Chapter 3 Current Status and Issues of Investment Climate

3.1 Outline

Although the mining administration has been centralized and to some extent improved, its performance is still not advanced due to a shortage of adequate manpower. Promotion of foreign investment is expected by using the new Mining Code and Tax Law; however, detailed elaboration of the regulations and systematization will be needed in future in order for them to be effective. PRISM of the World Bank is reforming the investment climate by strengthening the mining management capacity and compiling geological information. Management of mineral resources data is systemized, but its replenishment and utilization are tasks for future. Development of infrastructure, practical function of the environmental management system which is currently in the formation phase, and cultivation of human resource are also ~~is~~ the other tasks in the future to promote exploration and development.

Mining activities in Mauritania are presented by iron mining business conducted by a state enterprise, SNIM. Exploration is implemented by foreign companies with gold and diamond as targets; however, it is not yet fully activated. Exploration is hindered by shortage of infrastructure, manpower, and information.

The Mauritanian mining law is more competitive than the neighboring countries, from the viewpoint of the mining concessions area, the terms of royalty and license fee which are more favorable for investments (Appendix I, 1.2 and Appendix 1.2-1.3 in the Interim Report).

3.2 Mining Administration

Ministry of Mining and Industry (MMI) is responsible for total coordination among all activities of national mining sectors, including implementation of improvement based on the new mining policies adopted in March, 1997 by the government as well as the result of PRISM. Also, MMI is responsible for administration of Mining Law and mining regulations and activities of the mining and industrial sectors. Basic goals in the two sectors, mining and industry, are described as follows:

a. A goal in the mining sector is to develop and enhance extraction of mineral resources, namely the following:

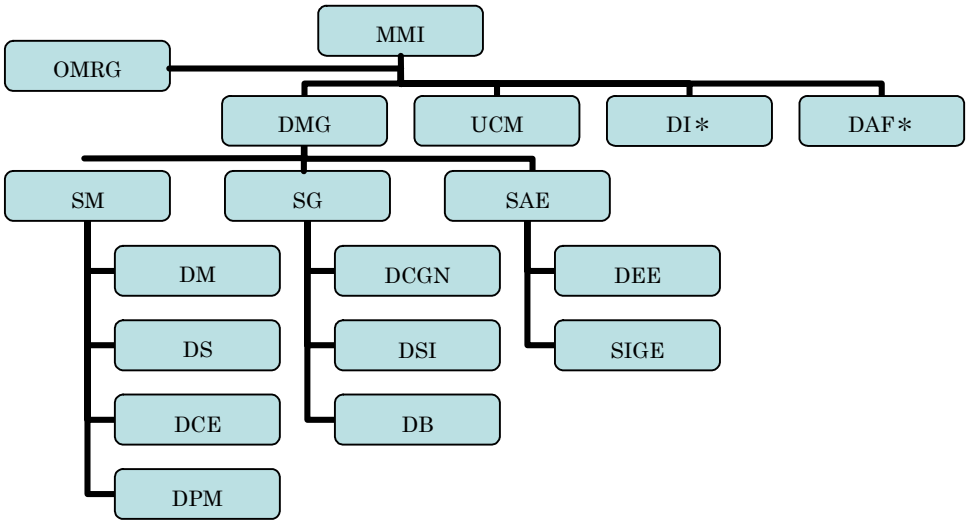
- To promote the exploration and geological survey.
- To present the geological information updated through geological surveys and share it within the mining sector.
- To promote, lead and control all the activities respecting mineral resources exploration, research, mining and processing technologies.

b. A goal in the industrial sector is to regulate and coordinate the industrial activities within the current legal framework, implemented by the following:

- To implement and enhance the industrial development.

- To define the development orientation of the industry and related activities according to the national necessity and focus on the program.
- To advance the ideas for industrial activities.

Mining Administration is under the jurisdiction of Ministry of Mining and Industry, which consists of Direction of Mine and Geology (DMG), Unit for Mining Cadastre (UCM), Direction of Industry and Direction of Finance and Administration (Fig.3.2.1).



(NB) MMI: Ministry of Mining & Industry DAF: Direction of Finance & Administration DI: Direction of Industry UCM: Unit for Mining Cadastre DMG: Direction of Mine & Geology SM: Service for Mines DM: Division of Mining DS: Division of Strategy DCE: Division of Environmental Control DPM: Division of Mining Promotion SG: Service for Geology DCGN: Division of National Geological Map DSI: Division of Information System DB: Division Library SAE: Service for Environmental Affairs DEE: Division of Environmental Studies SIGE: Environmental Information & Management System

Fig.3.2.1 Organization of MMI

3.2.1 Direction of Mine and Geology (DMG)

Top administrating organization for mining industry is Direction of Mine and Geology (DMG), which consists of Service for Mines (SM), Service for Geology (SG) and Service for Environmental Affairs (SAE). Main objectives of DMG are to draw up the mining policies, make drafts of mining laws and regulations and follow up the application of regulation as well as to collect geological data and save and present them to developers who are engaged in effective utilization of mineral resources.

Service for Mines (SM) consists of Division of Mining, Division of Strategy, Division of Environmental Control and Division of Mining Promotion. SM supervises mining activities of private companies and examines their activity reports. SM also formulates regulations for exploration and extraction of mineral resources and implements the current laws and regulations respecting exploration, extraction and fabrication. SM has the wide scope of service, collecting statistical documents for mining and industry, surveying influences caused by administrational decisions and transition of mining industry, and recommending action plans to promote private investment in

mining.

Service for Geology (SG) consists of Division of