	0.45	0.36	0.1	<0.005	0.01	1.7	0.5	0.02	44	3.29	<0.01	0.4	3.8	450	<0.5	<0.001	<0.005	0.2	<0.002	0.01	0.3	2	0.2	12.5	<0.05	<0.05	<0.2	<0.005	<0.02	0.1	9	5.2	2.7	3	2.7	
Sfariat	SFM002	<0.001	<0.01	0.27	<5	90	<0.05	<0.01	23.6	0.05	4.18	2.5	5	0.07	2.3	1.74	0.9	0.06	0.1	<0.005	0.04	2.9	1.3	5.47	4000	0.86	0.04	0.3	5.5	80	1.2	<0.001	<0.005	0.8	<0.002	0.05	<0.05	3	<0.2	85.8	<0.05	<0.05	0.4	0.007	0.03	0.7	16	0.8	2.1	7	5.2	
Sfariat	SFM004	0.002	<0.01	6.47	0.3	2460	0.6	<0.01	0.72	<0.02	21.9	0.8	14	0.24	6.8	0.64	14.75	0.15	1.3	<0.005	3.77	16.1	1.9	0.05	73	2.53	2.6	0.4	3	40	17.4	<0.001	<0.005	130	<0.002	0.01	0.06	2	0.4	251	<0.05	<0.05	3.2	0.026	0.56	0.2	5	3.5	1.3	2	37.2	
Sfariat	SFM005	0.002	0.02	6.65	0.7	580	0.67	<0.01	0.95	<0.02	7.47	1.1	11	1.18	23.6	0.48	18.8	0.15	3.4	<0.005	4.25	6.2	19.3	0.02	87	2.29	2.36	0.6	3.9	150	27	<0.001	<0.005	230	<0.002	<0.01	0.05	2	0.5	122	0.07	<0.05	2.2	0.017	1.04	1	4	3.2	4.9	3	76.7	
Sfariat	SFM006	0.001	0.04	0.07	8.4	80	0.14	<0.01	0.2	<0.02	4.99	1.7	28	<0.05	60.9	27.9	0.48	0.4	<0.1	<0.005	0.01	3	0.5	0.02	286	4.7	0.01	0.3	8.8	610	1	<0.001	<0.005	1.2	<0.002	0.03	0.4	2	0.3	11.3	<0.05	<0.05	<0.2	<0.005	0.03	0.2	9	5.7	6.5	6	1.9	
Sfariat	SFM007	0.001	<0.01	0.1	2	120	0.16	0.03	0.05	<0.02	6.09	0.7	39	<0.05	14.3	1.82	0.3	0.05	<0.1	<0.005	0.01	4	2.9	0.01	68	4.42	0.02	0.2	4.2	80	0.7	<0.001	<0.005	0.3	<0.002	0.02	0.18	3	0.3	10.1	<0.05	<0.05	0.5	0.007	<0.02	0.2	3	7.3	1.7	3	1.5	
Sfariat	SFM008	<0.001	<0.01	0.05	0.9	40	0.15	<0.01	0.04	<0.02	2.41	0.5	38	<0.05	6.4	1.76	0.38	<0.05	0.1	<0.005	<0.01	1.2	9.9	0.01	66	4.08	0.01	0.9	4	80	<0.5	<0.001	<0.005	0.2	<0.002	<0.01	0.07	2	0.8	5.4	0.14	<0.05	<0.2	0.008	<0.02	<0.1	2	5.9	2.1	<2	1.9	
Sfariat	SFM010	0.001	0.03	0.08	7.3	500	0.29	0.02	0.75	0.05	4.61	2.5	33	<0.05	14	15.3	0.52	0.21	<0.1	<0.005	0.03	2.7	2.6	0.23	2000	5.33	0.05	0.3	8.2	620	0.9	<0.001	<0.005	0.6	<0.002	0.2	0.16	2	0.3	66	<0.05	<0.05	<0.2	<0.005	0.02	3.1	176	6.1	3.7	10	1.9	
Sfariat	SFM011	<0.001	0.03	0.03	1.5	330	0.23	<0.01	0.53	<0.02	2.08	1.7	21	<0.05	4.9	16.95	0.35	0.21	<0.1	<0.005	0.02	1.3	2.2	0.15	2440	13.5	0.05	0.2	8.7	350	0.7	<0.001	<0.005	0.2	<0.002	0.11	0.11	2	0.2	53.5	<0.05	<0.05	<0.2	<0.005	0.02	3	24	5.2	2.4	23	1.3	
Sfariat	SFM012	0.001	0.03	0.03	5.8	330	0.15	<0.01	0.97	<0.02	1.44	0.8	22	<0.05	5.7	13.8	0.27	0.19	<0.1	<0.005	0.02	1	2.1	0.09	852	5.56	0.03	0.2	4.7	290	<0.5	<0.001	<0.005	0.6	<0.002	0.06	0.12	2	0.2	26.5	<0.05	<0.05	<0.2	<0.005	<0.02	2.6	160	3.1	2.4	4	0.8	
Tijirit	TJH001	0.002	0.07	6.69	2.2	250	0.36	0.12	6.22	0.13	13.15	49.2	18	0.1	70.7	10.4	18	0.18	0.9	0.081	0.2	5.4	13.4	3.42	1425	1.05	1.94	2.9	47.2	370	6	0.006	0.007	1.7	<0.002	0.01	2.36	1	0.6	180	0.24	<0.05	0.9	0.681	0.05	0.2	303	2.4	19.4	99	21.5	
Tijirit	TJH002	0.005	0.04	7.48	5.6	410	0.31	0.29	7.02	0.29	7.03	49	152	<0.05	125.5	6.99	17	0.13	0.4	0.06	0.03	2.9	10.2	3.71	1125	1.13	1.28	2.3	97.4	230	14	0.01	0.008	0.1	<0.002	0.02	0.68	2	0.6	300	0.16	<0.05	0.3	0.371	<0.02	0.1	210	1.8	15	97	13	
Tijirit	TJH003	0.003	<0.01	1.2	10	160	0.07	<0.01	28.9	0.25	5.11	27.5	41	<0.05	46	1.54	3.08	<0.05	0.2	0.007	0.06	4.3	4.9	1.97	635	0.33	0.03	0.7	45	140	1.8	0.007	<0.005	2.2	<0.002	0.03	0.19	3	0.2	184	0.05	<0.05	0.4	0.082	<0.02	0.8	54	0.5	5.7	25	8.8	
Tijirit	TJH004	0.001	0.02	7.21	3.7	250	0.16	0.12	5.96	0.08	8.72	46.3	114	0.58	63.5	8.1	16.7	0.12	0.6	0.085	0.27	4.5	14.7	4.07	1240	0.74	2.6	1.7	119	230	8.2	0.015	0.013	3.7	<0.002	0.01	1.3	2	1.1	208	0.14	0.05	0.3	0.479	0.05	0.1	317	1.6	20.5	73	15.7	
Tijirit	TJH005	0.002	0.03	0.95	<5	110	0.14	<0.01	27.9	0.06	3.52	30.1	147	<0.05	39.7	1.51	2.34	<0.05	0.2	0.011	0.03	2.1	4.1	4.1	699	0.25	0.02	0.5	102.5	60	0.9	0.007	0.006	0.8	<0.002	0.02	0.2	2	0.2	248	<0.05	<0.05	0.2	0.054	<0.02	0.7	55	0.6	3.6	18	6.1	
Tijirit	TJH007	0.002	0.03	7.61	9.1	270	0.24	0.01	6.23	0.14	6.52	47.4	74	0.05	268	8.27	17.8	0.13	0.8	0.059	0.04	2.5	9.4	3.88	1135	0.8	2.16	1.9	76.9	250	3.9	0.001	<0.005	0.9	<0.002	0.01	1.27	3	0.3	148	0.15	0.07	0.4	0.492	<0.02	0.1	342	1.2	23.2	59	23.8	
Tijirit	TJH008	0.002	0.02	7.11	10.6	630	0.41	0.04	6.22	0.12	17.75	41.4	132	0.38	77.2	5.96	17.25	0.12	1	0.033	0.21	9.2	11.2	3.55	1115	1.09	1.87	2.8	79.5	300	6.6	0.01	0.012	2.8	<0.002	0.02	0.98	2	0.6	243	0.22	<0.05	2.2	0.307	0.13	0.8	168	1.4	11	67	36.7	
Tijirit	TJH009	0.003	0.02	0.66	<5	180	0.09	<0.01	30.7	0.35	6.52	24.2	11	0.06	50.3	0.73	1.63	<0.05	0.2	0.005	0.06	4.1	2.1	1.51	904	0.25	0.03	0.6	22.2	110	3.4	0.004	<0.005	2.4	<0.002	0.03	0.15	3	<0.2	171.5	<0.05	<0.05	0.5	0.036	0.02	0.5	37	0.4	4.7	9	6	
Tijirit	TJH010	0.001	0.02	0.02	1.1	10	<0.05	<0.01	0.09	<0.02	0.15	0.7	23	<0.05	14.1	0.49	0.08	<0.05	<0.1	<0.005	0.01	<0.5	0.3	0.01	49	3.77	0.01	0.1	3.6	10	1.3	<0.001	<0.005	0.1	<0.002	<0.01	0.09	2	0.3	2.6	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	<1	6.6	0.1	2	1.3	
Tijirit	TJH011	0.001	0.02	8.21	51.6	520	0.41	0.07	4.21	0.27	4.72	36.9	247	<0.05	218	4.03	12.25	0.1	0.3	0.092	0.02	1.9	11.4	2.43	858	1.37	4.13	1.4	156.5	170	4.4	0.007	0.008	<0.1	<0.002	0.02	1.06	2	0.6	193.5	0.12	<0.05	0.2	0.356	<0.02	0.1	199	1.4	10.4	84	6.1	
Tijirit	TJH013	0.002	0.02	0.6	12	100	0.08	0.08	29.1	0.13	3.26	35.3	303	0.06	51.7	1.2	1.67	0.05	0.1	<0.005	0.06	2.2	2.8	3.6	883	0.38	0.03	0.3	191	180	1.7	0.009	0.006	2	<0.002	0.02	0.96	2	<0.2	178.5	<0.05	0.05	0.5	0.017	<0.02	0.5	41	0.8	1.8	27	4.3	
Tijirit	TJH014	0.005	0.02	6.81	2	230	0.16	0.09	6.16	0.08	7.9	56.3	111	0.81	52.4	8.79	14.8	0.17	0.8	0.072	0.22	3.2	21.2	4.84	1615	0.64	1.63	1.6	223	240	4.6	0.018	0.015	4.7	<0.002	0.01	0.79	1	0.7	163.5	0.14	<0.05	0.4	0.458	0.08	0.1	276	1.1	16.7	104	17.7	
Tijirit	TJH015	0.056	0.17	0.09	3.4	20	<0.05	<0.01	0.16	0.47	0.39	3.1	40	<0.05	1360	0.86	0.34	<0.05	<0.1	0.054	0.01	<0.5	1	0.06	83	4.42	0.01	0.1	7.4	10	8	0.001	<0.005	0.3	<0.002	0.01	0.78	2	0.3	3.7	<0.05	<0.05	<0.2	<0.005	<0.02	0.1	5	6.4	0.2	12	1.3	
Tijirit	TJH016	0.006	0.03	6.74	1.5	170	0.46	0.21	5.63	0.08	19.6	38.8	150	0.07	32.9	6.03	15.85	0.14	1	0.036	0.04	9.5	15.2	3.48	1110	1.09	1.26	2.7	79.5	290	6.2	0.012	0.008	0.3	<0.002	0.01	0.9	1	0.7	304	0.24	<0.05	2.7	0.313	0.03	0.8	163	1.5	10.4	97	32	
Tijirit	TJH017	0.004	<0.01	1.6	175	680	0.07	0.06	23.7	0.1	2.12	76	647	<0.05	35.9	3.7	3.8	0.08	0.1	0.008	0.02	1.1	3.5	5.28	2850	0.73	0.02	0.2	519	50	1.7	0.01	0.006	0.4	<0.002	0.02	0.89	2	<0.2	134.5	<0.05	0.06	0.3	0.029	0.03	1.1	202	1.1	1.3	32	4.6	
Tijirit	TJM001	15	3.01	0.1	6.7	10	<0.05	4.06	0.14	0.09	0.21	2.2	31	<0.05	1445	0.89	0.31	<0.05	<0.1	0.068	0.01	<0.5	0.5	0.07	70	4.23	0.01	0.1	12.8	30	1140	<0.001	<0.005	0.2	<0.002	0.01	0.74	6	0.4	4.8	<0.05	1.34	<0.2	0.007	<0.02	0.1	6	7	0.2	4	1.4	
Tijirit	TJM003	0.088	0.04	0.33	26.2	20	<0.05	0.06	1.97	0.18	1.37	6.6	74	<0.05	42.5	0.86	0.94	<0.05	<0.1	<0.005	0.02	0.7	1	0.35	269	2.89	0.01	0.1	45.4	30	18.2	<0.001	<0.005	0.5	<0.002	<0.01	0.42	1	0.2	13.8	<0.05	<0.05	<0.2	0.006	<0.02	0.1	17	3.6	1	18	1.7	
Tijirit	TJM005	0.027	0.21	0.21	6.6	110	<0.05	0.04	0.28	0.08	0.3	5.6	43	<0.05	1445	0.92	0.51	<0.05	<0.1	0.045	0.02	<0.5	1.1	0.06	110	5.33	0.02	0.1	10.8	10	6.6	<0.001	<0.005	0.5	<0.002	0.01	0.17	1	0.4	6.5	<0.05	<0.05	<0.2	0.013	<0.02	0.2	9	7.1	1.1	11	1.4	
Tijirit	TJM007	0.019	0.02	0.09	40.8	70	<0.05	0.16	0.69	<0.02	13.2	3	33	<0.05	18.6	1.24	0.4	<0.05	<0.1	<0.005	0.04	6.1	0.4	0.02	265	4.42	0.01	0.1	9.6	110	5.7	<0.001	<0.005	1.1	<0.002	<0.01	0.99	1	0.3	8.2	<0.05	<0.05	<0.2	<0.005	<0.02	0.3	48	5.7	5	5	2	
Tijirit	TJM008	0.685	0.07	0.25	85	170	<0.05	0.18	0.65	0.03	2.13	3.8	35	0.07	95.1	1.44	0.68	<0.05	<0.1	0.012	0.02	1.4	0.4	0.07	384	4.99	0.03	0.1	10.8	40	13.3	<0.001	<0.005	0.9	<0.002	0.02	1.89	1	0.4	12.8	<0.05	<0.05	0.2	<0.005	<0.02	0.5	63	7.7	0.9	12	1.6	
Tijirit	TJM009	0.002	0.02	0.21	5.1	20	<0.05	0.05	0.28	0.02	0.65	2.5	36	0.07	10.2	0.68	0.63	<0.05	<0.1	<0.005	0.02	<0.5	1	0.15	124	4.07	0.02	0.1	14.2	60	2.7	<0.001	<0.005	0.5	<0.002	<0.01	0.26	1	0.3	4.1	<0.05	<0.05	<0.2	0.006	<0.02	<0.1	8	6.7	0.4	4	1.6	
Tijirit	TJM010	0.002	0.02	0.03	1.6	10	<0.05	<0.01	0.07	<0.02	0.25	0.8	28	<0.05	7.3	0.64	0.17	<0.05	<0.1	<0.005	0.01	<0.5	0.4	0.01	64	3.64	<0.01	0.1	4.7	20	0.8	<0.001	<0.005	0.3	<0.002	<0.01	0.17	2	0.3	1.4	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	2	6.2	0.1	<2	0.9	
Tijirit	TJM011	0.193	0.13	0.2	9.8	10	<0.05	0.02	0.1	0.97	0.61	2.3	69	<0.05	1655	0.96	0.61	<0.05	<0.1	0.062	0.01	<0.5	0.5	0.19	80	4.94	<0.01	0.1	25.8	20	25.9	0.001	<0.005	0.2	<0.002	<0.01	1.03	1	0.4	3	<0.05	<0.05	<0.2	0.007	<0.02	0.4	9	8.1	0.2	18	1.8	
Tijirit	TJM012	0.748	0.11	0.35	23.3	30	<0.05	<0.01	1.2	3.23	0.69	8.6	69	<0.05	1110	1.16	1.07	<0.05	<0.1	0.007	0.01	<0.5	1.1	0.37	313	3.58	0.01	0.1	51.1	10	11.5	0.001	<0.005	0.3	<0.002	<0.01	0.86	1	0.3	7.8	<0.05	<0.05	<0.2	<0.005	<0.02	0.2	20	6.1	0.9	20	1.8	
Tijirit	TJM013	0.004	0.03	0.12	5.2	30	<0.05	<0.01	0.26	0.5	0.21	2.3	35	<0.05	1820	0.81	0.34	<0.05	<0.1	<0.005	0.01	<0.5	0.5	0.09	83	4.84	0.01	0.1	9.8	10	2.4	<0.001	<0.005	0.2	<0.002	<0.01	0.37	1	0.3	2.7	<0.05	<0.05	<0.2	<0.005	<0.02	0.2	6	6.6	0.1	2	1.1	
Tijirit	TJM014	0.139	0.05	0.17	216	90	<0.05	0.26	1.31	0.16	8.81	31.2	29	0.05	39.7	3.87	0.54	0.09	<0.1	<0.005	0.07	4.3	0.4	0.21	837	4.53	0.01	0.1	49.6	200	5.5	<0.001	<0.005	2.2	<0.002	0.04	1.14	2	0.3	12.7	<0.05	0.11	<0.2	<0.005	0.02	0.3	27	7.2	2.4	11	1.2	
Tasiast	TSH201	1.015	0.05	0.18	8.3	420	0.35	<0.01	0.21	<0.02	5.63	1.3	19	<0.05	4.5	21.4	1.11	0.27	0.1	<0.005	0.02	2.1	1.2	0.11	1125	2.63	0.02	0.3	10	30	1.4	<0.001	<0.005	1.1	<0.002	0.01	2.05	2	0.2	15.9	<0.05	<0.05	<0.2	0.005	0.02	0.8	5	5.2	3.5	16	2.3	
Tasiast	TSM102	2.55	0.89	0.22	21.3	480	0.23	0.1	0.21	0.03	3.24	1.7	16	<0.05	25.1	39.2	2.35	0.5	0.1	0.018	0.01	1.6	1.6	0.52	1495	2.71	0.03	0.5	7.4	390	5.8	<0.001	<0.005	0.3	<0.002	0.11	3.07	3	0.2	41.8	<0.05	0.7	0.2	0.015	<0.02	1.2	13	40.1	3.8	41	3.8	
Tasiast	TSM106	1.865	0.1	0.38	7.6	530	1.14	0.06	0.54	0.03	9.98	2.4	6	0.06	18.2	28	0.96	0.34	<0.1	<0.005	0.02	8.9	0.7	0.13	1190	1.29	0.03	0.3	8.5	150	3.9	<0.001	<0.005	0.8	<0.002	0.03	1.46	2	0.3	42.6	<0.05	0.17	<0.2	0.006	0.04	1.3	4	19.7	12.3	16	1.2	
Diaguili	DGH001	<0.001	<0.01	0.99	0.7	50	0.15	0.05	0.01	<0.02	20.6	1.8	296	0.17	5.2	0.43	1.6	0.07	0.9	0.005	0.1	9.9	1.4	0.1	88	2.17	0.02	0.9	13.6	40	1.9	<0.001	<0.005	4.5	<0.002	0.01	0.15	<1	0.7	19.7	0.06	<0.05	2.1	0.028	<0.02	0.3	8	2.2	3.4	6	26.7	
Diaguili	DGH003	<0.001	<0.01	0.91	0.5	80	0.12	0.01	0.03	<0.02	22.1	138	54	0.16	2.9	0.17	1.23	0.07	0.5	<0.005	0.06	11.2	1.4	0.05	63	0.23	0.03	<0.1	4.8	70	2.4	<0.001	<0.005	2.6	0.002	0.01	0.07	<1	<0.2	24.4	<0.05	<0.05	1.7	0.016	0.03	0.2	1	1180	4	4	12.6	
Diaguili	DGH004	<0.001	<0.01	1.11	0.8	90	0.22	0.02	0.04	<0.02	22.6	2.2	293	0.29	4	0.54	3.04	0.07	1.2	0.007	0.31	11.4	1.5	0.13	60	2.4	0.02	1	9.7	80	1.5	0.001	<0.005	12.6	<0.002	0.01	0.16	<1	0.9	17.4	0.08	<0.05	2.5	0.035	0.03	0.4	13	6.1	3.9	7	32.9	
Diaguili	DGH005	<0.001	<0.01	1.05	0.6	50	0.12	0.01	0.03	<0.02	24	114.5	40	0.18	2.5	0.17	1.88	0.07	0.9	0.006	0.12	12.1	1.1	0.08	32	0.2	0.02	0.5	4.5	120	1.6	<0.001	<0.005	5.2	0.008	<0.01	0.07	1	0.3	11.5	<0.05	<0.05	2.6	0.026	0.09	0.4	4	1030	5.4	3	26.9	
Diaguili	DGH006	<0.001	0.04	1.07	7.1	90	9.9	0.08	0.07	0.13	130	25.4	204	0.18	80.2	23.6	2.92	0.44	0.6	0.062	0.08	42	0.9	0.05	134	2.44	0.01	0.5	187.5	4940	4.2	<0.001	<0.005	4.3	<0.002	0.01	0.95	2	0.4	32.4	<0.05	0.07	2.1	0.01	<0.02	17.6	81	7.3	19.9	138	15.4	
Diaguili	DGH007	<0.001	<0.01	1.22	0.8	50	0.17	0.03	0.02	<0.02	26.3	127	277	0.14	4.5	0.32	1.64	0.08	0.7	0.026	0.05	11.1	0.9	0.06	94	0.12	0.02	0.4	7.6	90	2.4	<0.001	<0.005	2.5	0.008	<0.01	0.09	1	0.2	17.4	0.05	<0.05	1.8	0.024	0.1	0.4	6	1160	8.9	8	20	
Diaguili	DGH009	0.008	0.07	0.72	1.1	80	0.12	18.9	0.02	<0.02	5.02	6.5	265	0.27	3.7	7.69	1.94	0.11	0.3	<0.005	0.32	2.3	0.5	0.03	74	2.77	0.02	0.8	11	70	2.1	<0.001	<0.005	11.1	<0.002	<0.01	0.15	1	0.9	14.5	<0.05	0.05	1.2	0.04	0.04	0.3	72	50.4	2.1	6	10	
Diaguili	DGM004	<0.001	<0.01	0.06	1.1	100	<0.05	0.09	0.03	<0.02	0.64	201	84	0.17	9	0.27	0.17	0.05	<0.1	<0.005	0.01	<0.5	0.9	0.02	63	0.26	0.03	<0.1	3.4	<10	3.3	<0.001	<0.005	0.7	<0.002	<0.01	0.52	1	<0.2	10.8	<0.05	<0.05	<0.2	<0.005	0.02	<0.1	<1	1110	0.2	16	0.8	
Guidimaka	DGH013	0.002	<0.01	9.89	6.6	80	0.06	0.03	<0.01	0.02	1.86	204	>10000	<0.05	2	8.6	40.3	0.2	0.1	<0.005	<0.01	0.8	4.1	7.12	>10000	0.35	<0.01	0.5	1025	20	8.7	0.001	0.083	0.9	<0.002	<0.01	0.66	10	<0.2	5.2	<0.05	<0.05	<0.2	0.094	0.02	<0.1	518	86.6	0.7	1760	4.4	33.7
Guidimaka	DGH014	<0.001	<0.01	10.1	3.8	20	0.74	0.05	0.02	<0.02	150	79.2	863	<0.05	2.4	11.15	24.8	0.23	6.8	0.083	0.02	13.5	160	7.53	2710	2.22	0.02	20.1	897	260	4.7	0.002	0.007	0.6	<0.002	<0.01	0.21	2	2.7	3.3	1.77	<0.05	19.6	0.56	<0.02	2.5	155	4.9	18.8	92	192	

2.5 Chemical Assay2

	Sample	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
		ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Guidimaka	DGH015	<0.001	<0.01	5.84	1	10	0.22	0.01	0.08	<0.02	218	52.9	192	<0.05	<0.2
Guidimaka	DGH016	<0.001	0.02	7.61	9.8	40	0.19	0.01	<0.01	<0.02	6.75	120.5	>10000	0.26	1.9
Guidimaka	DGH017	<0.001	0.03	8.49	10.4	160	0.1	0.06	<0.01	0.04	5.33	147	>10000	0.15	2.1
Guidimaka	DGH018	<0.001	<0.01	0.2	0.5	20	<0.05	<0.01	<0.01	<0.02	0.66	152	2100	<0.05	4.8
Guidimaka	DGH019	<0.001	0.02	0.23	1.3	40	0.1	0.01	0.01	<0.02	1.43	41.7	1065	0.19	17.9
Guidimaka	DGH020	<0.001	0.02	8.74	11	30	0.39	<0.01	<0.01	<0.02	2.59	135.5	>10000	0.05	5.4
Guidimaka	DGH021	0.002	0.13	0.44	6.2	10	<0.05	<0.01	2.31	0.02	0.19	88.2	2130	0.05	12.4
Guidimaka	DGH022	<0.001	<0.01	0.33	2.8	20	0.09	<0.01	0.03	0.02	1.09	67.7	2820	<0.05	17.8
Guidimaka	DGH024	<0.001	0.06	0.37	6.2	20	<0.05	<0.01	1.2	<0.02	1.33	76	1380	<0.05	2.6
Guidimaka	DGH025	<0.001	<0.01	8.56	8	40	0.05	<0.01	<0.01	0.03	1.22	163	>10000	<0.05	2.6
Guidimaka	DGM006	0.001	<0.01	0.1	0.9	20	0.09	<0.01	<0.01	<0.02	2.94	27.1	2280	<0.05	17.4
Guidimaka	DGM011	<0.001	0.08	0.5	2.7	<10	0.36	0.02	0.01	0.02	1.92	162	2840	0.05	8.9
Guidimaka	DGM012	<0.001	0.02	7.88	9.9	20	0.07	0.01	<0.01	0.02	3.08	177	>10000	0.07	3.9
Guidimaka	DGM013	<0.001	0.02	1.14	16.2	70	0.46	<0.01	0.03	0.03	11.6	155	7670	0.17	5.1
Guidimaka	DGM014	<0.001	0.03	9.44	12.1	90	0.11	0.03	<0.01	0.04	3.04	163	>10000	0.08	16
Guidimaka	DGM015	0.001	0.05	5.66	0.7	90	0.06	<0.01	0.01	<0.02	1.25	31.1	846	0.06	4
Guidimaka	DGM017	<0.001	<0.01	0.59	0.9	50	0.21	<0.01	0.02	<0.02	3.82	67.3	2180	<0.05	16.4
Guidimaka	DGM018	<0.001	0.05	9.36	0.6	10	0.07	<0.01	0.28	<0.02	7.52	54.3	294	<0.05	0.8
Guidimaka	DGM019	<0.001	0.1	0.5	2.3	20	0.52	<0.01	0.08	0.05	2.66	47	2030	0.09	10
Guidimaka	DGM101	0.008	<0.01	10.05	1.4	40	0.64	0.01	<0.01	0.04	4.42	116.5	######	<0.05	2.6
Guidimaka	DGM102	0.003	<0.01	10.85	4.3	60	0.07	0.01	<0.01	0.02	1.64	151.5	50,000	0.05	6.1
Guidimaka	DGM103	0.007	<0.01	10.7	5.4	120	0.05	0.01	<0.01	0.02	1.81	133	13,000	<0.05	3.5
Guidimaka	DGM104	0.003	<0.01	10.5	4.8	40	0.11	0.01	<0.01	<0.02	2.38	152	16,000	<0.05	2.7
Guidimaka	DGM105	<0.001	<0.01	11	5.8	40	0.08	0.01	<0.01	0.02	1.52	191	27,000	0.05	2.3
Guidimaka	DGM106	0.005	0.02	10.4	8.8	100	0.08	0.12	<0.01	0.04	3.83	143	19,000	0.06	2.3
Guidimaka	DGM107	0.003	<0.01	11.7	5.2	40	<0.05	0.01	<0.01	0.02	1.14	168.5	12,000	<0.05	2.5
Guidimaka	DGM108	0.002	<0.01	11.85	7.1	70	0.08	0.04	<0.01	0.02	2.25	143.5	22,000	0.05	2.5
Guidimaka	DGM110	0.004	<0.01	8.01	6.5	100	0.43	0.05	<0.01	0.02	5.78	120.5	6,000	0.15	2.1
Guidimaka	DGM111	0.002	<0.01	9.73	8.8	30	0.08	0.01	<0.01	0.03	1.94	154.5	22,000	<0.05	1.7
Guidimaka	DGM112	<0.001	<0.01	11.55	5.4	20	0.08	0.01	<0.01	0.03	1.27	127.5	18,000	<0.05	2.5
Guidimaka	DGM113	<0.001	<0.01	11.25	8	30	0.08	0.02	<0.01	<0.02	2.79	136.5	24,000	<0.05	2.9
Guidimaka	DGM114	0.002	<0.01	10.85	8.1	70	0.09	0.02	<0.01	0.05	2.47	131.5	8,000	<0.05	1.9
Guidimaka	DGM115	0.005	0.02	11.45	8.1	80	0.09	0.02	<0.01	0.04	2.38	152	16,000	<0.05	2.3
Guidimaka	DGM116	<0.001	<0.01	11.3	5.6	40	0.13	0.01	<0.01	0.03	2.37	140	14,000	<0.05	3.7
Guidimaka	DGM117	0.007	0.02	11.3	5.4	50	0.07	0.06	<0.01	<0.02	1.13	146	14,000	<0.05	2.6
Guidimaka	DGM119	<0.001	<0.01	11.3	8.4	130	0.12	0.01	<0.01	0.05	4.35	151	16,000	<0.05	2.6
Guidimaka	DGM120	<0.001	<0.01	11.95	6.7	90	0.07	0.01	<0.01	0.03	2.69	151	23,000	0.06	3.1
Guidimaka	DGM121	<0.001	0.02	12.1	8.4	80	0.08	0.03	<0.01	0.04	4.78	141	20,000	0.07	2.9
Guidimaka	DGM123	0.003	<0.01	9.96	8.2	20	0.05	0.01	<0.01	<0.02	1.38	118	13,000	<0.05	1.8
Guidimaka	DGM124	<0.001	0.02	11.95	8	120	0.14	0.01	<0.01	0.04	2.57	138.5	13,000	<0.05	66.7
Guidimaka	DGM125	<0.001	<0.01	12.25	6.9	40	0.07	0.02	<0.01	0.03	1.12	136	11,000	0.08	1.9
Guidimaka	DGM126	<0.001	<0.01	8.56	5.7	50	0.07	0.02	<0.01	0.02	2.06	110.5	10,000	0.07	2.7
Guidimaka	DGM127	0.002	<0.01	8.29	7.2	140	0.08	0.02	<0.01	0.03	2.9	115	10,000	0.08	3
Guidimaka	DGM129	0.001	0.02	9.33	4.3	60	1.82	0.02	<0.01	0.02	4	120	16,000	0.22	3.3
Guidimaka	DGM130	<0.001	<0.01	12.6	3.4	40	<0.05	0.01	<0.01	0.12	0.93	117	10,000	<0.05	2.5
Guidimaka	DGM131	0.001	<0.01	11.85	4.8	100	0.08	0.02	<0.01	0.04	1.72	135.5	73,000	<0.05	5.3
Guidimaka	DGM132	<0.001	<0.01	13.05	4.6	140	0.05	0.02	<0.01	0.03	1.88	151	20,000	<0.05	2.3
Guidimaka	DGM133	<0.001	<0.01	10.7	5.5	50	0.06	0.01	<0.01	<0.02	1.96	127	27,000	<0.05	3.6
Guidimaka	DGM134	<0.001	<0.01	12.55	6.7	30	<0.05	0.01	<0.01	<0.02	0.81	153.5	11,000	<0.05	4.7
Guidimaka	DGB101	0.002	<0.01	10.75	4.5	40	0.25	0.01	<0.01	0.04	6.68	145	######	<0.05	5.9
Guidimaka	DGT002	<0.001	<0.01	9.71	5.5	20	0.17	0.01	<0.01	0.02	3.25	141.5	######	<0.05	3.6
Guidimaka	DGT003	<0.001	<0.01	9.87	3.4	40	0.25	0.01	<0.01	0.03	7.68	134	######	<0.05	3.6
Guidimaka	DGT004	0.005	0.03	0.55	0.9	30	0.06	<0.01	0.06	0.02	1.56	90.2	3590	<0.05	23.7
Guidimaka	DGT005	0.002	0.04	0.3	0.4	10	<0.05	0.01	0.02	0.26	1.04	95.9	3530	<0.05	58.9
Guidimaka	DGT006	<0.001	<0.01	10.15	0.7	20	0.05	<0.01	0.21	0.06	4.73	87.2	240	<0.05	28.2
Guidimaka	DGT007	<0.001	0.02	6.85	1	10	<0.05	<0.01	0.41	<0.02	3.66	91.7	204	<0.05	12.6
Guidimaka	DGT008	<0.001	<0.01	10.65	6.9	120	0.11	0.01	<0.01	0.03	4.34	152	18,000	<0.05	2.3
Guidimaka	DGT009	0.001	<0.01	12.5	6.2	70	<0.05	0.01	<0.01	0.03	1.53	163.5	12,000	<0.05	3.7
Guidimaka	DGT010	<0.001	<0.01	12.3	7.3	50	0.07	0.01	<0.01	0.04	1.42	161	49,000	<0.05	3.9
Guidimaka	DGT011	0.001	<0.01	10.75	6.3	110	<0.05	0.21	<0.01	0.03	1.88	136	11,000	0.05	1.9
Guidimaka	DGT012	<0.001	<0.01	12.75	7.3	90	0.12	0.02	<0.01	0.04	2.34	149	19,000	0.05	4
Guidimaka	DGT014	0.007	<0.01	13.7	9.5	120	0.17	0.02	<0.01	0.04	3.08	152	25,000	0.05	3.5
Guidimaka	DGT015	0.006	0.02	12.5	7.3	150	0.18	0.01	<0.01	0.04	3.15	153.5	24,000	<0.05	7
Guidimaka	DGT016	0.004	0.02	12	8.8	100	0.17	0.01	<0.01	0.03	4.52	133	8,000	0.05	6.3
Guidimaka	DGT017	<0.001	<0.01	12.05	5.4	70	<0.05	0.04	<0.01	0.03	1.19	138	13,000	<0.05	2.9
Guidimaka	DGT018	0.009	<0.01	11.55	4.9	160	0.06	<0.01	0.02	0.02	1.96	141.5	15,000	<0.05	4.1
Guidimaka	DGT020	0.003	<0.01	11.5	7.3	140	0.06	0.01	<0.01	0.02	2.03	141	12,000	<0.05	2.2
Guidimaka	DGT021	<0.001	<0.01	9.23	6	150	0.07	0.01	<0.01	0.02	3	144.5	11,000	0.06	6.5
Guidimaka	DGT023	<0.001	<0.01	11.15	8.2	130	0.06	0.02	<0.01	0.02	2.47	134	14,000	<0.05	2
Guidimaka	DGT024	0.009	<0.01	9.94	9.6	90	<0.05	0.02	<0.01	0.02	3.11	149.5	71,000	0.05	2.3
Guidimaka	DGT025	0.001	<0.01	11	12.4	170	0.07	0.02	<0.01	0.03	3.35	141	14,000	0.05	2.3
Guidimaka	DGT026	0.027	<0.01	10.65	7.2	180	0.05	<0.01	<0.01	0.02	1.76	168	17,000	0.07	2.5
Guidimaka	DGT027	0.007	<0.01	8.82	9.9	80	0.08	0.01	<0.01	0.03	4.86	121.5	9,000	0.14	2.3
Guidimaka	DGT028	0.009	<0.01	11	10.2	160	<0.05	0.01	<0.01	0.05	2.82	144.5	10,000	0.05	2.2
Guidimaka	DGT031	0.003	0.02	8.33	12.4	40	0.1	0.01	<0.01	0.04	4.02	135.5	10,000	0.14	3.8
Guidimaka	DGT033	<0.001	<0.01	8.6	5	60	0.21	0.01	<0.01	0.02	5.58	115.5	6,000	0.23	1.9
Guidimaka	DGT034	0.003	<0.01	9.54	7.6	40	0.09	0.01	<0.01	0.03	2.61	131.5	77,000	0.09	2.4
Guidimaka	DGT035	0.001	<0.01	12.05	7.6	80	0.23	0.02	<0.01	0.04	1.85	133.5	35,000	<0.05	4
Guidimaka	DGT036	0.005	<0.01	11.95	4.9	30	<0.05	0.01	<0.01	0.06	0.97	135	16,000	<0.05	3.4
Guidimaka	DGT037	0.001	<0.01	11.65	5.7	80	0.07	0.01	<0.01	0.02	2.66	128.5	50,000	<0.05	3.4
Guidimaka	DGT038	<0.001	<0.01	11.1	5.4	100	0.07	0.02	<0.01	0.02	1.75	118	9,000	<0.05	6.8
Guidimaka	DGT039	<0.001	<0.01	12.05	3.8	40	<0.05	0.01	<0.01	0.06	1.45	136	22,000	<0.05	2.2
Guidimaka	DGT040	0.003	<0.01	10.1	5.9	120	0.07	0.01	<0.01	0.02	3.56	129	7,000	0.05	10.8
Indice	IDH040	0.008	<0.01	8.61	48	60	2.6	0.04	7.71	0.13	297	66.6	598	<0.05	0.7
Indice	IDH041	0.001	0.05	8.3	5.8	640	2.45	0.14	0.53	0.04	75.4	14.1	47	5.58	38.5
Indice	IDH042	<0.001	<0.01	6.43	1.4	910	1.8	0.02	0.12	0.02	85.7	1.4	10	3.52	5.9
Indice	IDH043	0.015	0.08	7.84	8.4	390	1.03	0.34	3.62	0.09	125.5	26.6	144	1.34	1845
Indice	IDH044	0.022	0.35	7.52	7.9	70	0.44	0.31	6.63	0.15	116.5	17.1	115	0.12	2640
Indice	IDH045	0.077	0.58	3.66	2.9	490	0.6	0.49	6.7	0.08	98.7	9.6	36	1.59	1640
Indice	IDH047	0.001	<0.01	8.21	87.4	300	1.69	0.03	5.64	0.11	156.5	36.8	294	0.36	13.4
Indice	IDH049	0.001	0.02	6.25	49.3	130	1.16	0.12	8.12	0.21	125	22.2	239	0.09	5.6
Indice	IDH050	0.001	<0.01	8.78	12	150	1.08	0.08	11.4	0.16	104	5.3	114	0.27	28.5
Indice	IDH051	0.009	0.26	7.27	5.5	110	0.34	0.11	9.82	0.23	79.3	6	105	0.18	588
Indice	IDH052	0.001	0.07	7.14	10.6	110	0.8	0.08	8.58	0.16	99	5.4	91	0.2	52.9
Indice	IDH053	<0.001	0.17	6.82	6.6	1700	2.76	0.18	1.91	0.06	77.7	23	59	4.7	244
Indice	IDH054	<0.001	0.11	8.26	21	280	1.13	0.07	10.75	0.14	138.5	8.8	118	0.62	169
Indice	IDH055	<0.001	0.08	0.07	1.2	30	<0.05	<0.01	0.08	0.03	1.24	0.7	39	0.05	13.4
Indice	IDH056	<0.001	<0.01	7.36	3.7	820	2.7	0.09	0.25	0.02	90	3.4	8	7.79	1.1
Indice	IDH057	0.009	0.37	0.09	3	60	0.05	0.51	0.12	0.02	5.28	1.4	44	0.2	379
Indice	IDH059	0.032	0.67	8.07	5	3850	5.07	0.41	0.6	0.03	169.5	14.4	53	8.41	5830
Indice	IDH060	0.001	<0.01	9.31	65.7	2500	2.84	0.14	1.6	0.08	190.5	25.2	8	4	18.9
Indice	IDH061	0.007	<0.01	7.78	2.8	2190	3.5	0.06	0.51	<0.02	73.9	15.1	92	10.8	32.1
Indice	IDH062	0.001	0.06	8.14	8.2	70	0.92	0.07	9.87	0.21	98.1	11.1	118	0.13	120.5
Indice	IDH063	7.53	0.91	5.68	13	1720	3.04	0.11	2.63	0.05	106.5	11.8	250	5.35	20500
Indice	IDM001	19.35	210	0.21	2.3	80	0.09	91.5	0.05	0.02	2.85	2	9	0.19	97100
Indice	IDM002	0.043	0.58	0.39	1.3	50	0.05	0.57	0.12	<0.02	2.11	3.5	38	0.06	448
Indice	IDM003	0.004	0.06	0.16	1.4	2300	<0.05	0.03	0.24	0.02	2.46	1.1	47	0.1	32.9
Indice	IDM004	0.004	0.11	0.13	1.3	40	<0.05	0.08	0.25	<0.02	1.8	1.1	47	0.06	84.4

	Sample	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Pd	Pt	Rb	Re	S	Sb	Se	Sn
		%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Guidimaka	DGH015	8.26	23	0.35	6.1	0.057	<0.01	121.5	179.5	10.75	2320	0.18	<0.01	19.4	286	400	1.1	0.001	<0.005	<0.1	<0.002	<0.01	0.1	2	2.6
Guidimaka	DGH016	9.53	20.6	0.27	0.1	0.011	<0.01	3.5	15	9.62	>10000	0.29	0.01	0.4	1205	<10	16.3	0.002	0.104	0.6	<0.002	<0.01	5.13	7	0.2
Guidimaka	DGH017	9.73	29.7	0.27	<0.1	<0.005	<0.01	3.3	16.4	6.47	>10000	0.31	0.01	0.3	1535	10	33.4	<0.001	0.1	1.4	<0.002	<0.01	12.8	16	<0.2
Guidimaka	DGH018	0.63	0.67	0.06	<0.1	<0.005	<0.01	0.5	1.2	0.11	354	0.24	0.01	<0.1	62.3	<10	1.4	<0.001	<0.005	0.5	0.003	<0.01	0.15	1	<0.2
Guidimaka	DGH019	2.47	1	0.09	<0.1	<0.005	0.01	0.5	2.9	5.03	405	0.78	<0.01	0.2	686	10	1.6	0.001	<0.005	0.6	<0.002	<0.01	0.34	1	0.2
Guidimaka	DGH020	7.59	36.7	0.2	0.1	0.009	<0.01	1.3	26.5	7.16	>10000	0.5	<0.01	0.5	1170	20	35.5	0.001	0.099	1	<0.002	<0.01	8.4	12	0.3
Guidimaka	DGH021	4.65	0.95	0.16	<0.1	0.005	<0.01	<0.5	1.3	>15.0	838	0.29	<0.01	0.1	2230	20	1.9	0.002	0.012	<0.1	<0.002	0.01	0.47	1	<0.2
Guidimaka	DGH022	2.29	0.87	0.07	<0.1	0.005	0.01	0.7	1.8	0.72	320	1.03	<0.01	0.4	352	10	2.1	0.003	0.008	0.5	<0.002	0.02	0.12	1	0.2
Guidimaka	DGH024	5.84	1.16	0.18	<0.1	0.006	<0.01	0.7	1.8	>15.0	707	0.28	<0.01	0.1	1975	10	1.1	0.003	<0.005	<0.1	<0.002	<0.01	0.53	1	<0.2
Guidimaka	DGH025	9.45	37.2	0.21	<0.1	0.01	<0.01	0.6	13.4	7.34	>10000	0.48	<0.01	0.4	941	30	12.5	<0.001	0.082	0.5	<0.002	<0.01	2.13	7	0.2
Guidimaka	DGM006	7.77	0.7	0.13	<0.1	<0.005	0.01	1.5	1.2	0.04	102	3.15	<0.01	0.5	353	80	1	0.003	0.009	0.3	<0.002	<0.01	0.08	1	0.3
Guidimaka	DGM011	7.98	1.42	0.47	<0.1	0.019	<0.01	0.7	4.1	>15.0	805	0.52	0.01	0.2	3990	10	0.7	0.003	0.013	<0.1	<0.002	<0.01	0.4	1	<0.2
Guidimaka	DGM012	9.27	29.6	0.23	<0.1	0.006	<0.01	1.2	18.2	7.6	>10000	0.39	0.01	0.4	935	10	23.8	0.002	0.075	0.7	<0.002	<0.01	3.62	7	<0.2
Guidimaka	DGM013	7.31	3.36	0.18	0.2	0.034	0.04	4.9	11.4	3.75	869	0.75	<0.01	0.5	2060	50	2.7	0.005	0.025	8	<0.002	<0.01	0.24	2	<0.2
Guidimaka	DGM014	8.28	37.1	0.24	0.1	0.005	0.01	1.3	8	7.18	>10000	1.19	<0.01	0.6	1220	20	122	0.002	0.083	1.6	<0.002	<0.01	6.04	14	<0.2
Guidimaka	DGM015	4.42	10.95	0.14	0.1	0.039	0.07	0.8	90	13.5	3080	0.17	<0.01	1	707	<10	1.9	<0.001	0.006	1.1	<0.002	<0.01	0.11	1	0.2
Guidimaka	DGM017	5.31	1.76	0.11	0.1	0.007	0.01	9.5	1.9	0.12	543	0.45	<0.01	0.4	85.6	130	1.8	0.007	0.016	0.7	0.004	<0.01	0.12	1	0.2
Guidimaka	DGM018	8.38	17.95	0.22	0.3	0.063	<0.01	4.2	51.6	>15.0	3000	0.1	<0.01	2.8	284	430	4.2	<0.001	0.006	0.1	<0.002	<0.01	0.08	2	0.7
Guidimaka	DGM019	6.17	1.52	0.32	<0.1	0.018	0.01	1.1	5	>15.0	722	0.45	<0.01	0.1	3830	50	8.4	0.001	0.005	0.4	<0.002	0.01	0.38	1	<0.2
Guidimaka	DGM101	8.04	30.4	0.1	0.6	0.019	<0.01	2.6	4.9	9.07	5000	0.8	<0.01	1.5	1220	10	2.6	<0.001	<0.005	0.5	<0.002	0.01	0.22	2	0.5
Guidimaka	DGM102	8.29	30.4	0.11	0.1	0.008	<0.01	1.2	22.4	8.73	12950	0.92	0.01	0.5	1135	50	8.4	0.001	0.01	0.6	<0.002	0.01	1.56	3	0.2
Guidimaka	DGM103	8.07	32.4	0.1	<0.1	0.007	<0.01	0.8	4.3	7.86	9270	1.08	0.01	0.4	1225	80	8.5	0.001	0.006	0.6	<0.002	0.01	1.03	4	0.2
Guidimaka	DGM104	8.73	32.8	0.11	<0.1	0.01	<0.01	1.3	6.8	8.77	12400	0.75	0.01	0.4	1050	110	8.6	0.002	0.005	0.7	<0.002	0.01	1.71	5	0.3
Guidimaka	DGM105	9.76	33.8	0.12	0.1	0.008	<0.01	0.9	9.4	8.07	13050	0.72	0.01	0.5	1065	60	8.5	0.004	<0.005	1	<0.002	0.01	0.87	7	0.2
Guidimaka	DGM106	9.32	29.4	0.13	<0.1	0.009	<0.01	1.2	7.6	8.41	13500	0.75	0.01	0.4	1425	160	28.1	<0.001	<0.005	1.1	0.002	0.01	6.76	7	0.2
Guidimaka	DGM107	9.79	39	0.12	<0.1	<0.005	<0.01	0.6	3.4	7.91	10200	0.77	0.01	0.4	1080	30	4.1	0.003	<0.005	0.9	<0.002	0.01	0.47	8	0.2
Guidimaka	DGM108	9.37	36.8	0.11	<0.1	0.005	<0.01	1.1	7.7	7.66	13050	1.31	0.01	0.5	1420	110	20.8	0.005	0.027	1.2	<0.002	0.02	4.26	10	0.2
Guidimaka	DGM110	11.7	18.2	0.14	<0.1	0.016	<0.01	2.8	30.1	9.01	15050	0.45	0.01	0.3	1330	20	13.8	<0.001	<0.005	0.8	<0.002	0.01	4.52	6	0.2
Guidimaka	DGM111	9.94	34.1	0.12	0.1	0.006	<0.01	1	17.4	7.19	15950	0.63	<0.01	0.4	1205	70	25.2	0.005	<0.005	1.2	<0.002	0.01	3.29	11	0.2
Guidimaka	DGM112	8.44	34.5	0.11	<0.1	0.01	<0.01	0.6	5	8.97	10250	0.81	<0.01	0.4	1320	30	10.2	0.001	<0.005	0.9	<0.002	0.01	0.86	7	0.2
Guidimaka	DGM113	9.42	37.2	0.13	0.1	0.01	<0.01	1	10.4	7.85	12150	0.69	<0.01	0.5	1340	40	7.2	<0.001	<0.005	1.2	<0.002	0.01	1.34	11	0.3
Guidimaka	DGM114	8.74	32.8	0.13	<0.1	0.009	<0.01	1.5	10.2	8.14	13550	0.58	0.01	0.4	1435	40	10.8	0.001	<0.005	1.1	<0.002	0.01	1.7	10	<0.2
Guidimaka	DGM115	9.85	39.4	0.12	<0.1	0.007	<0.01	1.1	14.6	6.92	13500	0.76	<0.01	0.4	1420	30	24.6	0.005	<0.005	1.4	<0.002	0.01	3.05	14	0.2
Guidimaka	DGM116	8.81	33.6	0.11	<0.1	0.01	<0.01	0.9	6.2	9.11	12100	0.69	0.01	0.4	1305	10	12.8	<0.001	<0.005	0.9	<0.002	0.01	2.09	8	0.2
Guidimaka	DGM117	8.88	34.2	0.11	<0.1	0.007	<0.01	0.6	4.6	8.52	10100	1.48	0.01	0.4	1315	40	19.6	<0.001	<0.005	1	<0.002	0.01	0.61	9	0.2
Guidimaka	DGM119	9.55	33.7	0.1	<0.1	0.006	<0.01	1.4	16.2	6.96	11700	0.7	<0.01	0.4	1575	40	19.4	<0.001	<0.005	1.3	<0.002	0.01	3.4	11	<0.2
Guidimaka	DGM120	8.99	38.5	0.11	0.1	0.008	<0.01	1	4.9	7.1	10050	1.08	0.01	0.5	1445	20	7.7	<0.001	0.014	1.5	<0.002	0.01	1.13	12	0.2
Guidimaka	DGM121	10.25	35.1	0.14	<0.1	0.005	<0.01	1.9	10	7.12	17150	0.7	0.01	0.5	1640	80	49.4	<0.001	0.011	1.5	<0.002	0.02	7.53	13	0.2
Guidimaka	DGM123	8.19	34.4	0.1	<0.1	0.011	<0.01	0.6	71.7	6.95	10650	0.72	<0.01	0.4	1300	<10	22.5	<0.001	<0.005	1.4	<0.002	0.01	9.87	12	0.2
Guidimaka	DGM124	9.81	34.4	0.13	<0.1	0.01	<0.01	1.5	12.2	7.39	12050	0.64	0.01	0.4	1635	30	22.6	0.002	0.011	1.4	<0.002	0.01	4.1	12	<0.2
Guidimaka	DGM125	9.69	40.1	0.13	<0.1	0.01	<0.01	0.6	13.4	6.64	11150	1.12	0.01	0.5	1210	30	17.8	<0.001	0.005	1.5	<0.002	0.02	2.65	14	0.2
Guidimaka	DGM126	10.3	21.1	0.12	<0.1	0.005	<0.01	1.5	5.8	8.89	15100	0.5	0.01	0.4	1275	20	10.8	0.01	<0.005	0.8	<0.002	0.01	7.03	7	<0.2
Guidimaka	DGM127	9.84	23.4	0.12	<0.1	0.007	<0.01	1.9	8.5	7.65	15150	0.5	0.01	0.4	1245	20	18.8	<0.001	0.006	1.2	<0.002	0.01	8.52	11	<0.2
Guidimaka	DGM129	10.1	27.2	0.15	<0.1	0.016	<0.01	2	60.6	9.03	15600	0.43	0.01	0.4	1535	20	17.4	<0.001	<0.005	0.8	<0.002	0.01	3.33	5	0.2
Guidimaka	DGM130	7.65	39	0.1	<0.1	0.005	<0.01	0.5	4.4	6.74	5170	0.96	<0.01	0.4	1370	210	22	<0.001	<0.005	1	<0.002	0.01	0.39	9	0.2
Guidimaka	DGM131	9.02	38.7	0.14	0.2	0.01	<0.01	1.1	5.8	8.39	9860	0.68	0.01	0.5	1225	90	16.4	<0.001	<0.005	0.7	<0.002	0.02	1.16	5	0.2
Guidimaka	DGM132	8.64	45.5	0.18	<0.1	0.01	<0.01	1	7.2	7.47	7330	0.86	<0.01	0.5	1570	180	29.6	<0.001	<0.005	1	<0.002	0.02	0.75	8	0.2
Guidimaka	DGM133	8.73	30.2	0.14	0.1	<0.005	<0.01	1	4.1	6.8	9980	0.58	<0.01	0.4	1065	50	9.7	<0.001	<0.005	1.1	<0.002	0.01	2.28	10	0.2
Guidimaka	DGM134	9.32	38.8	0.15	<0.1	0.005	<0.01	0.5	7.4	7.13	9590	0.54	0.01	0.4	1095	40	6.7	0.002	<0.005	1.3	<0.002	0.01	1.04	13	<0.2
Guidimaka	DGB101	10.05	34.7	0.15	0.7	0.036	<0.01	3.2	4.9	9.46	6850	0.58	<0.01	1.2	1185	<10	4.1	<0.001	<0.005	0.9	<0.002	0.01	0.23	8	0.5
Guidimaka	DGT002	9.85	34.5	0.14	0.3	0.018	<0.01	1.7	4	8.77	5970	0.58	<0.01	0.7	1180	40	2.3	0.001	0.007	1.1	0.002	0.01	0.2	11	0.4
Guidimaka	DGT003	10.5	33.4	0.14	0.6	0.021	<0.01	5.8	13	8.73	6580	0.42	<0.01	1	1160	80	4.6	<0.001	<0.005	1	<0.002	0.01	0.27	10	0.5
Guidimaka	DGT004	5.54	1.3	0.12	<0.1	0.008	0.01	0.7	0.8	21.6	1565	0.34	<0.01	0.2	1705	130	2.5	<0.001	<0.005	0.3	<0.002	<0.01	0.09	1	0.2
Guidimaka	DGT005	7.87	2.94	0.11	<0.1	<0.005	<0.01	<0.5	0.4	21	1250	0.42	<0.01	0.1	2050	50	20.3	<0.001	0.029	0.3	<0.002	<0.01	0.16	1	0.3
Guidimaka	DGT006	14.8	24.5	0.22	0.8	0.102	0.01	1.2	39	11.3	15350	0.39	<0.01	3.8	1620	60	2.9	0.001	<0.005	0.3	<0.002	<0.01	0.05	1	2.2
Guidimaka	DGT007	15.9	18.15	0.23	1	0.086	<0.01	1.8	2.8	12.4	18350	0.14	<0.01	5.1	376	340	1.2	0.001	<0.005	0.2	0.003	<0.01	0.1	1	0.3
Guidimaka	DGT008	9.25	32.8	0.14	<0.1	0.009	<0.01	1.5	11	9.03	13300	0.55	<0.01	0.4	1480	190	27.4	<0.001	<0.005	0.5	<0.002	0.02	4.13	3	<0.2
Guidimaka	DGT009	9.09	38.7	0.16	<0.1	0.01	<0.01	0.8	11.2	8.49	11700	0.66	<0.01	0.4	1590	150	9.9	<0.001	0.025	0.8	<0.002	0.01	1.68	7	<0.2
Guidimaka	DGT010	9.56	38.9	0.18	0.1	0.007	<0.01	0.8	12.6	7.75	12400	0.71	<0.01	0.5	1500	380	16.2	<0.001	<0.005	1	<0.002	0.01	1.5	9	0.2
Guidimaka	DGT011	9.07	31.8	0.16	<0.1	0.007	<0.01	1.3	4.5	8.67	12000	0.89	<0.01	0.4	1620	90	6.8	<0.001	<0.005	0.9	<0.002	0.01	4.29	8	<0.2
Guidimaka	DGT012	9.02	39.9	0.16	<0.1	0.013	<0.01	1.1	6.3	7.85	11400	0.85	<0.01	0.5	1590	80	13.8	<0.001	<0.005	1.3	<0.002	0.01	1.14	10	<0.2
Guidimaka	DGT014	8.94	41.1	0.17	<0.1	0.011	<0.01	1.4	8.8	8.04	11250	0.69	<0.01	0.5	1820	90	16	<0.001	0.02	1.6	0.002	0.01	1.91	10	<0.2
Guidimaka	DGT015	9.03	39.5	0.15	<0.1	0.011	<0.01	1	16.3	7.91	12300	0.76	<0.01	0.5	1615	90	11.2	<0.001	0.018	1.2	<0.002	0.01	0.91	11	<0.2
Guidimaka	DGT016	10	32.2	0.16	<0.1	0.009	<0.01	1.9	20.7	8.92	16300	0.44	0.01	0.3	1725	50	42.7	<0.001	<0.005	1	<0.002	0.01	3.39	9	<0.2
Guidimaka	DGT017	8.52	37.2	0.14	<0.1	0.008	<0.01	0.5	2.7	7.81	7670	1.22	<0.01	0.4	1305	40	17.8	0.001	<0.005	0.9	<0.002	0.01	2.1	9	<0.2
Guidimaka	DGT018	9.05	34.9	0.14	<0.1	0.007	<0.01	0.9	4	8.81	10800	0.49	<0.01	0.4	1410	130	29.4	<0.001	<0.005	0.8	<0.002	0.02	1.73	6	0.2
Guidimaka	DGT020	9.18	35.8	0.16	<0.1	0.008	0.01	1.3	7.3	8.59	14250	0.49	<0.01	0.4	1530	120	9.1	0.001	0.024	0.9	<0.002	0.03	4.09	7	<0.2
Guidimaka	DGT021	8.8	26.6	0.17	<0.1	0.008	<0.01	1.1	14.6	10.25	15000	0.44	0.01	0.3	1425	110	35.9	<0.001	<0.005	0.5	<0.002	0.01	4.34	3	<0.2
Guidimaka	DGT023	9.43	29.9	0.15	<0.1	0.012	<0.01	1.5	11.5	9.05	15950	0.51	<0.01	0.4	1565	50	17.6	<0.001	<0.005	0.8	<0.002	0.01	4.88	7	<0.2
Guidimaka	DGT024	9.88	30.6	0.15	0.2	0.013	<0.01	1.8	11.4	8.96	18350	0.42	0.01	0.4	1440	20	28.9	0.001	<0.005	0.9	<0.002	0.01	2.51	9	<0.2
Guidimaka	DGT025	10.05	28.7	0.17	<0.1	0.009	<0.01	2	15.4	9.53	16500	0.53	<0.01	0.4	1615	90	22.5	0.04	0.032	0.9	<0.002	0.02	7.8	8	<0.2
Guidimaka	DGT026	9.94	34.4	0.15	<0.1	0.006	<0.01	1.2	9.9	7.88	14600	0.95	0.01	0.5	1310	40	14.6	0.015	0.012	1.1	<0.002	0.01	4.06	9	0.2
Guidimaka	DGT027	11.25	22	0.2	<0.1	0.011	<0.01	2.7	13.8	9.4	19150	0.37	0.01	0.4	1420	40	16.1	0.005	<0.005	0.8	<0.002	0.01	6.55	7	<0.2
Guidimaka	DGT028	10.2	30.8	0.17	<0.1	0.008	<0.01	1.7	7.5	8.03	16500	0.64	0.01	0.4	1415	20	25.2	0.002	<0.005	1.1	0.002	0.01	7	10	<0.2
Guidimaka	DGT031	12	21.2	0.14	<0.1	0.012	<0.01	2.3	5.1	8.29	17800	0.51	0.01	0.4	1620	10	15.4	<0.001	<0.005	1.2	0.002	0.01	6.05	11	<0.2
Guidimaka	DGT033	11.35	16	0.22	<0.1	0.011	<0.01	2.6	11.4	10.95	13450	0.41	0.01	0.3	1385	60	14.3	0.004	<0.005	0.5	<0.002	0.01	4.75	3	0.2
Guidimaka	DGT034	9.38	28.5	0.13	0.2	0.016	<0.01	1.4	46.1	9.71	11050	0.49	0.01	0.5	1200	40	20.4	<0.001	<0.005	0.8	<0.002	0.01	5.95	7	0.3
Guidimaka	DGT035	8.03	35.3	0.13	0.1	0.009	<0.01	1	19.6	8.58	9970	0.9	<0.01	0.4	1575	40	40.9	<0.001	<0.005	0.9	<0.002	0.01	7.12	9	0.2
Guidimaka	DGT036	8.43	36.3	0.12	<0.1	0.007	<0.01	0.5	3.9	7.68	7050	1.32	<0.01	0.5	1165	80	17.2	<0.001	0.005	1.2	<0.002	0.01	0.65	11	0.2
Guidimaka	DGT037	9.23	36.8	0.13	0.1	0.011	<0.01	1.1	4.6	8.44	9610	0.79	<0.01	0.5	1305	110	13.4	<0.001	<0.005	1.1	0.002	0.01	0.72	10	0.2
Guidimaka	DGT038	8.94	33.8	0.13	<0.1	0.012	<0.01	1	6.2	8.89	11500	0.41	0.01	0.4	1160	120	28.8	<0.001	0.01	0.8	<0.002	0.01	1.35	8	<0.2
Guidimaka	DGT039	8.86	34.3	0.13	0.1	0.006	<0.01	0.9	4.9	7.27	10200	0.69	<0.01	0.4	1290	50	9.8	<0.001	0.009	0.7	<0.002	0.01	0.97	6	0.2
Guidimaka	DGT040	8.85	30.1	0.15	<0.1	0.018	<0.01	1.8	45.4	8.17	14000	0.45	0.01	0.4	1300	20	24.9	<0.001	<0.005	0.9	<0.002	0.01	2.42	9	0.2
Indice	IDH040	8.26	24.9	0.9	12.7	0.109	0.01	135	68.8	6.66	1985	1.26	0.01	83.7	458	5610	15.5	0.002	<0.005	0.3	<0.002	<0.01	3.24	2	5.4
Indice	IDH041	4.24	22.6	0.16	4.3	0.095	2.97	20.6	31.6	1.28	990	0.87	0.67	14.6	33.7	610	5.3	0.001	<0.005	122	<0.002	<0.01	0.71	1	2.7
Indice	IDH042	1.12	14.15	0.14	3.8	0.014	3.97	47.6	7.7	0.14	319	1.2	1.24	13	4.7	360	20.9	<0.001	<0.005	166	<0.002	<0.01	0.28	1	1.4
Indice	IDH043	4.37	14.7	0.25	2.3	0.054	0.57	59.1	23	1.71	1345	1.3	3.87	35.1	68.7	2800	16.3	<0.001	<0.005	24.1	<0.002	<0.01	1.15	1	1.3
Indice	IDH044	4.73	18.3	0.21	1.9	0.046	0.06	53.8	12.4	0.98	1430	1.52	2.27	29.6	46.8	2360	39.5	<0.001	<0.005	1.8	<0.002	<0.01	1.16	1	1.2
Indice	IDH045	1.96	7.02	0.15	1.4	0.029	0.67	60.3	11	0.8	2090	1.14	1.35	11.4	24.4	1170	16.6	<0.001	<0.005	28.4	<0.002	<0.01	0.44	1	0.6
Indice	IDH047	6.33	18.5	0.78	5	0.051	0.18	74.2	11.1	2.35	1165	1.22	3.76	39.9	81.8	2940	16.8	0.002	<0.005	5.8	<0.002	<0.01	3.15	2	1.6
Indice	IDH049	5.19	14.2	0.29	3.6	0.08	0.03	51.9	15.2	1.28	1290	1.32	0.15	35.3	35.6	2770	15	0.001	<0.005	1.2	<0.002	<0.01	1.21	2	1.8
Indice	IDH050	5.92	20.1	0.19	2.8	0.054	0.12	49.7	3.7	0.26	1095	1.5	0.48	27.5	12.2	2730	22.3	<0.001	<0.005	3.8	<0.002	<0.01	0.98	1	1.3
Indice	IDH051	5.68	19.05	0.16	2	0.041	0.11	40.3	3.7	0.25	1105	1.76	0.46	20.7	24.6	1980	32.5	<0.001	<0.005	3.5	<0.002	<0.01	0.67	1	1
Indice	IDH052	5.17	22.5	0.18	2.7	0.06	0.08	47.1	2.3	0.13	1600	1.36	0.82	27.7	21.9	2570	27.7	<0.001	<0.005	3.2	<0.002	<0.01	1.92	1	1.5
Indice	IDH053	3.91	18.7	0.2	1.7	0.078	1.88	36.8	42.9	2.99	1125	0.95	0.86	20.3	45.1	590	11.1	0.002	<0.005	66.8	<0.002	0.01	1.61	1	2.7
Indice	IDH054	5.9	23.9	0.2	4.4	0.063	0.29	59.3	4	0.17	983	1.98	0.26	34.8	47.2	3350	22.7	<0.001	<0.005	10.6	<0.002	<0.01	0.97	1	1.5
Indice	IDH055	0.64	0.25	0.06	0.1	<0.005	0.01	0.6	0.2	0.01	100	4.18	0.01	0.3	5	30	4.4	<0.001	<0.005	0.7	<0.002	<0.01	0.22	1	0.3
Indice	IDH056	2.19	18.3	0.19	4.3	0.055	3.66	40.6	26.6	0.3	451	0.78	1.82	15.7	1.9	450	15	<0.001	<0.005	188	<0.002	<0.01	1.29	1	2.1
Indice	IDH057	1.8	0.36	0.07	0.1	<0.005	0.04	3.3	0.5	0.01	159	5.28	0.04	0.4	5.8	300	9.8	<0.001	<0.005	1.8	<0.002	<0.01	0.32	1	0.4
Indice	IDH059	4.39	17.45	0.23	6.2	0.093	4.76	84.4	39.6	0.85	344	2.3	0.58	52.3	35.6	1360	21.4	<0.001	<0.005	203	<0.002	0.01	0.62	2	1.9
Indice	IDH060	5.81	19.45	0.34	7.1	0.063	4.29	93.5	19.8	0.39	894	0.73	3.03	38.3	19	3920	18.8	<0.001	<0.005	153	<0.002	<0.01	1.85	2	1.5
Indice	IDH061	3.56	18.55	0.19	4.7	0.058	5.16	34.5	34.4	0.98	179	0.85	0.07	29.1	55	780	5.6	<0.001	<0.005	222	<0.002	<0.01	0.38	1	1.9
Indice	IDH062	6.2	23	0.19	2.7	0.057	0.07	48	5.1	0.87	1165	1.93	0.9	24	38.4	2310	24.6	0.001	<0.005	2.4	<0.002	<0.01	0.63	1	1.4
Indice	IDH063	6.58	15.9	0.22	5	0.112	2.25	54.8	24	1.06	911	3.52	0.4	27.7	90.6	2280	20.8	0.003	<0.005	107	<0.002	0.01	0.93	2	1.6
Indice	IDM001	1.22	0.54	0.09	0.1	<0.005	0.08	1.7	1.3	0.13	108	3.63	0.01	0.9	14.8	250	5.1	<0.001	<0.005	3.7	<0.002	0.88	1.18	9	0.3
Indice	IDM002	0.74	0.76	0.05	0.1	<0.005	0.03	1.2	2.4	0.23	168	3.78	0.13	0.4	12.4	110	2.4	<0.001	<0.005	1.1	<0.002	<0.01	0.23	1	0.3
Indice	IDM003	0.68	0.46	0.05	0.1	<0.005	0.05	1.3	0.9	0.02	285	4.35	0.01	0.7	8.7	120	5.7	<0.001	<0.005	1.7	<0.002	0.06	0.21	1	0.3
Indice	IDM004	0.69	0.31	0.06	0.1	<0.005	0.02	0.9	0.5	0.02	170	4.33	0.05	0.4	7.1	40	3.7	<0.001	<0.005	1	<0.002	<0.01	0.16	1	0.3

	Sample	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Cr2o3
		ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Guidimaka	DGH015	3.7	1.71	<0.05	16.6	0.431	<0.02	2.7	114	4.9	50.3	124	161	
Guidimaka	DGH016	6.4	<0.05	<0.05	<0.2	0.073	<0.02	<0.1	380	5	2	13100	9.7	22.6
Guidimaka	DGH017	8.3	<0.05	0.08	<0.2	0.081	0.05	<0.1	477	30.6	1.5	13500	0.8	32.4
Guidimaka	DGH018	1.7	<0.05	<0.05	<0.2	<0.005	0.05	<0.1	8	1180	0.3	144	1.7	
Guidimaka	DGH019	1.2	<0.05	<0.05	<0.2	0.005	<0.02	0.1	23	6.2	0.3	50	1.3	
Guidimaka	DGH020	3.7	<0.05	0.05	<0.2	0.093	<0.02	<0.1	490	17.8	1.7	1660	4.5	32.8
Guidimaka	DGH021	31	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	36	17.1	0.2	87	<0.5	
Guidimaka	DGH022	2.5	<0.05	<0.05	<0.2	<0.005	<0.02	0.2	31	200	1.4	63	11.7	
Guidimaka	DGH024	14.3	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	28	9	0.6	38	0.7	
Guidimaka	DGH025	4	<0.05	<0.05	<0.2	0.09	<0.02	<0.1	542	3.2	1.7	1325	2.1	31.7
Guidimaka	DGM006	0.9	<0.05	<0.05	<0.2	0.005	<0.02	0.3	28	1.6	4.5	38	14.2	
Guidimaka	DGM011	1.6	0.05	<0.05	<0.2	0.01	<0.02	<0.1	36	6.4	1.4	114	0.7	
Guidimaka	DGM012	4.6	<0.05	<0.05	<0.2	0.084	<0.02	<0.1	461	3.6	1.2	4870	1.8	29.7
Guidimaka	DGM013	5.8	<0.05	<0.05	<0.2	0.022	0.03	0.5	110	136	8.1	171	28.9	
Guidimaka	DGM014	5.5	<0.05	0.09	<0.2	0.094	0.02	0.1	473	3.4	0.8	5350	2.1	33
Guidimaka	DGM015	2.4	0.12	<0.05	<0.2	0.434	<0.02	<0.1	222	5.1	2.5	111	3.4	
Guidimaka	DGM017	4.2	<0.05	0.05	0.2	0.016	0.05	0.3	55	500	2.1	39	4.4	
Guidimaka	DGM018	4.8	0.28	<0.05	<0.2	0.827	<0.02	0.1	300	10	17.8	141	3.8	
Guidimaka	DGM019	5	<0.05	<0.05	<0.2	0.013	<0.02	0.1	39	6.5	2.4	84	0.5	
Guidimaka	DGM101	3.3	0.1	<0.05	0.2	0.113	0.07	0.1	647	2.2	4.6	360	18	
Guidimaka	DGM102	5.8	<0.05	0.05	<0.2	0.129	<0.02	<0.1	527	2.3	0.9	2630	5	
Guidimaka	DGM103	4.6	<0.05	<0.05	<0.2	0.097	<0.02	<0.1	512	2.6	0.8	2100	1.3	
Guidimaka	DGM104	6.5	<0.05	0.06	<0.2	0.092	<0.02	<0.1	592	2.6	1.6	2520	1.6	
Guidimaka	DGM105	6.8	<0.05	0.08	<0.2	0.111	<0.02	<0.1	614	2.4	0.7	2720	2.7	
Guidimaka	DGM106	7.2	<0.05	0.1	<0.2	0.11	<0.02	0.1	528	3.1	0.6	5730	1.9	
Guidimaka	DGM107	4.8	<0.05	0.12	<0.2	0.099	<0.02	<0.1	570	2.1	0.6	1955	1.2	
Guidimaka	DGM108	7.5	<0.05	0.14	<0.2	0.107	<0.02	0.1	656	2.4	0.4	4660	2.2	
Guidimaka	DGM110	12.5	<0.05	0.06	<0.2	0.073	<0.02	0.1	461	3	2	######	0.6	
Guidimaka	DGM111	5.5	<0.05	0.13	<0.2	0.107	<0.02	<0.1	672	2.1	1.3	3050	2.2	
Guidimaka	DGM112	2.6	<0.05	0.11	<0.2	0.105	<0.02	<0.1	561	2.1	0.6	1610	1.8	
Guidimaka	DGM113	3.7	<0.05	0.15	<0.2	0.102	<0.02	<0.1	658	1.8	1	1860	2.4	
Guidimaka	DGM114	8.2	<0.05	0.13	<0.2	0.092	<0.02	<0.1	549	2	1.3	3920	0.8	
Guidimaka	DGM115	5.2	<0.05	0.22	<0.2	0.122	0.02	<0.1	753	1.6	0.8	4760	1.6	
Guidimaka	DGM116	3.6	<0.05	0.11	<0.2	0.103	<0.02	<0.1	546	2	0.9	2380	1.4	
Guidimaka	DGM117	4.3	<0.05	0.13	<0.2	0.101	<0.02	<0.1	542	2.1	0.7	1785	1.4	
Guidimaka	DGM119	8.2	<0.05	0.14	<0.2	0.102	0.02	0.1	564	1.9	0.6	4120	1.6	
Guidimaka	DGM120	6.9	<0.05	0.16	<0.2	0.106	<0.02	<0.1	597	2.2	0.6	2820	2.3	
Guidimaka	DGM121	8.3	<0.05	0.18	<0.2	0.101	<0.02	0.1	613	2.9	0.5	9520	2	
Guidimaka	DGM123	4.4	<0.05	0.17	<0.2	0.103	<0.02	<0.1	580	3.7	1.5	3000	1.3	
Guidimaka	DGM124	7.3	<0.05	0.15	<0.2	0.098	0.02	<0.1	584	2.1	0.7	5200	1.3	
Guidimaka	DGM125	6	<0.05	0.22	<0.2	0.097	<0.02	<0.1	642	2.6	0.6	3970	1.1	
Guidimaka	DGM126	5.5	<0.05	0.08	<0.2	0.087	<0.02	<0.1	546	4.5	0.4	9340	1	
Guidimaka	DGM127	9.1	<0.05	0.12	<0.2	0.08	<0.02	<0.1	572	3.7	0.6	117000	1	
Guidimaka	DGM129	7.6	<0.05	0.07	<0.2	0.093	<0.02	0.1	451	2.1	1.3	6750	1.6	
Guidimaka	DGM130	8	<0.05	0.13	<0.2	0.093	<0.02	<0.1	573	1.5	0.4	1615	1	
Guidimaka	DGM131	7.8	<0.05	0.05	<0.2	0.09	<0.02	<0.1	560	1.4	1.5	7880	7.3	
Guidimaka	DGM132	12.5	<0.05	0.14	<0.2	0.098	<0.02	0.1	618	1.1	1.2	2800	2	
Guidimaka	DGM133	3.6	<0.05	0.1	<0.2	0.083	<0.02	<0.1	514	1.4	0.8	9230	2.7	
Guidimaka	DGM134	4.9	<0.05	0.15	<0.2	0.106	<0.02	<0.1	609	1.1	0.3	7090	1.1	
Guidimaka	DGB101	4.1	0.09	0.08	0.2	0.136	0.04	0.1	685	0.6	12.8	463	26.7	
Guidimaka	DGT002	2.7	<0.05	0.09	<0.2	0.11	0.02	0.1	699	1.1	2.7	676	12.4	
Guidimaka	DGT003	5.5	0.06	0.07	0.2	0.118	<0.02	0.1	614	0.8	11.3	565	20.9	
Guidimaka	DGT004	3	<0.05	<0.05	<0.2	0.006	<0.02	0.1	50	0.2	1.6	158	1.2	
Guidimaka	DGT005	1.5	<0.05	<0.05	<0.2	0.007	<0.02	<0.1	27	0.2	1.2	234	0.6	
Guidimaka	DGT006	2.8	0.35	<0.05	<0.2	1.98	0.03	0.1	1025	0.5	12.2	543	20.1	
Guidimaka	DGT007	2.5	0.41	<0.05	<0.2	3.15	<0.02	<0.1	1490	2.9	13.5	129	28.9	
Guidimaka	DGT008	11.6	<0.05	<0.05	<0.2	0.128	<0.02	<0.1	522	2.4	1	4270	1.8	
Guidimaka	DGT009	7.1	<0.05	0.07	<0.2	0.124	<0.02	<0.1	584	1.8	1	2280	1.2	
Guidimaka	DGT010	15	<0.05	0.11	<0.2	0.125	<0.02	0.1	640	2.6	1	2820	4.9	
Guidimaka	DGT011	18.8	<0.05	0.08	<0.2	0.12	<0.02	<0.1	518	2.8	0.5	5870	1.1	
Guidimaka	DGT012	8.6	<0.05	0.14	<0.2	0.102	<0.02	0.1	677	2.3	0.5	2070	1.9	
Guidimaka	DGT014	10.7	<0.05	0.13	0.2	0.128	<0.02	0.1	601	1.9	0.7	2270	2.5	
Guidimaka	DGT015	8.2	<0.05	0.15	<0.2	0.107	0.02	0.1	611	2.3	1.2	1525	2.4	
Guidimaka	DGT016	8.1	<0.05	0.09	<0.2	0.103	<0.02	<0.1	520	2.9	0.7	5670	0.8	
Guidimaka	DGT017	6.7	<0.05	0.1	<0.2	0.103	<0.02	<0.1	629	3.2	0.2	4310	1.3	
Guidimaka	DGT018	9.6	<0.05	0.05	<0.2	0.118	0.02	0.1	538	2	0.7	5580	1.5	
Guidimaka	DGT020	24.9	<0.05	0.09	<0.2	0.113	<0.02	<0.1	530	2.6	0.8	5550	1.2	
Guidimaka	DGT021	9.6	<0.05	<0.05	<0.2	0.092	<0.02	<0.1	479	2.5	0.7	5020	1.1	
Guidimaka	DGT023	9.8	<0.05	0.07	<0.2	0.113	<0.02	<0.1	512	2.3	0.6	5370	1.4	
Guidimaka	DGT024	4.6	<0.05	0.1	<0.2	0.084	<0.02	<0.1	539	3	0.9	6960	7.1	
Guidimaka	DGT025	9	<0.05	0.09	<0.2	0.09	<0.02	<0.1	634	2.4	0.7	4340	1.4	
Guidimaka	DGT026	7.1	<0.05	0.1	<0.2	0.105	0.03	<0.1	663	2.2	0.5	6770	1.7	
Guidimaka	DGT027	7.5	<0.05	0.06	<0.2	0.091	<0.02	<0.1	483	2.9	0.6	134000	0.9	
Guidimaka	DGT028	6.3	<0.05	0.14	<0.2	0.101	<0.02	<0.1	560	3.1	0.8	120000	1	
Guidimaka	DGT031	4.6	<0.05	0.1	<0.2	0.1	<0.02	<0.1	523	2.8	0.8	128000	1	
Guidimaka	DGT033	7.8	<0.05	<0.05	<0.2	0.076	<0.02	0.1	420	2.4	1.3	129000	0.6	
Guidimaka	DGT034	6	<0.05	0.08	<0.2	0.136	<0.02	<0.1	704	3.1	3	4110	7.7	
Guidimaka	DGT035	6.2	<0.05	0.09	<0.2	0.096	<0.02	<0.1	561	2.8	1	1660	3.5	
Guidimaka	DGT036	3	<0.05	0.14	<0.2	0.092	<0.02	<0.1	672	2.7	0.5	4160	1.6	
Guidimaka	DGT037	5	<0.05	0.11	<0.2	0.14	<0.02	<0.1	607	1.7	1.5	8230	5	
Guidimaka	DGT038	5	<0.05	0.08	<0.2	0.084	<0.02	0.1	515	0.9	0.7	7920	0.9	
Guidimaka	DGT039	7.7	<0.05	0.1	<0.2	0.104	<0.02	<0.1	594	1.6	0.8	7270	2.2	
Guidimaka	DGT040	11.4	<0.05	0.08	<0.2	0.095	<0.02	<0.1	502	2.7	1.5	228000	0.7	
Indice	IDH040	1275	3.53	<0.05	29.8	1.105	<0.02	4.8	344	3.4	35.4	186	489	
Indice	IDH041	66.9	1.14	0.08	10.2	0.445	0.67	1.6	102	3.4	27	85	126	
Indice	IDH042	39.4	1.55	<0.05	20	0.103	0.86	2.8	7	2.8	19.9	22	94.1	
Indice	IDH043	766	1.77	<0.05	7.5	0.66	0.08	1.3	146	2.1	24.4	106	79.5	
Indice	IDH044	2360	1.44	<0.05	6.4	0.552	<0.02	1.5	175	1.9	23.8	48	56.8	
Indice	IDH045	674	0.62	0.06	2.9	0.251	0.09	0.8	62	2	9.7	37	44	
Indice	IDH047	1170	1.96	<0.05	12.1	0.677	<0.02	0.7	106	1.4	21.2	51	178	
Indice	IDH049	1315	1.74	<0.05	8.6	0.529	<0.02	1	108	2	15.7	32	99	
Indice	IDH050	2000	1.56	<0.05	6.6	0.626	<0.02	1.1	223	2.3	16.5	8	72.5	
Indice	IDH051	2430	1.04	<0.05	4.9	0.469	<0.02	0.7	229	2.3	12.9	8	54.4	
Indice	IDH052	2460	1.45	<0.05	6.6	0.587	<0.02	1.2	211	2.1	18.5	7	78	
Indice	IDH053	561	1.58	0.12	12.1	0.419	0.4	1.7	94	2.7	23.2	106	48.8	
Indice	IDH054	2280	1.72	0.05	7.6	0.681	<0.02	7	194	3	25.3	7	153	
Indice	IDH055	37	<0.05	<0.05	0.2	0.005	<0.02	0.1	2	5.9	0.3	2	2.5	
Indice	IDH056	26	1.36	<0.05	15.6	0.314	0.8	1.5	31	2.9	38.5	66	114	
Indice	IDH057	36.7	<0.05	<0.05	0.2	0.02	<0.02	0.3	6	7	0.7	5	2.9	
Indice	IDH059	96.7	2.63	<0.05	16.8	0.396	0.73	2.4	118	6	26.1	42	220	
Indice	IDH060	374	1.86	<0.05	13.8	0.731	0.56	2.9	78	2.9	25.7	78	266	
Indice	IDH061	46.1	1.62	<0.05	14.4	0.411	0.79	2	102	5	18.6	48	131	
Indice	IDH062	1595	1.26	<0.05	6.3	0.592	<0.02	0.8	245	2.7	16	22	74.4	
Indice	IDH063	765	1.14	0.05	10.8	0.443	0.38	1.7	170	6.4	26.6	21	174	
Indice	IDM001	8.9	<0.05	41.4	<0.2	0.034	<0.02	1.9	13	6.5	1.1	6	6.6	
Indice	IDM002	16.8	<0.05	0.22	<0.2	0.007	<0.02	<0.1	4	5.3	0.4	9	2.6	
Indice	IDM003	57.8	<0.05	<0.05	0.2	0.014	<0.02	<0.1	5	5.8	0.5	<2	2.4	
Indice	IDM004	21	<0.05	<0.05	0.2	0.008	<0.02	<0.1	3	5	0.4	2	3.4	

2.5 Chemical Assay3

	Sample	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
		ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Indice	IDM005	0.003	0.22	5.74	2.9	690	0.68	1.07	7.03	0.3	44.6	2.3	142	1.08	229
Indice	IDM006	<0.001	<0.01	7.68	17.4	150	0.77	0.17	8.57	0.3	120	17.5	106	0.33	18.8
Indice	IDM007	<0.001	0.02	0.15	3	60	<0.05	0.01	0.05	0.05	2.43	3.6	38	0.06	14.5
Indice	IDM008	<0.001	0.02	0.23	1.2	50	0.06	0.02	0.06	<0.02	1.47	0.8	35	0.18	21.4
Indice	IDM009	0.001	<0.01	0.34	1.2	40	<0.05	0.02	0.03	<0.02	1.88	3.8	40	0.05	11.7
Indice	IDM010	<0.001	0.07	0.12	1	50	<0.05	0.01	0.04	<0.02	1.2	1.1	38	0.05	23.1
Indice	IDM011	0.622	2.78	0.12	0.6	60	<0.05	0.42	0.12	0.02	1.94	1.1	35	0.15	1175
Indice	IDM012	0.005	<0.01	0.29	1.1	10	<0.05	0.01	0.28	0.02	2.93	0.7	35	<0.05	10.5
Kadiar	KDB001	0.002	0.05	0.83	111.5	100	0.22	0.67	0.07	0.21	5.4	76.8	1325	0.26	44.7
Kadiar	KDB002	0.005	0.08	0.55	158.5	130	0.21	0.69	0.2	0.12	7.05	29	650	0.4	92.8
Kadiar	KDH003	<0.001	0.04	0.23	2.8	30	<0.05	0.02	0.04	0.03	1.95	1.4	44	0.05	27.1
Kadiar	KDH005	0.362	0.18	0.07	91.5	70	0.18	0.43	0.13	0.64	1.75	242	37	<0.05	1715
Kadiar	KDH006	0.046	0.06	0.04	62.6	30	0.07	0.25	0.08	0.21	2.89	103	21	<0.05	1195
Kadiar	KDH007	0.267	0.19	0.29	35.9	120	0.29	0.32	0.46	0.41	6.91	124.5	52	0.12	2230
Kadiar	KDH008	0.163	0.11	0.02	25.2	20	0.07	0.12	0.06	0.41	1.99	87.9	29	<0.05	3760
Kadiar	KDH010	0.703	0.08	0.24	54.2	40	0.15	0.56	0.12	0.39	7.28	149	86	0.06	538
Kadiar	KDH012	4.4	0.84	0.19	17.1	50	0.12	2.4	0.1	0.38	16.3	21.4	109	0.06	376
Kadiar	KDH013	0.033	<0.01	1.2	1.4	190	0.22	0.03	0.01	0.02	11.4	2.6	41	0.58	15.6
Kadiar	KDH014	0.007	<0.01	1.08	1.2	230	0.19	0.02	0.03	<0.02	10.9	1.6	37	0.54	29.3
Kadiar	KDH015	<0.001	0.06	8.22	1.7	20	0.26	<0.01	0.26	0.04	115.5	54.7	98	<0.05	61
Kadiar	KDH016	0.001	0.02	0.18	8.2	140	0.15	<0.01	0.04	0.08	1.69	60.8	1720	0.06	21.6
Kadiar	KDH018	<0.001	<0.01	0.2	3.2	50	0.11	<0.01	0.01	0.03	0.74	69.7	2390	<0.05	17.3
Kadiar	KDH019	0.001	<0.01	0.25	3.1	130	0.26	<0.01	0.08	0.04	2.88	76.1	1120	<0.05	16.6
Kadiar	KDH023	<0.001	0.07	6.46	0.9	10	<0.05	<0.01	0.15	0.03	41.4	74	279	<0.05	23.6
Kadiar	KDH024	0.001	<0.01	0.21	28.1	70	0.09	<0.01	0.14	0.06	2.42	82.2	1295	<0.05	6.8
Kadiar	KDH025	0.001	<0.01	0.2	14.8	100	0.08	<0.01	0.16	0.04	2.36	82.7	1590	<0.05	6.8
Kadiar	KDH026	0.001	0.34	5.82	0.3	10	0.07	0.05	4.83	0.35	275	61.7	162	0.13	0.2
Kadiar	KDH027	<0.001	<0.01	1.42	1	240	0.28	0.02	0.03	<0.02	16.65	2.7	43	0.66	10.9
Kadiar	KDH028	<0.001	<0.01	0.25	18.7	70	0.07	<0.01	0.09	0.03	2.64	97.6	1820	<0.05	8.3
Kadiar	KDH029	0.006	<0.01	6.21	0.3	5320	1.8	0.27	0.08	0.02	71.8	50.6	65	0.65	21.8
Kadiar	KDH030	0.252	0.73	0.28	30.8	140	0.21	0.22	0.24	6.03	6.09	138	31	0.1	12600
Kadiar	KDH031	0.262	1.68	0.07	24.1	60	0.11	0.41	0.3	3.71	5.32	227	37	<0.05	14300
Kadiar	KDH033	0.002	<0.01	6.69	<0.2	10	0.5	<0.01	0.05	0.02	94.4	36.8	79	<0.05	45.3
Kadiar	KDH034	0.002	<0.01	0.75	1.9	10	0.14	0.03	0.06	0.02	1.08	75.8	1160	<0.05	18.7
Kadiar	KDH036	0.01	0.09	0.42	114	370	0.42	2.99	0.05	0.25	18.55	58.2	609	0.12	480
Kadiar	KDH037	<0.001	<0.01	5.32	3.3	50	0.73	0.02	0.1	0.04	28.9	70.3	29	<0.05	810
Kadiar	KDH039	<0.001	0.02	4.73	0.8	20	0.4	<0.01	0.86	0.03	204	60	163	<0.05	21.5
Kadiar	KDH040	0.004	0.14	0.4	7	90	0.16	0.01	0.05	0.3	4.06	45.7	948	<0.05	58.5
Kadiar	KDH042	0.009	<0.01	0.06	4.6	20	<0.05	0.07	0.02	0.07	1.42	6.5	134	<0.05	98.7
Kadiar	KDH043	0.005	0.04	0.06	5.7	60	0.08	0.03	0.09	0.14	3.45	20.5	153	<0.05	146.5
Kadiar	KDH045	0.116	2.09	0.04	29.7	110	0.19	0.38	0.23	7.7	9.55	227	104	<0.05	25500
Kadiar	KDH046	0.051	0.67	0.03	27	80	0.13	0.08	0.11	2.41	1.74	280	21	<0.05	5260
Kadiar	KDH047	0.003	0.04	0.48	28.1	70	0.12	0.09	0.05	0.11	4.26	12.4	1095	<0.05	107.5
Kadiar	KDH048	0.021	<0.01	6.09	1	30	0.28	0.12	0.26	0.02	284	67.6	215	<0.05	180.5
Kadiar	KDH049	0.001	<0.01	9.87	1.7	20	0.67	0.01	0.05	0.02	142	53.7	105	<0.05	12.4
Kadiar	KDH050	<0.001	<0.01	9.6	1.2	30	0.67	0.01	0.06	0.07	309	62.2	226	<0.05	36
Kadiar	KDH051	<0.001	<0.01	1.12	0.6	120	0.36	0.02	0.01	<0.02	14.6	3.4	36	0.95	14.7
Kadiar	KDM001	0.27	0.42	0.06	72.1	30	0.29	0.15	0.09	0.67	3.87	319	21	<0.05	35700
Kadiar	KDM003	0.003	<0.01	0.18	6.5	190	0.41	<0.01	0.19	0.05	7.31	108.5	1380	<0.05	80.8
Kadiar	KDM004	0.001	<0.01	0.27	18.2	80	0.19	<0.01	0.06	0.04	3.38	27.5	1485	0.15	34.6
Kadiar	KDM005	0.006	<0.01	0.25	28.9	50	0.19	0.02	0.19	0.05	1.77	92.3	1075	<0.05	16.5
Kadiar	KDM006	0.003	<0.01	0.1	3.2	140	0.23	<0.01	0.42	0.06	3.14	94.2	1145	<0.05	18.6
Kadiar	KDM007	<0.001	<0.01	0.16	7.4	110	<0.05	0.07	0.05	0.02	1.67	81	1140	<0.05	13.8
Kadiar	KDM008	<0.001	0.11	7.55	2.2	50	0.09	0.01	0.59	0.05	71.7	82.7	363	<0.05	24.7
Kadiar	KDM009	0.006	0.02	0.66	11	280	0.52	0.08	0.05	0.12	51.8	162.5	1080	0.13	203
Kadiar	KDM010	0.002	0.12	0.61	23.9	530	0.66	0.09	0.06	1.17	19.35	130	267	0.15	946
Kadiar	KDM011	0.037	1.02	0.28	20.1	310	0.3	0.24	0.15	1.2	6.96	83.3	64	0.09	1995
Kadiar	KDM012	0.002	0.02	0.08	3.9	40	0.09	<0.01	0.1	0.05	1.04	56.3	1035	<0.05	36.1
Oudelemguil	BTB001	0.006	0.12	2.66	0.8	120	0.3	0.05	0.06	0.02	1.7	63.2	2050	<0.05	148
Oudelemguil	BTH003	<0.001	1.3	6.72	1.3	60	0.42	0.14	0.09	0.07	37	49	188	0.12	4680
Oudelemguil	BTH004	0.301	4.35	2.81	1.7	10	0.11	9.28	0.03	0.31	84.6	79.8	<1	<0.05	290000
Oudelemguil	BTH005	0.066	21.8	7.55	2.2	20	0.2	1.82	0.01	0.14	37.8	61.4	<1	<0.05	109500
Oudelemguil	BTH006	0.042	1.23	7.11	3	20	0.18	0.2	0.08	2.47	313	64.5	<1	<0.05	89300
Oudelemguil	BTH007	0.002	0.94	9.22	1.2	80	0.46	0.02	0.07	0.29	37.1	76.6	7	0.05	2040
Oudelemguil	BTH008	<0.001	0.45	9.31	1.1	40	0.23	0.01	0.38	0.07	67.4	81.7	26	<0.05	1580
Oudelemguil	BTH009	<0.001	0.17	10.5	1	80	0.29	<0.01	0.32	0.06	24.6	83	138	0.07	1250
Oudelemguil	BTH011	0.134	196	2.62	2.7	10	0.07	0.08	0.1	5.28	9.38	31.9	<1	<0.05	344000
Oudelemguil	BTH012	0.14	5.49	8.38	0.7	20	0.16	2.66	6.8	0.28	3.16	41.8	96	<0.05	38800
Oudelemguil	BTH013	0.001	1.04	6.6	1.3	10	0.22	0.04	0.12	0.22	19.55	87.7	182	<0.05	2060
Oudelemguil	BTH014	0.004	0.37	7.62	0.9	70	0.29	0.02	0.08	0.82	5.97	74.6	194	<0.05	2710
Oudelemguil	BTH015	0.027	0.29	1.35	1.6	30	0.58	0.13	0.15	0.04	13.6	9.1	67	<0.05	533
Oudelemguil	BTH016	<0.001	0.11	1.64	1	110	0.24	<0.01	0.07	0.05	4.99	12.5	54	0.05	242
Oudelemguil	BTH017	<0.001	0.05	1.42	1.1	80	0.24	<0.01	0.09	0.04	31.9	5.9	59	0.07	154.5
Oudelemguil	BTH019	0.001	0.05	1.35	1.9	50	0.42	<0.01	0.06	0.14	11.75	12.4	45	0.11	371
Oudelemguil	BTH020	0.008	0.09	1.76	1.4	50	0.19	<0.01	0.06	0.02	8.8	6.4	73	<0.05	58
Oudelemguil	BTH022	0.001	0.03	1.37	0.7	20	0.21	<0.01	0.03	<0.02	25	3.3	51	<0.05	86.1
Oudelemguil	BTH023	0.003	0.14	1.75	0.7	50	0.19	0.11	0.04	0.11	0.9	111.5	3220	<0.05	50.3
Oudelemguil	BTH024	0.068	24.6	8.37	<0.2	30	0.33	0.34	5.99	0.19	15.35	41.3	133	0.05	6820
Oudelemguil	BTH025	0.247	3.54	6.65	1.3	10	0.18	0.39	1.34	0.08	17.15	80.3	634	0.08	46200
Oudelemguil	BTH026	0.593	1.72	6.83	1.2	20	0.09	0.23	1.95	0.09	10.7	78.6	87	0.16	29900
Oudelemguil	BTH027	0.006	0.55	2.75	0.2	130	0.21	0.03	0.09	0.02	2.01	29.5	2590	0.06	789
Oudelemguil	BTM001	0.072	1.88	10.05	0.7	10	0.35	1.22	0.02	0.26	30.5	95	377	0.05	20800
Oudelemguil	BTM003	0.003	0.49	6.67	0.9	10	0.4	0.06	0.03	0.02	6.19	71.7	959	<0.05	2620
Oudelemguil	BTM004	0.035	5.55	9.45	1	340	0.49	0.15	0.06	0.14	0.66	54.8	305	0.31	16700
Oudelemguil	BTM007	0.001	0.28	7.21	1.8	30	0.43	0.01	0.03	0.05	33	43.7	4	0.07	9690
Oudelemguil	BTM008	<0.001	0.34	3.4	2.7	110	0.29	0.02	0.07	0.06	43.8	58.9	81	0.16	1140
Oudelemguil	BTM009	<0.001	0.25	6.02	2.6	40	0.45	<0.01	0.03	0.03	22	41.4	132	0.05	7890
Oudelemguil	BTM010	0.068	7.49	9.31	0.9	30	0.17	2.38	1.6	0.05	7.12	91.8	176	0.26	25000
El Aouj (Centra	AOH001	0.003	0.03	0.04	0.8	40	<0.05	<0.01	0.03	<0.02	3.22	3.1	306	<0.05	6.7
Atomai	ATM001	0.003	0.09	0.08	3.9	90	0.44	0.16	0.13	<0.02	2.13	0.6	25	0.07	79.0
El Aouj	EAM002	0.002	0.05	0.06	1.7	60	0.22	0.05	0.29	<0.02	4.35	0.9	19	0.09	48.0
El Rhein	RHH002	<0.001	0.04	0.08	1.5	80	<0.05	<0.01	0.20	<0.02	2.31	0.8	20	<0.05	47.3
TO14	KEH002	0.001	0.10	0.12	6.3	10	0.46	0.03	0.01	<0.02	2.23	0.9	14	<0.05	94.0
near T1	KEH003	0.002	0.04	1.16	12.3	40	0.75	0.06	0.02	<0.02	12.1	1.8	21	0.10	15.6
M'Haoudat	MHH001	0.001	0.04	0.05	1.4	10	0.54	<0.01	0.01	<0.02	1.23	0.5	22	<0.05	23.2
M'Haoudat	MHH002	0.003	0.13	10.75	1.0	380	3.75	0.16	0.10	<0.02	117.0	0.9	39	3.35	8.4
El Rhein	RHH003	0.003	0.10	5.58	0.4	2330	0.92	0.07	0.59	0.03	12.9	27.0	193	20.5	91.7
El Rhein	RHH006	<0.001	0.02	6.38	1.9	2450	0.61	<0.01	0.34	<0.02	96.8	2.6	11	1.19	26.4
Sebkha	SKM003	0.007	0.02	0.62	3.8	70	0.06	0.05	0.29	<0.02	2.9	11.9	32	<0.05	404
Seyala	SYH001	0.001	0.16	7.65	13.5	550	1.82	0.49	0.11	0.26	60.6	9.1	65	8.51	28.0
TO14	KEH001	0.148	0.04	9.97	11.6	20	2.33	0.68	0.03	0.08	33	4.4	120	<0.05	249
El Rhein	RHH004	0.001	0.05	0.33	1.2	70	0.30	0.01	0.95	<0.02	8.67	1.0	17	0.07	25.0
Tazadit	TZM002	0.003	0.04	0.59	4.9	60	0.21	0.08	0.05	<0.02	7.36	1.7	37	0.28	99.2
Khneifissat	TSH020														
piment	TSH001	0.041	0.09	0.61	469	110	0.28	0.16	0.24	0.11	17.8	3.1	343	0.08	24.3
piment	TSH002	0.011	0.08	9.9	10.0	970	0.74	0.10	0.37	0.05	29.6	10.7	75	1.80	76.3
piment	TSH003	0.004	<0.01	8.69	3.1	350	0.61	0.02	5.26	0.02	28.5	4.4	28	0.99	14.1
piment	TSH004	0.034	0.17	4.35	43.3	380	0.45	0.07	6.42	0.08	18.85	18.5	89	0.36	26.0

Sample	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm
IDM005	4.34	17.15	0.12	1.6	0.022	0.53	20.9	4.5	0.12	850	2.24	0.36	10.2	12.6	870	990
IDM006	5.57	24.3	0.29	2.4	0.061	0.14	55.1	8.6	0.73	1355	1.53	0.92	33	46.2	3030	19.1
IDM007	0.63	0.45	0.05	<0.1	<0.005	0.01	0.7	1.4	0.13	181	4.6	0.01	0.3	11.8	40	5.6
IDM008	0.51	0.56	0.06	<0.1	<0.005	0.07	1.1	0.5	0.02	158	3.19	0.04	0.2	4.9	120	1.7
IDM009	1.04	1.12	0.06	<0.1	<0.005	0.02	1.1	3.7	0.22	272	4.41	<0.01	0.2	13.7	50	2.5
IDM010	0.65	0.31	0.05	<0.1	<0.005	0.03	0.8	0.5	0.03	122	3.65	0.02	0.3	5.6	120	2.3
IDM011	0.43	0.47	0.06	<0.1	<0.005	0.06	1	0.9	0.04	106	2.88	<0.01	0.3	6.7	70	2.4
IDM012	0.6	0.93	0.06	<0.1	<0.005	0.01	1.7	0.3	0.02	115	3.03	0.04	0.3	4.5	50	3.2
KDB001	1.85	2.47	0.13	0.2	<0.005	0.1	3.3	16.1	0.77	1615	2.7	0.01	0.4	603	170	20.4
KDB002	4.3	1.82	0.16	0.2	<0.005	0.12	6.3	6.2	0.09	2810	4.88	0.01	0.6	619	930	51.8
KDH003	1.35	0.81	0.1	0.1	<0.005	0.01	1.2	0.6	0.02	127	9.62	0.01	0.2	9.8	110	2.8
KDH005	26.6	0.38	0.5	0.1	0.327	0.01	1.1	1.1	0.03	1610	8.64	<0.01	0.3	343	530	37.2
KDH006	34.64	0.26	0.56	<0.1	0.103	0.01	1.6	0.2	0.04	1085	8	0.01	0.3	382	480	20.6
KDH007	20.8	0.95	0.38	0.1	0.138	0.04	3.2	3.5	0.33	2090	2.72	0.01	0.6	612	1130	42.5
KDH008	18.9	0.18	0.35	0.1	0.076	0.01	1.1	0.6	0.25	1790	4.05	<0.01	0.2	486	510	13.2
KDH010	34.17	0.75	0.56	0.1	0.165	0.02	4.2	1.6	0.04	649	7.24	0.01	0.5	723	540	60.8
KDH012	21.6	0.75	0.44	0.1	<0.005	0.02	8.3	2.2	0.04	413	3.16	0.01	0.5	665	510	119.5
KDH013	1.13	2.98	0.13	1.2	<0.005	0.4	5.5	2.9	0.06	86	2.66	0.01	1.3	19.9	30	3.3
KDH014	0.74	2.58	0.11	1	<0.005	0.37	5.9	2.4	0.07	108	2.51	0.02	0.8	16.9	40	2.3
KDH015	6.55	11.05	0.39	1.1	0.022	0.01	68.5	7.7	>15.0	1170	0.36	<0.01	10	1305	1170	3.7
KDH016	3.86	0.46	0.14	0.1	<0.005	0.01	1.2	3.6	0.52	641	4.79	<0.01	0.4	796	190	2.3
KDH018	2.72	0.39	0.13	0.1	<0.005	<0.01	<0.5	1.4	0.06	419	3.77	<0.01	0.6	330	50	1.2
KDH019	5.35	0.56	0.15	0.1	<0.005	0.01	1.2	1	0.05	1460	2.9	<0.01	0.5	671	280	0.9
KDH023	9.85	12.65	0.25	2.6	0.046	<0.01	24.9	0.9	14.4	2980	8.51	<0.01	32	389	760	1.2
KDH024	4.26	0.48	0.27	<0.1	<0.005	0.01	1.3	0.8	>15.0	766	0.38	<0.01	0.8	2820	380	1
KDH025	4.69	0.5	0.26	<0.1	<0.005	0.01	1.3	0.7	>15.0	1060	0.23	<0.01	0.8	1785	330	1.6
KDH026	10.9	10.9	0.43	5.3	0.524	<0.01	120	74.1	5.1	2400	0.27	<0.01	135	546	930	10
KDH027	0.75	3.37	0.1	1.6	<0.005	0.51	9.2	3	0.17	127	2.35	0.03	1.8	22.3	40	3.3
KDH028	5.5	0.49	0.21	0.1	<0.005	0.01	1.1	0.7	>15.0	816	0.27	<0.01	0.9	1950	200	0.9
KDH029	6.3	13.25	0.2	2.7	0.136	1.62	28.8	192.5	6.84	2800	0.26	0.05	7.3	201	40	8.5
KDH030	17.85	1.64	0.34	0.1	0.092	0.07	2.8	4.6	0.73	9770	5.7	0.02	0.4	440	960	22.9
KDH031	13.35	0.87	0.29	0.1	0.108	0.01	2.5	1.5	0.43	7300	6.41	0.01	0.3	482	370	22.3
KDH033	7.15	31.4	0.29	5.8	0.054	<0.01	48.9	129.5	10.7	1065	0.07	<0.01	8.4	146.5	280	2.1
KDH034	2.94	3.57	0.28	0.1	<0.005	<0.01	0.7	1.7	>15.0	262	0.09	<0.01	0.2	1640	20	0.6
KDH036	21	2.54	1.17	0.3	0.424	0.03	9	3.3	10.45	1445	12.3	0.01	0.9	411	310	54.8
KDH037	9.98	23.8	0.24	1.1	0.035	0.01	10	61	8.77	2850	0.75	<0.01	1	636	40	6.8
KDH039	8.72	11.2	0.38	2.9	0.035	<0.01	88.8	19.6	10.65	1385	0.1	<0.01	33.7	574	4230	2.5
KDH040	5.14	1.06	0.16	0.1	<0.005	0.01	1.7	5.5	0.77	2360	3.76	<0.01	0.4	1325	230	8.3
KDH042	3.27	0.35	0.1	0.1	0.011	0.01	0.7	3.5	0.07	165	3.14	<0.01	0.2	125	110	1.1
KDH043	4.68	0.56	0.12	0.2	0.099	0.01	1.6	2.9	0.08	453	5.46	<0.01	0.4	157	250	2.7
KDH045	24.6	0.69	0.46	0.2	0.099	0.01	4.5	1.5	0.51	8560	3.19	0.01	0.5	555	1330	28.4
KDH046	9.6	1.22	0.26	<0.1	0.026	0.01	0.8	2	0.46	>10000	4.6	0.01	0.4	1590	380	30.6
KDH047	1.02	1.84	0.1	0.2	0.008	0.01	1.9	8.3	0.91	335	2.69	<0.01	0.2	226	50	7.1
KDH048	14.05	12.15	0.53	6.4	0.598	<0.01	129.5	92.8	7.31	3670	0.13	<0.01	14.6	204	1360	6.2
KDH049	8.36	16.35	0.32	3.4	0.102	<0.01	63.3	74.9	12.8	1865	0.16	<0.01	7.6	392	210	1.1
KDH050	8.96	15.6	0.44	6.5	0.166	0.01	158.5	37	12.7	1760	0.21	<0.01	30.9	803	440	5.1
KDH051	0.94	2.42	0.07	0.8	<0.005	0.41	5.4	4.9	0.26	143	2.43	0.01	1.6	20.4	40	1.8
KDM001	32.28	0.46	0.66	0.1	0.451	0.01	1.7	1	0.19	2170	4.84	<0.01	0.4	1475	2230	31.3
KDM003	11.3	0.57	0.31	0.1	<0.005	0.01	3.3	1.4	0.19	2480	2.2	<0.01	0.8	1460	210	1.6
KDM004	2.77	0.55	0.18	0.1	<0.005	0.02	1.3	7.1	0.21	443	3.37	0.01	0.3	622	190	1.6
KDM005	4.2	0.49	0.26	0.1	<0.005	0.01	0.8	0.4	>15.0	443	0.35	<0.01	0.9	1880	520	1.4
KDM006	4.29	0.35	0.2	0.1	<0.005	0.01	1.2	1.2	0.22	1360	3.64	<0.01	0.7	1025	300	0.9
KDM007	3.79	0.51	0.22	<0.1	<0.005	<0.01	0.8	0.2	>15.0	617	0.24	<0.01	0.3	1925	50	1.6
KDM008	10.6	6.38	0.31	4.9	0.054	0.01	31.3	2.4	13.55	5210	0.12	<0.01	73.5	584	2650	3.4
KDM009	4.23	2.28	0.18	0.1	0.007	0.03	5.3	9.8	7.8	2120	2.03	0.01	0.8	1125	50	9.1
KDM010	19.05	2.73	0.49	0.2	0.081	0.04	6.9	7.2	0.83	>10000	3.48	0.01	0.5	1405	600	7.7
KDM011	13.65	1.63	0.39	0.2	0.062	0.04	2.9	2.8	0.36	5240	4.08	0.01	0.5	370	730	18.3
KDM012	2.83	0.37	0.18	0.1	<0.005	0.01	0.5	2.8	0.41	393	3.19	<0.01	0.3	872	60	1.3
BTB001	4	6.89	0.14	<0.1	0.012	0.02	0.8	29.1	3.21	571	1.5	0.01	0.1	908	30	3.5
BTH003	8.39	15.85	0.19	0.9	0.03	0.13	18.4	36.4	4.47	1560	1.69	0.01	2.7	121	210	3.6
BTH004	17.65	7.69	0.34	2.1	2.29	<0.01	14.1	10.6	1.34	3490	6.09	<0.01	2.9	66.5	580	3.4
BTH005	18.25	28.8	0.43	1.2	0.493	0.02	16.9	44.6	3.88	2870	3.19	<0.01	3.3	114.5	630	5.6
BTH006	15.95	25.6	0.64	1.9	0.234	<0.01	158	37.4	3.73	3120	2.08	<0.01	8.4	291	>10000	2.2
BTH007	20.9	30.1	0.36	0.7	0.05	0.04	19	49.7	3.54	3550	0.76	<0.01	11.3	148	330	1.3
BTH008	20.7	32.8	0.41	0.5	0.047	0.01	34.6	51.5	4.24	3840	0.6	<0.01	5.9	80.4	2170	1.2
BTH009	21	25.8	0.35	0.9	0.033	0.15	17.6	63.4	5.44	4810	0.44	0.01	8.5	155.5	1870	0.9
BTH011	9.71	5.82	0.26	<0.1	1.15	<0.01	2	10.4	2.52	1350	6.83	<0.01	0.2	214	540	11.2
BTH012	9	15.4	0.17	0.2	0.186	<0.01	2.3	20.7	3.96	2640	1.89	0.16	0.2	190.5	230	6.2
BTH013	15.9	22.7	0.33	1.1	0.034	0.01	8.1	50	5.24	3600	0.54	<0.01	7.5	255	450	1.2
BTH014	21.1	25.2	0.33	0.2	0.03	0.02	3.9	48.9	2.92	3060	0.5	0.01	6	253	300	0.9
BTH015	10.4	6.06	0.17	0.3	0.016	0.01	8	7.7	0.09	244	3.85	0.01	0.2	25	110	11.4
BTH016	2.02	3.89	0.07	1	0.006	0.03	2.1	8.2	0.05	487	3.15	0.01	0.5	18.8	220	2.6
BTH017	1.9	3.43	0.12	1.4	0.008	0.03	21.8	4.1	0.08	229	4.8	0.02	0.7	25.8	170	3.9
BTH019	9.94	6.88	0.18	0.5	0.028	0.03	6	2.8	0.09	238	4.25	0.01	1.1	37.8	250	3.9
BTH020	2.94	4.82	0.08	0.4	0.01	0.01	4.3	6.2	0.05	185	3.2	0.01	0.7	28	70	2.2
BTH022	1.51	3.47	0.14	1.5	<0.005	0.01	14.7	3.7	0.01	54	3.53	0.01	0.5	12.5	120	2.2
BTH023	4.32	4.16	0.13	0.1	0.005	0.01	0.5	20.3	2.23	372	1.6	<0.01	0.3	1130	30	4.8
BTH024	6.86	14.35	0.14	0.4	0.053	<0.01	7.3	14.6	4.33	1735	0.49	0.01	1.4	127	380	2.1
BTH025	14.45	22.6	0.32	0.4	0.507	0.01	6.9	33.2	6.03	3270	3.51	<0.01	2.4	512	740	2.2
BTH026	16.65	17.95	0.34	0.2	0.524	0.01	5.3	55.9	4.98	3990	1.09	<0.01	0.8	251	450	1.8
BTH027	3.73	6.96	0.11	0.1	0.008	0.01	0.8	17.2	3.74	1670	0.88	<0.01	0.2	930	130	1.4
BTM001	23.2	31.8	0.38	2.8	0.495	0.01	15.1	54.7	5.3	3740	1	<0.01	24.7	173.5	820	2.2
BTM003	12.9	21.6	0.22	1.4	0.05	0.01	2	29.8	5.41	1985	0.75	<0.01	3.7	640	300	1.1
BTM004	11.35	15.6	0.2	0.1	0.171	0.98	<0.5	53	5.6	3010	0.7	0.59	0.2	817	450	1.3
BTM007	13.4	29	0.29	1.8	0.366	0.02	15.7	46.8	4.79	2040	0.65	0.01	20.2	60	170	2.6
BTM008	7.52	13.25	0.15	0.3	0.166	0.06	14.2	21	1.68	1475	3.15	0.01	1.6	78.6	120	2.3
BTM009	16	38.4	0.34	0.9	0.221	0.01	8.1	54.9	5.44	2150	1.69	<0.01	9.2	89.5	160	1.6
BTM010	13.25	19.75	0.25	0.3	0.335	0.01	2.8	65.7	7.81	3480	0.6	<0.01	0.7	211	190	1.9
AOH001	13.60	0.93	0.16	<0.1	<0.005	<0.01	2.5	0.9	0.07	79	3.09	<0.01	0.4	13.6	150	1.1
ATM001	37.9	0.75	0.72	<0.1	<0.005	0.02	1.3	1.7	0.09	108	4.47	0.03	0.8	3.1	380	1.6
EAM002	36.4	1.55	0.57	0.1	<0.005	0.04	2.9	14.9	0.63	373	3.22	0.05	0.7	3.7	230	0.7
RHH002	37.9	0.67	0.25	<0.1	<0.005	0.01	1.4	0.8	0.45	166	2.67	0.04	0.2	3.5	280	0.6
KEH002	46.5	0.66	0.81	0.1	<0.005	<0.01	1.4	2.2	0.01	58	2.53	<0.01	0.6	4.9	30	2.3
KEH003	32.4	2.69	0.27	0.3	0.008	0.01	6.7	6.2	<0.01	28	1.56	0.01	1.0	5.8	270	8.5
MHH001	33.2	0.44	0.63	<0.1	<0.005	0.01	0.9	4.1	0.01	53	3.64	<0.01	0.4	2.8	70	0.6
MHH002	1.81	30.6	0.33	1.7	0.052	4.10	76.8	39.6	0.24	32	0.58	0.06	2.5	9.6	150	5.0
RHH003	17.05	26.6	0.26	0.1	0.031	4.11	6.3	24.3	2.17	806	4.36	0.56	1.7	99.4	340	14.1
RHH006	1.29	13.55	0.19	1.0	0.008	3.89	56.2	10.4	0.22	85	2.28	1.44	1.3	4.6	140	25.5
SKM003	8.15	8.34	0.13	6.7	0.016	0.04	1.4	8.5	0.13	602	3.18	0.31	1.1	13.7	30	1.4
SYH001	4.39	22.7	0.17	0.8	0.056	2.74	31.6	31.7	0.73	373	2.80	0.16	4.7	63.3	300	12.8
KEH001	18.75	11.3	0.37	4.1	0.012	0.01	21.8	17.6	0.01	84	0.80	0.01	1.0	42.0	360	17.9
RHH004	37.6	4.03	0.58	0.1	<0.005	0.10	4.9	6.0	0.97	382	2.55	0.05	0.9	3.7	340	0.6
TZM002	13.45	1.84	0.29	0.5	<0.005	0.13	3.9	3.0	0.02	87	3.08	0.01	0.7	9.0	100	4.1
TSH020																
TSH001	11.80	3.63	0.20	0.1	0.006	0.03	8.6	1.6	0.03	99	6.87	0.03	0.9	12.5	940	12.6
TSH002	0.74	21.8	0.10	2.7	0.048	1.37	28.7	19.2	0.28	56	0.37	0.11	0.8	25.6	210	4.0
TSH003	0.39	20.3	<0.05	2.8	0.016	0.98	13.6	17.8	0.18	75	0.47	0.13	1.2	8.0	30	6.9
TSH004	1.90	9.94	0.06	1.1	0.015	0.37	9.3	9.6	0.14	742	2.97	0.03	0.8	20.5	160	9.8

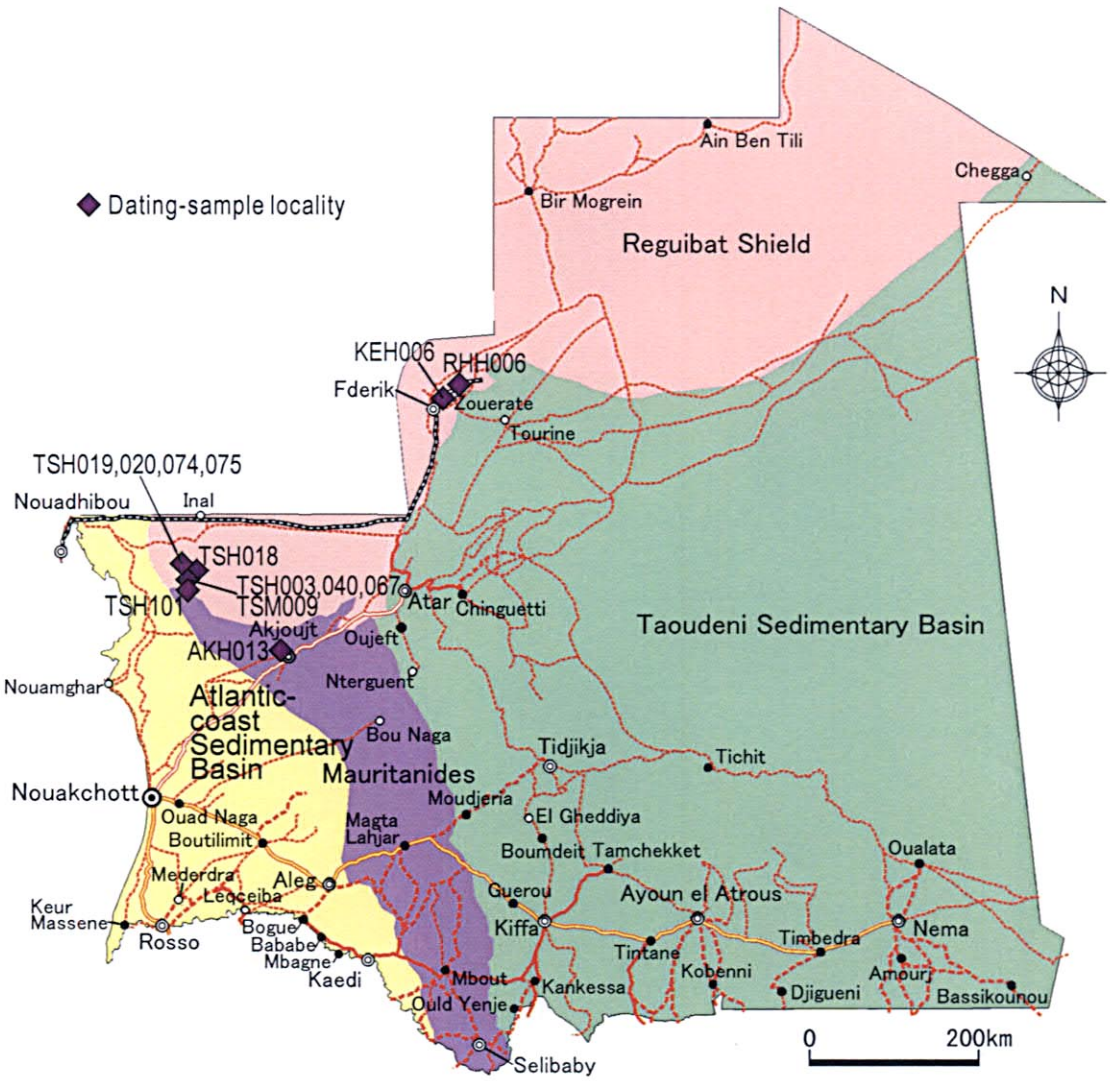
Sample	Pd	Pt	Rb	Re	S	Sb	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Cr2o3
	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
IDM005	<0.001	<0.005	18.8	<0.002	<0.01	0.53	1	0.9	1650	0.57	<0.05	3.3	0.191	0.05	1	182	3	7.6	2	47.3	
IDM006	<0.001	<0.005	4.4	<0.002	<0.01	0.88	1	1.5	1470	1.65	<0.05	7.1	0.662	<0.02	0.7	137	2	19.9	36	55.8	
IDM007	<0.001	<0.005	0.5	<0.002	<0.01	0.22	1	0.3	22.3	<0.05	<0.05	<0.2	0.005	<0.02	<0.1	3	6.1	0.3	7	1.7	
IDM008	<0.001	<0.005	3.6	<0.002	<0.01	0.15	1	0.3	10.2	<0.05	<0.05	<0.2	0.006	<0.02	<0.1	3	4.4	0.4	2	1.3	
IDM009	<0.001	<0.005	1.5	<0.002	<0.01	0.14	1	0.3	6.5	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	3	6.4	0.6	16	1.7	
IDM010	<0.001	<0.005	1	<0.002	0.01	0.1	1	0.3	9	<0.05	<0.05	<0.2	0.007	<0.02	<0.1	3	5.1	0.3	3	1.7	
IDM011	<0.001	<0.005	3	<0.002	0.01	0.12	1	0.3	9.6	<0.05	1.28	<0.2	0.007	<0.02	<0.1	4	4.4	0.4	3	2.8	
IDM012	<0.001	<0.005	0.4	<0.002	<0.01	0.16	<1	0.3	123.5	<0.05	<0.05	<0.2	0.006	<0.02	0.2	9	3.9	0.8	2	2.7	
KDB001	<0.001	<0.005	6.3	<0.002	0.01	1.96	1	0.3	21.2	<0.05	0.37	0.4	0.014	0.06	0.7	20	3.4	2.5	39	5.9	
KDB002	0.001	0.01	8.4	<0.002	0.01	3.97	1	0.4	11	<0.05	0.57	0.6	0.015	0.07	0.4	14	6	3.1	69	7	
KDH003	<0.001	<0.005	0.5	<0.002	0.04	0.17	1	0.3	12.4	<0.05	<0.05	0.2	<0.005	<0.02	0.5	21	6.9	0.8	4	7.7	
KDH005	<0.001	<0.005	0.6	0.003	0.12	6.8	21	5	9.3	<0.05	0.74	<0.2	<0.005	0.06	0.8	9	3.3	3.3	1125	4.4	
KDH006	<0.001	0.007	0.3	<0.002	0.09	1.64	19	3	17.2	<0.05	0.29	<0.2	<0.005	<0.02	0.9	11	2.8	3.1	828	2.6	
KDH007	<0.001	<0.005	2.9	<0.002	0.22	3.45	11	1.8	19.2	<0.05	0.36	0.4	0.014	0.08	1.3	15	2.5	5.1	1295	7.5	
KDH008	<0.001	<0.005	0.2	<0.002	0.03	1.3	10	1.4	3.6	<0.05	0.29	<0.2	<0.005	<0.02	0.9	66	3.6	3.7	632	4.4	
KDH010	<0.001	<0.005	1.3	<0.002	0.2	6.03	18	6	8.3	<0.05	0.39	0.3	0.007	0.03	1.8	31	2.9	6.6	1350	4.6	
KDH012	<0.001	0.008	1.5	<0.002	0.14	6.94	22	32.1	7.9	<0.05	1.64	0.5	0.012	<0.02	1.1	46	3.7	12.8	1860	4.8	
KDH013	<0.001	0.005	17.2	<0.002	<0.01	0.14	1	0.5	5.9	0.11	<0.05	3	0.048	0.06	0.4	10	4.5	2.2	20	33.2	
KDH014	<0.001	0.012	15.2	<0.002	<0.01	0.11	1	0.5	5	0.05	<0.05	2.4	0.029	0.07	0.5	8	4.1	2.3	12	28.5	
KDH015	0.001	0.01	0.4	<0.002	0.01	0.38	1	0.2	10.7	0.71	<0.05	15.8	0.512	<0.02	0.7	74	0.5	8.1	79	32.5	
KDH016	<0.001	0.007	0.5	<0.002	0.01	0.21	1	0.3	5.7	<0.05	<0.05	0.2	0.005	<0.02	0.2	16	9.6	1.1	42	18.7	
KDH018	<0.001	0.011	0.2	<0.002	0.01	0.1	<1	0.3	1.7	<0.05	<0.05	<0.2	<0.005	<0.02	0.1	16	5.8	0.6	28	11.6	
KDH019	<0.001	0.013	0.8	<0.002	0.02	0.09	<1	0.3	7.9	<0.05	<0.05	0.2	0.005	0.02	0.5	15	4.3	2	32	15.9	
KDH023	<0.001	0.011	0.1	<0.002	<0.01	0.07	1	0.2	3.5	2.37	<0.05	2.1	0.795	<0.02	0.4	259	3.1	13.5	68	82.6	
KDH024	<0.001	0.014	0.5	<0.002	0.03	2.67	1	<0.2	8.5	<0.05	<0.05	<0.2	<0.005	<0.02	0.2	16	1	1.2	43	1.4	
KDH025	<0.001	0.012	0.4	<0.002	0.04	1.8	<1	<0.2	10.8	<0.05	<0.05	0.2	<0.005	<0.02	0.2	18	0.8	1.3	49	1.7	
KDH026	0.002	0.009	0.2	<0.002	<0.01	0.08	2	9.2	828	9.18	0.08	24.3	2.12	<0.02	6.7	375	0.7	83.1	144	153	
KDH027	<0.001	0.009	21.9	<0.002	<0.01	0.12	1	0.5	9.5	0.14	<0.05	4.2	0.066	0.09	0.5	12	4.3	2.9	5	43.8	
KDH028	0.001	0.006	0.3	<0.002	0.03	2.13	1	<0.2	8	0.05	<0.05	0.3	0.005	<0.02	0.2	18	1	0.9	36	2.2	
KDH029	0.001	0.011	17.8	<0.002	<0.01	0.75	1	3.3	82.5	0.72	<0.05	8.8	0.186	0.29	1.7	131	2	10.1	128	76.4	
KDH030	<0.001	0.007	2.1	<0.002	0.09	2.5	5	2.4	31.8	<0.05	0.29	0.3	0.008	0.16	2.4	47	4.4	10.9	3010	5	
KDH031	<0.001	0.005	0.6	<0.002	0.09	1.69	7	5.1	15.2	<0.05	0.18	0.2	<0.005	0.12	2.4	11	3.9	8.8	2570	4.5	
KDH033	<0.001	0.005	<0.1	<0.002	<0.01	0.06	1	0.8	8.9	0.73	<0.05	14.3	0.198	<0.02	2.6	84	0.6	8.4	113	163	
KDH034	<0.001	<0.005	0.1	<0.002	<0.01	0.4	<1	<0.2	2.5	<0.05	<0.05	0.2	0.007	<0.02	0.1	19	0.5	0.4	33	1.6	
KDH036	0.001	0.006	2.1	<0.002	0.04	21.7	13	3.1	11.6	0.05	2.79	2	0.022	0.02	3.3	122	1	5.2	964	20.8	
KDH037	0.001	0.006	0.6	<0.002	<0.01	0.2	1	0.8	7.2	0.07	0.06	2.2	0.039	<0.02	1.3	148	0.3	4.5	1035	37.4	
KDH039	0.001	0.005	0.1	<0.002	<0.01	0.16	3	0.3	43.6	2.46	0.05	23.4	1.115	<0.02	1.2	72	0.4	32.7	104	86.2	
KDH040	0.001	0.005	0.5	<0.002	0.01	0.6	2	0.3	17	<0.05	<0.05	0.3	0.014	<0.02	1	23	3.4	5.7	65	5.7	
KDH042	<0.001	<0.005	0.4	<0.002	0.01	0.13	1	0.3	1.9	<0.05	0.06	0.2	<0.005	<0.02	0.7	4	4.1	1	45	14.8	
KDH043	<0.001	0.006	0.2	0.002	0.02	0.28	1	0.4	5	<0.05	0.15	1.2	0.023	<0.02	1.2	9	4	2.7	46	33.8	
KDH045	<0.001	0.007	0.3	<0.002	0.15	4.89	12	4.7	18	<0.05	0.54	4	0.015	<0.02	5.2	16	2.3	8.4	1875	8.4	
KDH046	<0.001	<0.005	0.4	<0.002	0.04	0.58	5	2.9	69.3	<0.05	0.13	<0.2	0.023	0.31	1.4	8	2.4	6.2	4480	3	
KDH047	0.001	<0.005	0.3	<0.002	0.01	0.27	1	0.2	4.4	<0.05	0.08	0.3	0.005	<0.02	0.7	12	3.2	0.8	53	5.1	
KDH048	0.002	0.005	0.3	<0.002	0.01	0.16	1	2.6	23.7	1.09	0.12	33.9	1.03	<0.02	8	119	1	20.5	163	206	
KDH049	0.002	0.007	0.1	<0.002	<0.01	0.06	1	1.1	10.9	0.53	<0.05	21.5	0.208	0.02	1.8	122	0.7	9.2	112	105	
KDH050	0.001	0.01	0.3	<0.002	<0.01	0.11	2	3.3	13	1.9	<0.05	49.9	0.634	<0.02	4.3	108	9	21	113	199	
KDH051	<0.001	0.011	21.3	<0.002	<0.01	0.07	1	0.4	5.1	0.09	<0.05	2.3	0.03	0.09	0.4	8	4.2	2	11	27.8	
KDM001	0.001	0.005	0.4	<0.002	0.15	2.78	10	7.2	7.7	<0.05	0.6	0.2	<0.005	0.03	0.9	13	1.6	8.7	1955	4.2	
KDM003	0.001	<0.005	0.5	<0.002	0.04	0.12	1	0.2	11.5	<0.05	0.07	0.7	<0.005	0.02	0.9	21	3.4	3.3	41	34	
KDM004	0.001	<0.005	0.9	<0.002	0.02	0.51	1	0.3	7.4	<0.05	<0.05	3.8	0.008	<0.02	0.3	14	5.3	1.2	46	8.4	
KDM005	0.001	0.008	0.2	<0.002	0.02	2.62	1	<0.2	12.8	<0.05	<0.05	0.2	<0.005	<0.02	0.2	18	0.4	1	40	2.3	
KDM006	<0.001	0.008	0.2	<0.002	0.06	0.13	1	0.3	11.8	<0.05	<0.05	<0.2	<0.005	<0.02	0.4	15	5.9	1.5	24	19.6	
KDM007	0.001	0.005	0.1	<0.002	0.01	0.69	1	<0.2	5.7	<0.05	<0.05	<0.2	0.005	<0.02	0.1	14	0.3	0.4	33	1.3	
KDM008	0.001	<0.005	0.3	<0.002	0.02	0.2	2	0.5	18.7	5.46	0.06	5.2	1.47	<0.02	0.9	246	2.3	33	88	182	
KDM009	0.001	<0.005	2.1	<0.002	<0.01	0.67	1	0.2	6.9	0.05	0.11	0.8	0.017	0.03	1.2	47	1.8	3.3	41	5.2	
KDM010	0.001	<0.005	2	<0.002	0.02	0.98	7	0.4	65.7	<0.05	0.55	0.4	0.008	0.08	3.1	45	2.6	11.9	475	11.6	
KDM011	0.001	<0.005	2.4	<0.002	0.07	4.8	5	1.7	27.9	<0.05	0.49	0.7	0.009	0.08	3.3	39	2.6	3.8	1230	9.9	
KDM012	<0.001	<0.005	0.4	<0.002	0.01	0.2	1	0.3	4.6	<0.05	<0.05	<0.2	<0.005	<0.02	0.6	9	5.2	0.9	41	5	
BTB001	0.004	0.01	0.7	<0.002	0.27	0.06	2	0.2	9.4	<0.05	<0.05	<0.2	0.042	<0.02	0.1	58	2.8	1.7	47	2.2	
BTH003	0.007	0.005	4.1	<0.002	<0.01	0.17	2	0.8	11.4	0.22	<0.05	1.5	0.564	0.06	0.9	190	1.7	14.2	542	26.4	
BTH004	0.005	<0.005	0.1	<0.002	0.03	0.06	29	6.5	5.7	0.41	4.87	11.4	0.141	0.05	1.7	60	0.5	39.3	521	62.2	
BTH005	0.002	<0.005	0.8	<0.002	0.07	0.06	43	1.6	5.6	0.35	1.82	3.9	0.234	<0.02	0.7	149	0.7	11.9	934	37.8	
BTH006	0.046	0.007	0.2	<0.002	<0.01	<0.05	25	1.3	31.1	0.64	0.16	5.6	0.599	<0.02	1.5	263	0.6	135	1105	41.9	
BTH007	0.001	0.006	1.2	<0.002	0.01	0.15	3	0.4	40.2	0.88	<0.05	0.9	1.3	<0.02	0.2	332	2.3	42	1365	15.2	
BTH008	<0.001	0.009	0.6	<0.002	<0.01	<0.05	3	0.2	91.8	0.47	<0.05	1.2	0.799	<0.02	0.2	259	1.2	44.1	977	11	
BTH009	0.002	<0.005	1.5	<0.002	<0.01	0.11	3	0.8	28.7	0.72	<0.05	0.5	0.89	<0.02	0.3	221	0.7	45.8	1310	25.1	
BTH011	0.004	0.118	<0.1	<0.002	0.1	0.1	37	14.6	10.1	<0.05	1.43	<0.2	0.034	0.05	2.2	216	0.3	8.6	1280	1.6	
BTH012	0.002	0.007	<0.1	<0.002	0.02	0.08	8	1.2	509	0.07	1.49	0.2	0.06	<0.02	0.4	86	0.7	3.1	320	4.9	
BTH013	<0.001	<0.005	0.1	<0.002	<0.01	<0.05	2	0.7	5.2	0.62	0.06	<0.2	0.917	<0.02	0.3	319	0.5	14.1	889	35.2	
BTH014	0.003	0.007	0.3	<0.002	0.01	<0.05	1	0.4	24.2	0.4	0.07	<0.2	0.45	<0.02	0.1	182	0.2	4.9	1100	5.9	
BTH015	<0.001	0.011	0.4	<0.002	0.08	0.09	7	0.3	12.2	<0.05	0.08	0.5	0.045	<0.02	0.5	40	1.8	7.6	46	8	
BTH016	<0.001	<0.005	1.1	<0.002	0.01	0.08	1	0.3	11.7	<0.05	<0.05	0.3	0.049	<0.02	0.3	43	3.3	2.3	11	32.1	
BTH017	0.001	0.014	1.3	<0.002	0.02	0.1	1	0.5	33.3	0.09	<0.05	9	0.034	<0.02	0.5	36	7.9	3.6	11	43.2	
BTH019	<0.001	<0.005	1.8	<0.002	0.01	0.07	2	0.4	15.5	0.11	<0.05	2.2	0.051	<0.02	1.4	96	2.6	23.6	81	15.8	
BTH020	0.001	<0.005	0.6	<0.002	0.01	0.07	1	0.4	9.6	0.05	<0.05	0.5	0.082	<0.02	0.3	75	3.1	4.6	11	15.6	
BTH022	<0.001	<0.005	0.5	<0.002	<0.01	0.06	2	0.4	28.5	0.06	<0.05	8.1	0.032	<0.02	0.7	34	3.8	6.1	6	46.5	
BTH023	0.002	<0.005	0.3	<0.002	0.18	0.08	2	<0.2	4.6	<0.05	<0.05	0.2	0.039	<0.02	0.1	93	1.3	3.4	182	5.9	
BTH024	0.011	<0.005	0.2	<0.002	0.02	<0.05	1	0.2	476	0.14	<0.05	0.3	0.309	<0.02	0.1	146	0.4	9.9	222	11.2	
BTH025	0.014	<0.005	0.2	<0.002	<0.01	0.06	24	0.9	174	0.25	1.72	0.3	0.283	<0.02	0.5	140	0.5	12.6	433	16	
BTH026	0.009	<0.005	0.2	<0.002	0.01	<0.05	19	0.8	232	0.11	1.45	<0.2	0.192	<0.02	0.2	150	0.4	6.1	521	8.1	
BTH027	0.002	<0.005	0.5	<0.002	0.01	0.06	1	0.2	7.6	<0.05	<0.05	<0.2	0.049	<0.02	0.2	66	0.6	1.9	150	2.9	
BTM001	<0.001	0.006	0.5	<0.002	0.02	<0.05	12	1.8	45.5	1.77	0.81	2.2	0.731	<0.02	0.8	237	0.7	38.3	968	96.5	
BTM003	0.001	<0.005	0.4	<0.002	<0.01	<0.05	3	1.7	4.7	0.26	0.06	1.1	0.513	<0.02	0.8	140	0.6	22.3	620	42.8	
BTM004	0.037	0.014	5.1	<0.002	0.01	0.08	4	0.7	37	0.05	0.45	<0.2	0.049	0.17	0.3	76	0.2	1.3	1595	4.1	
BTM007	0.001	<0.005	0.7	<0.002	<0.01	<0.05	10	7.6	6.2	1.43	0.16	1.4	0.631	<0.02	0.8	383	0.5	28.7	568	58	
BTM008	0.001	0.01	6	<0.002	0.01	0.19	2	0.8	11.3	0.12	0.05	0.2	0.214	0.03	0.2	163	1.6	9	169	7.1	
BTM009	<0.001	<0.005	0.6	<0.002	0.01	0.09	4	8.8	5.7	0.72	0.07	0.2	1.39	<0.02	0.3	458	0.7	22.8	479	20.8	
BTM010	0.009	0.009	0.2	<0.002	<0.01	0.18	6	1.7	141	0.11	0.25	<0.2	0.217	<0.02	0.1	166	0.3	5.6	517	11.5	
AOH001	<0.001	<0.005	0.1	<0.002	0.02	0.21	<1	0.9	16.6	<0.05	<0.05	<0.2	0.026	<0.02	0.1	18	3.3	0.3	5	0.9	
ATM001	<0.001	<0.005	0.3	<0.002	0.08	0.25	<1	1.0	20.0	0.14	<0.05	<0.2	<0.005	<0.02	0.1	2	6.5	1.1	<2	2.5	
EAM002	<0.001	<0.005	2.1	<0.002	0.05	0.42	<1	0.4	12.2	<0.05	<0.05	0.4	0.006	<0.02	0.1	3	5.0	2.5	8	3.6	
RHH002	<0.001	<0.005	0.2	<0.002	0.01	0.10	<1	0.4	6.3	<0.05	<0.05	<0.2	0.005	<0.02	<0.1	1	4.7	0.8	8	1.2	
KEH002	<0.001	<0.005	0.3	<0.002	<0.01	0.32	<1	0.2	1.3	<0.05	<0.05	0.6	<0.005	<0.02	0.4	5	4.8	1.4	6	2.9	
KEH003	<0.001	<0.005	0.6	<0.002	<0.01	1.24	<1	0.4	17.9	<0.05	<0.05	2.2	0.032	<0.02	1.1	9	2.4	5.8	11	9.2	
MHH001	<0.001	<0.005	0.6	<0.002	<0.01	0.11	<1	0.3	1.5	<0.05	<0.05	<0.2	<0.005	<0.02	<0.1	2	4.3	2.5	<2	2.0	
MHH002	<0.001	<0.005	170.5	<0.002	<0.01	<0.05	<1	5.2	60.8	0.47	<0.05	19.1	0.173	0.58	1.1	18	1.6	7.6	9	37.9	
RHH003	0.001	<0.005	460.0	0.002	0.36	<0.05	<1	1.1	173.5	<0.05	<0.05	0.3	1.11	1.8	0.7	307	0.1	2.7	160	1.9	
RHH006	<0.001	<0.005	140.5	<0.002	0.01	0.08	<1	0.4	274	<0.05	<0.05	33.5	0.071	0.78	0.9	12	2.6	2.9	16	26.7	
SKM003	<0.001	<0.005	0.8	<0.002	0.01	<0.05	<1	1.2	49.8	<0.05	<0.05	0.3	0.383	<0.02	0.8	204	1.8	1.8	29	405.0	
SYH001	<0.001	<0.005	152.0	<0.002	0.01	0.34	<1	2.8	37.8	<0.05	<0.05	15.7	0.217	0.73	5.5	90	3.8	13.6	168	34.8	
KEH001	0.012	0.006	0.6	<0.002	<0.01	0.20	<1	0.7	3.5	0.91	<0.05	35.1	0.100	<0.02	5.8	5	1.6	30.6	122	107.5	
RHH004	<0.001	<0.005	4.0	<0.002	0.02	0.11	<1	0.5	20.5	<0.05	<0.05	0.2	0.018	<0.02	0.1	6	4.0	2.8	7	3.0	
TZM002	<0.001	<0.005	3.2	<0.002	0.02	1.29	<1	0.4	11.0	<0.05	<0.05	1.8	0.015	<0.02	0.6	14	3.9	2.4	6	16.4	
TSH020	<0.001	<0.005																			
TSH001	<0.001	<0.005	1.3	<0.002	0.05	1.86	1	1.0	88.8	<0.05	0.32	1.0	0.046	0.04	0.8	13	3.6	1.6	49	8.6	
TSH002	0.001	0.008	44.1	0.002	0.02	0.29	1	0.7	73.9	0.09	<0.05	5.0	0.136	0.35	1.7	190	6.3	29.9	48	98.7	
TSH003	<0.001	<0.005	30.9	<0.002	2.75	0.20	1	0.5	1065	0.12	<0.05	4.6	0.078	0.22	1.2	34	3.4	2.4	20	80.8	
TSH004	<0.001	<0.005	11.4	<0.002	2.98	1.75	1	0.5	2100	0.07	0.08	3.0	0.049	0.40	1.7	50	10.4	3.1	23	33.1	

2.5 Chemical Assay4

	Sample	Au	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Pd	Pt	Rb	Re	S	Sb	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr	Cr2o3
		ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
piment	TSH005	0.009	0.15	0.38	92.4	140	0.69	0.19	0.06	0.20	8.56	136.0	25	0.10	26.6	5.81	2.35	<0.05	0.6	0.011	0.05	4.6	2.4	0.05	37	3.22	0.03	0.5	8.6	300	26.1	<0.001	<0.005	2.1	0.008	0.03	1.66	2	0.3	48.4	0.08	<0.05	1.0	0.032	0.03	0.6	8	1060	1.0	37	13.5	
piment	TSH006	0.002	0.02	0.5	15.4	130	0.22	0.04	0.77	0.03	3.12	2.5	195	<0.05	9.9	9.25	1.74	0.13	0.2	<0.005	0.02	5.0	0.7	0.44	780	2.82	0.04	0.5	11.2	100	0.8	<0.001	<0.005	0.8	<0.002	0.01	0.36	1	0.5	14.0	<0.05	<0.05	0.3	0.014	<0.02	0.3	14	4.8	2.4	15	7.0	
piment	TSH007	0.001	0.03	1.32	4.7	170	0.25	0.06	1.33	0.03	6.52	49.7	26	0.05	9.0	15.60	3.80	0.24	0.2	0.006	0.05	6.4	1.5	0.88	1915	0.99	0.08	0.7	14.3	150	1.0	<0.001	<0.005	1.2	0.008	0.01	0.44	1	0.3	20.0	0.07	<0.05	1.1	0.048	0.10	0.3	18	460	4.2	28	6.5	
piment	TSH008	0.017	0.03	0.15	3.2	200	0.32	0.03	0.31	0.02	3.26	46.4	8	0.09	7.1	17.15	0.84	0.26	<0.1	<0.005	0.02	8.5	1.0	0.07	358	1.03	0.01	0.3	3.4	90	1.8	<0.001	<0.005	0.8	0.006	0.01	0.74	1	<0.2	7.9	<0.05	<0.05	<0.2	<0.005	0.11	0.5	4	460	4.9	14	0.9	
piment	TSH009	0.115	<0.01	0.03	6.9	40	0.09	<0.01	0.02	<0.02	0.48	1.5	249	<0.05	8.5	1.64	0.21	<0.05	<0.1	<0.005	<0.01	<0.5	0.3	0.01	138	3.19	0.01	0.2	9.1	<10	0.7	<0.001	<0.005	0.1	<0.002	<0.01	0.96	1	0.7	2.8	<0.05	<0.05	<0.2	<0.005	<0.02	0.1	5	5.1	0.3	3	<0.5	
piment	TSH010	1.045	0.06	0.26	5.7	560	0.55	0.03	0.27	0.04	4.44	19.0	7	0.14	6.8	35.9	1.41	0.52	0.1	<0.005	0.05	2.9	0.8	0.13	1440	0.53	0.02	0.5	5.0	140	1.8	<0.001	<0.005	3.3	0.002	0.01	3.32	1	<0.2	15.1	<0.05	<0.05	0.4	0.011	0.07	0.9	7	145.5	3.5	10	2.0	
Piment east	TSH011	0.002	0.04	0.33	17.1	570	0.71	0.03	7.42	0.12	10.35	18.5	68	0.09	12.9	14.45	1.71	0.25	0.1	<0.005	0.03	7.2	5.0	0.10	2300	0.94	0.01	0.4	13.3	210	2.4	<0.001	<0.005	1.3	<0.002	0.04	1.23	1	0.3	52.1	<0.05	<0.05	0.4	0.012	0.10	1.3	15	1.4	4.2	15	2.4	
Tasiast north	TSH012	0.056	<0.01	0.24	0.9	20	<0.05	0.01	0.03	<0.02	0.42	172.5	10	<0.05	6.6	0.18	0.70	<0.05	<0.1	<0.005	0.01	<0.5	0.5	0.05	15	0.18	0.01	<0.1	1.4	10	0.7	<0.001	<0.005	0.1	0.003	<0.01	0.26	1	<0.2	3.6	<0.05	<0.05	<0.2	<0.005	0.05	<0.1	4	301	0.2	10	<0.5	
Tasiast north	TSH013	0.008	<0.01	0.63	<0.2	270	0.07	0.01	22	0.23	14.45	5.4	27	0.06	7.8	2.38	2.26	<0.05	0.3	0.082	0.03	7.2	2.0	0.84	3300	1.82	0.04	0.4	1.8	130	6.5	<0.001	<0.005	0.7	<0.002	0.02	0.27	1	0.3	511	<0.05	<0.05	0.6	0.056	<0.02	1.9	28	13.2	21.5	24	7.4	
Tasiast north	TSH014	0.001	0.03	0.22	1.5	240	0.12	0.04	0.23	0.03	4	1.6	178	0.27	21.1	13.50	1.43	0.18	<0.1	<0.005	0.06	2.9	1.0	0.20	940	2.02	0.02	0.3	7.0	180	1.3	<0.001	<0.005	3.9	<0.002	0.01	0.35	1	0.5	20.3	<0.05	<0.05	0.2	0.006	<0.02	0.3	9	2.8	2.1	8	1.4	
Tasiast north	TSH015	0.002	0.02	0.14	2.0	70	0.05	0.03	0.29	<0.02	0.98	1.6	225	0.26	10.7	1.54	0.49	<0.05	<0.1	<0.005	0.06	0.6	0.9	0.04	190	2.99	0.02	0.3	8.6	10	1.1	<0.001	<0.005	3.9	<0.002	<0.01	0.26	1	0.8	6.8	<0.05	<0.05	<0.2	0.005	<0.02	0.1	7	3.6	0.5	3	0.8	
Tasiast north	TSH017	0.002	0.03	8.78	3.3	570	0.76	0.03	1.52	0.05	32	8.3	71	0.56	5.6	1.80	18.00	0.06	0.9	0.020	0.98	19.1	14.6	0.61	321	1.17	3.64	2.9	24.8	470	24.5	<0.001	<0.005	28.7	<0.002	0.01	0.18	1	0.8	339	0.13	<0.05	5.6	0.180	0.11	1.1	46	3.4	5.3	67	23.4	
Ndaouds	TSH018	0.011	<0.01	6.82	<0.2	220	0.16	0.11	7.88	0.07	5.32	51.8	142	0.14	120.5	6.73	13.00	0.10	0.2	0.051	0.09	2.0	8.3	3.59	1240	0.20	1.42	0.8	112.5	200	0.7	0.01	0.012	1.9	0.003	0.01	<0.05	1	0.4	106.5	<0.05	0.09	0.2	0.342	0.03	0.1	218	74.5	12.0	61	2.9	
Khneifissat	TSH019	<0.001	<0.01	9.6	0.3	640	0.97	0.24	5.12	0.18	60.8	53.2	29	0.34	18.1	2.22	19.15	0.13	0.6	0.028	0.34	33.3	10.7	0.74	672	0.40	2.25	2.3	30.6	450	12.6	<0.001	<0.005	8.9	0.005	0.02	0.16	1	0.7	715	0.17	<0.05	9.0	0.237	0.10	1.5	57	296	11.8	43	14.6	
Inkebden	TSH021	0.001	0.04	8.27	0.6	30	0.27	0.01	8.13	0.13	7.24	74.5	108	0.75	149.0	9.44	16.45	0.12	0.7	0.071	0.08	2.6	19.6	4.32	1535	0.47	1.23	1.9	115.0	310	0.6	<0.001	<0.005	0.9	0.007	0.11	0.09	2	0.6	102.0	0.16	<0.05	0.3	0.561	0.05	0.1	312	197.0	18.2	85	13.9	
Inkebden SW	TSH022	<0.001	0.23	5.07	15.4	920	2.08	0.15	0.46	0.09	40.6	30.8	842	0.14	98.9	40.2	25.5	0.52	1.1	0.141	0.03	21.9	9.5	0.12	309	5.10	0.05	4.7	87.6	1660	12.0	0.003	0.005	1.0	0.002	0.11	0.32	3	0.9	34.3	0.27	0.16	7.3	0.302	<0.02	3.2	1175	1.8	23.3	81	30.9	
Inkebden SW	TSH023	<0.001	<0.01	9.72	<0.2	210	0.09	<0.01	10.05	<0.02	2.5	31.7	230	<0.05	14.7	3.33	11.15	<0.05	0.2	0.014	0.04	2.0	2.3	6.67	787	0.36	0.63	0.3	167.0	50	0.6	<0.001	<0.005	0.8	<0.002	0.02	0.06	1	0.3	108.5	<0.05	<0.05	0.3	0.071	<0.02	0.1	108	0.7	3.5	19	5.8	
Piment TR40	TSH024	0.122	0.04	0.16	6.9	1380	0.21	<0.01	2.4	0.02	8.44	2.2	140	<0.05	7.1	24.90	1.52	0.33	<0.1	<0.005	0.01	3.4	0.5	0.08	1195	2.63	0.02	0.4	7.8	130	1.2	<0.001	<0.005	0.5	<0.002	0.03	1.02	1	0.4	31.7	<0.05	<0.05	<0.2	0.005	<0.02	0.7	9	14.0	2.8	5	0.9	
Piment TR40	TSH025	0.100	0.20	0.82	48.3	3630	0.92	0.28	0.62	0.25	13.2	2.2	20	0.58	18.7	31.4	6.39	0.47	0.1	0.017	0.06	10.9	1.8	0.64	1605	1.44	0.07	0.7	20.7	510	2.5	<0.001	<0.005	5.4	0.002	0.14	1.60	1	0.2	171.5	0.05	0.29	0.5	0.027	0.03	1.7	46	2.7	10.2	48	3.2	
Piment TR40	TSH026	0.195	0.04	0.32	5.4	630	0.18	0.02	0.44	0.02	3.86	1.6	241	0.14	9.1	12.65	1.45	0.17	0.1	<0.005	0.03	3.4	0.8	0.22	558	2.49	0.05	0.4	8.7	80	1.2	<0.001	<0.005	1.9	<0.002	0.02	0.43	1	0.6	16.0	<0.05	<0.05	0.2	0.010	<0.02	0.4	13	19.0	2.2	10	2.1	
Piment TR40	TSH028	0.003	<0.01	8.27	0.9	1450	0.71	0.10	0.27	<0.02	16.35	2.1	67	2.78	2.8	2.40	18.00	0.11	2.3	0.026	2.56	10.8	21.2	0.60	150	1.07	0.17	5.9	9.6	30	7.4	<0.001	<0.005	95.8	<0.002	0.01	0.12	1	1.4	186.0	0.21	<0.05	16.1	0.102	0.30	2.0	14	2.6	3.4	21	49.3	
Piment TR40	TSH030	0.003	<0.01	0.39	2.8	250	0.17	0.05	1.36	<0.02	3.2	89.7	8	0.05	7.9	2.68	1.28	<0.05	0.1	<0.005	0.03	5.7	1.0	0.19	339	1.19	0.02	0.2	3.5	60	1.1	<0.001	<0.005	0.9	0.009	0.01	0.19	1	0.2	8.9	<0.05	<0.05	0.5	0.009	0.17	0.3	9	790	1.5	10	4.2	
Piment TR40	TSH031	0.071	0.02	2.4	3.3	430	0.24	0.14	1.76	0.06	9.3	74.3	33	<0.05	5.6	11.80	7.01	0.19	0.4	0.011	0.05	14.8	3.5	1.30	1850	0.47	0.09	1.1	38.6	150	1.3	<0.001	<0.005	0.4	0.008	0.01	0.37	1	0.3	19.0	0.11	<0.05	2.3	0.083	0.13	0.4	19	550	5.2	89	13.8	
Piment TR40	TSH032	0.081	<0.01	0.27	3.0	480	0.19	0.12	0.98	0.04	3.25	106.0	10	<0.05	9.0	5.01	0.93	0.08	0.1	<0.005	0.01	6.2	0.6	0.34	637	0.92	0.02	0.1	3.1	110	0.8	<0.001	<0.005	0.2	0.008	0.02	0.23	1	<0.2	22.7	<0.05	<0.05	0.3	0.007	0.12	0.2	5	710	2.1	8	1.6	
Piment TR40	TSH033	<0.001	<0.01	0.09	5.2	50	0.11	<0.01	0.19	<0.02	2.9	130.0	9	0.09	8.1	2.87	0.56	0.05	<0.1	<0.005	0.03	6.0	0.4	0.03	139	0.81	<0.01	<0.1	3.2	40	1.0	<0.001	<0.005	2.1	0.005	<0.01	0.49	1	<0.2	3.5	<0.05	<0.05	<0.2	<0.005	0.08	0.2	5	358	1.9	3	<0.5	
Piment TR40	TSH034	0.021	0.03	0.08	23.5	20	0.15	0.01	0.02	0.02	8.01	127.5	4	0.06	2.1	15.55	1.01	0.26	<0.1	<0.005	0.01	13.7	0.4	0.01	85	7.00	<0.01	0.1	5.1	30	1.2	<0.001	<0.005	0.7	0.004	<0.01	0.44	1	<0.2	1.8	<0.05	<0.05	<0.2	<0.005	0.06	0.3	7	346	3.3	4	<0.5	
Piment TR40	TSH035	0.025	0.08	0.13	38.7	350	0.32	0.01	0.20	0.08	12.55	67.2	4	<0.05	4.2	22.9	0.92	0.40	0.1	<0.005	0.02	33.5	0.9	0.11	3370	2.02	0.01	0.4	11.6	110	4.4	<0.001	<0.005	0.6	0.007	0.01	0.86	1	0.2	36.3	<0.05	<0.05	<0.2	0.005	0.14	1.0	7	460	15.2	14	0.7	
Piment TR40	TSH036	0.035	0.02	0.06	9.2	140	0.17	0.01	0.08	0.02	3.86	104.5	11	0.06	5.2	10.40	0.85	0.17	<0.1	<0.005	0.02	3.7	0.6	0.03	300	0.82	<0.01	0.1	3.2	90	1.0	<0.001	<0.005	1.0	0.004	0.01	1.69	1	<0.2	6.6	<0.05	<0.05	<0.2	<0.005	0.06	0.6	6	336	2.4	6	<0.5	
Piment TR40	TSH037	0.004	<0.01	0.02	7.0	40	<0.05	0.02	0.01	<0.02	0.97	182.0	12	<0.05	4.3	0.32	0.14	<0.05	<0.1	<0.005	<0.01	0.5	0.2	0.01	182	0.59	<0.01	<0.1	1.2	10	0.5	<0.001	<0.005	0.4	0.005	<0.01	0.25	1	<0.2	3.2	<0.05	<0.05	<0.2	<0.005	0.09	<0.1	<1	670	0.2	<2	<0.5	
Piment TR40	TSH038	0.013	0.02	0.12	4.1	110	0.21	0.02	0.49	0.02	4.14	87.1	11	0.07	7.5	12.05	0.88	0.23	<0.1	<0.005	0.02	4.5	0.5	0.05	294	1.08	<0.01	0.1	3.0	50	2.1	<0.001	<0.005	1.7	0.006	<0.01	0.74	1	<0.2	5.6	<0.05	<0.05	<0.2	<0.005	0.07	0.6	4	364	2.4	5	<0.5	

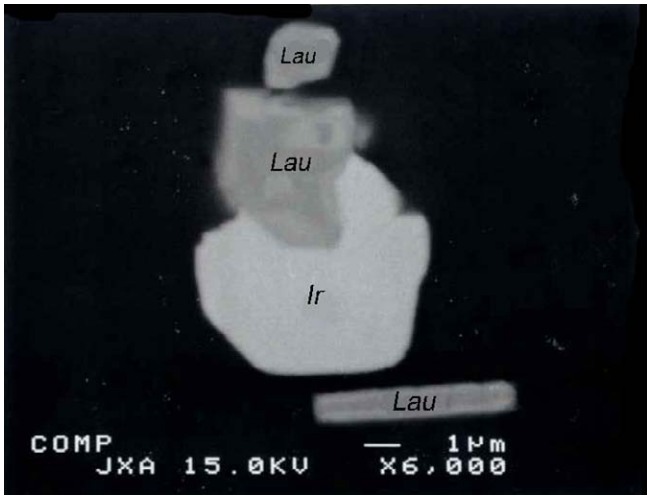
2.6 Isotopic ages

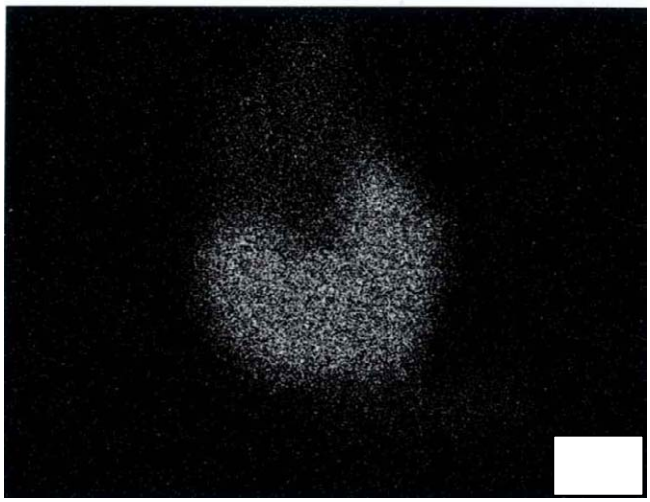
Geological Province	Area	Sample name	Locality				Rock	Media to be analyzed	Isotopic age Ma		$^{40}Ar^{*}$ %	K %	Interpretation Event to be determined	Remark	Probable age (Ma)
			Lati. (N)		Lon. (W)										
			°	'	°	'									
Maurita-nides	Akjoujt (G.Moghrein)	AKH013	19	44.841	14	25.454	muscovite schist	muscovite	393 ± 10	Devonian Pragian	97.4 96.8	4.34 4.34	metamorphism		403—383
Reguibat shield	Tiris (G.El Rhrein)	RHH006	22	52.776	12	19.658	leptynite	K-feldspar	1480 ± 40	Proterozoic Riphean	99.3 99.4	10.65 10.63	metamorphism		1520—1440
	Tiris (G.El Rhrein)	RHH006	22	52.776	12	19.658	leptynite	whole rock	1480 ± 40	Proterozoic Riphean	99.4 99.3	5.76 5.76	metamorphism		
	Koedia (G.El Hamariat)	KEH006	22	43.211	12	30.958	muscovite schist	muscovite	2407.1 ± 67.7 ?	Proterozoic Huronian	99.7	1.27	metamorphism	low K content	1.9Ga?
	Tasiast (Piment)	TSH040	20	34.320	15	30.744	muscovite schist	muscovite	1750 ± 40	Proterozoic Animikian	99.4 99.3	3.28 3.27	metamorphism		1733.3—1710.0
	Tasiast (Piment)	TSH067	20	34.341	15	30.739	chlorite-garnet-muscovite-biotite schist	muscovite	1686.5 ± 46.8	Proterozoic Animikian	99.7	5.21	metamorphism		
	Tasiast (Piment)	TSM009	20	34.383	15	30.722	amphibole schist	hornblende	1756.9 ± 49.4	Proterozoic Animikian	97.7	0.17	metamorphism		
	Tasiast (Piment)	TSH003	20	34.149	15	30.819	white argillized rock	sericite	1851.5 ± 51.7 ?	Proterozoic Animikian	99.9	1.28	sericitization	low K content	1.4Ga?
	Tasiast (N'Daouas)	TSH018	20	41.198	15	24.284	meta-amphibolite	amphibole	3190 ± 80	Archean Swazian	96.9 97.1	0.08 0.08	igneous-activity		3270—3110
	Tasiast (N'Daouas)	TSH018	20	41.198	15	24.284	meta-amphibolite	whole rock	3080 ± 80	Archean Swazian	96.8 98.4	0.09 0.09	igneous-activity		
	Tasiast (10km E to Inkebden)	TSH101	20	26.952	15	30.597	muscovite-bearing pegmatite	muscovite	3756.8 ± 105.2 ?	Archean Isuan	98.4	1.05	igneous-activity	low K content	2919.0—2909.1
	Tasiast (Khnefissat)	TSH020	20	47.568	15	34.357	muscovite-bearing pegmatite	muscovite	3003.0 ± 93.9	Archean Swazian	99.7	7.46	igneous-activity		
	Tasiast (Khnefissat)	TSH075	20	46.663	15	35.281	muscovite from pegmatite	muscovite	2840.0 ± 79.0	Archean Swazian	99.7	7.66	igneous-activity		
	Tasiast (Khnefissat)	TSH019	20	47.262	15	33.879	muscovite biotite granodiorite	hornblende	2251.7 ± 62.5	Proterozoic Huronian	99.3	0.94	igneous-activity		2207.3—2189.2
	Tasiast (Khnefissat)	TSH074	20	44.955	15	34.872	granodiorite	biotite	2147.5 ± 59.8	Proterozoic Animikian	99.9	5.62	igneous-activity		

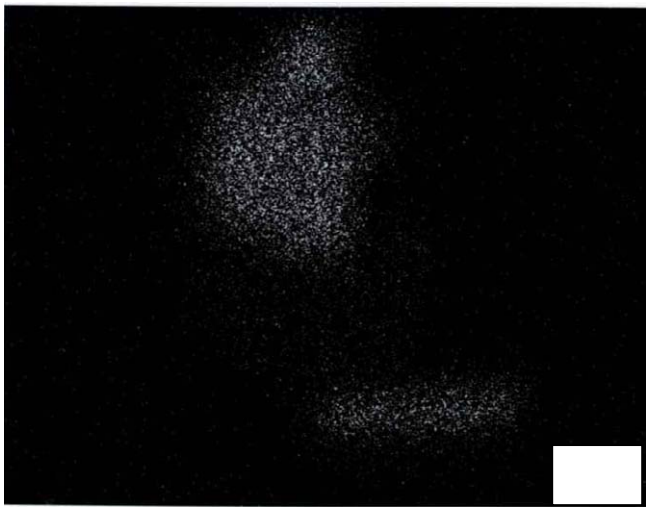


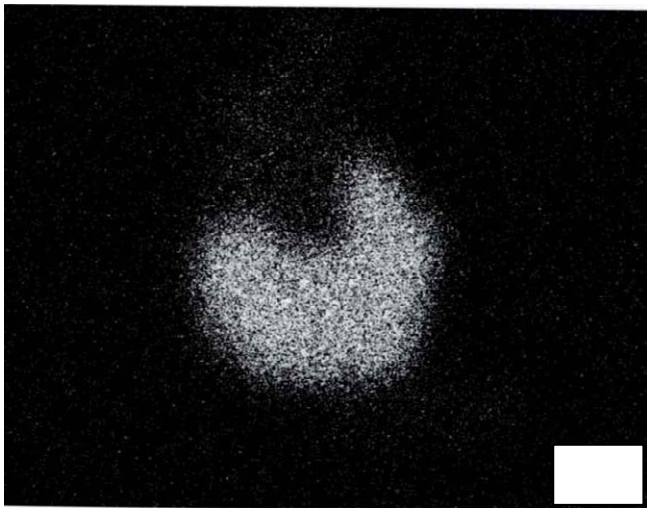
2. 7 The location map of samples for dating

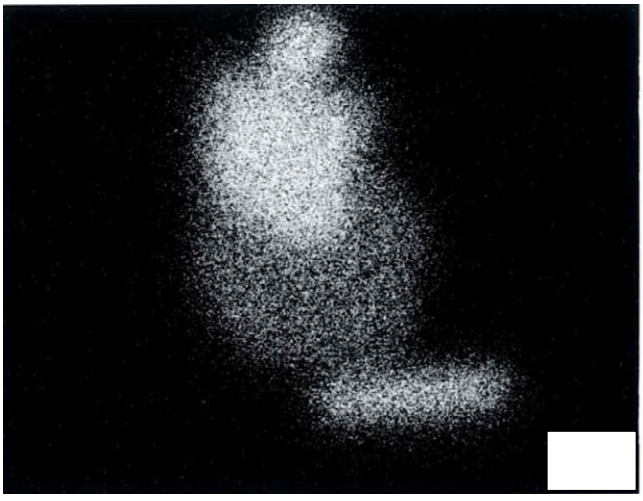
2.8 EPMA scanning images (1)









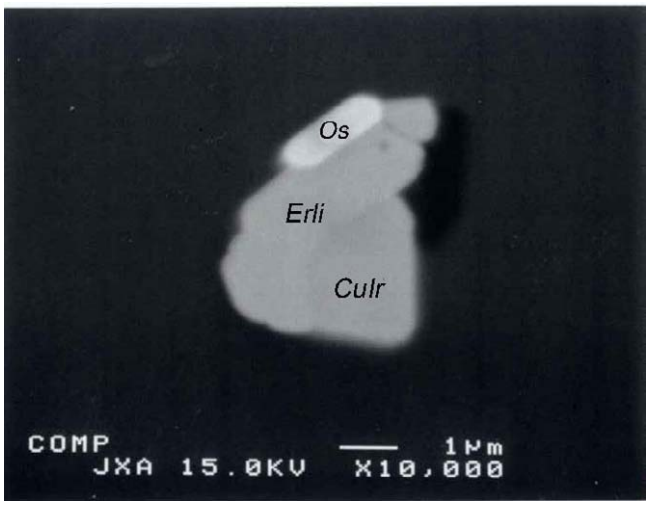


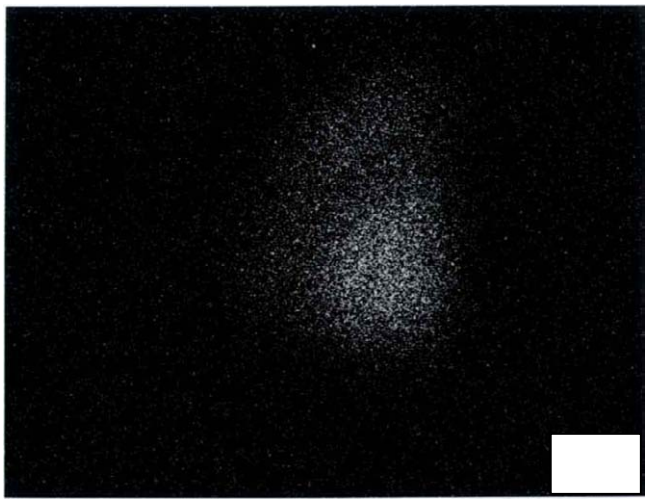
Sample No. DGM 111

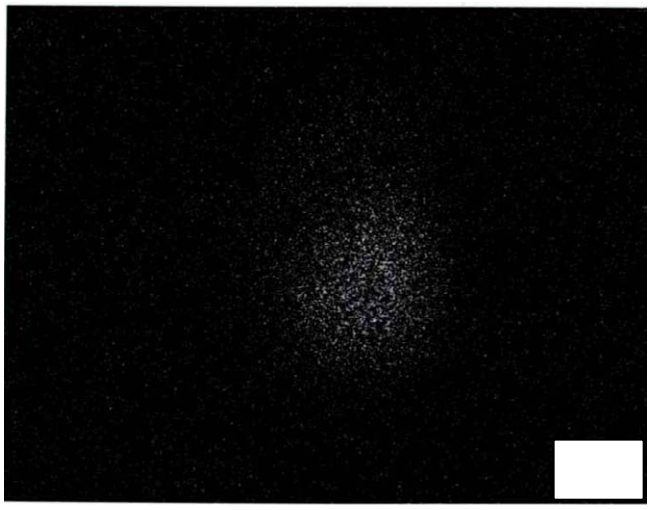
Lau: Laurite (RuS_2)

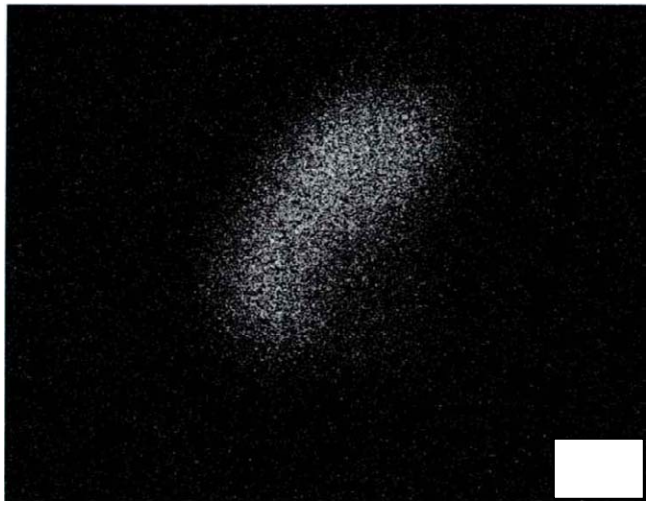
Ir: Irarsite ((Ir,Ru) AsS)

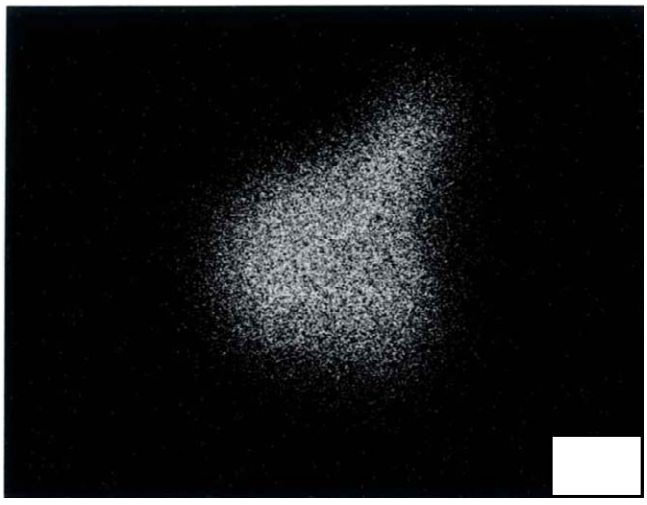
2.8　EPMA scanning images（2）











Sample No. DGM 111

Os: Osmium (Os)

Erli: Erlichmanite (OsS_2)

Cuir: Cuproiridsite ($CuIr_2S_4$)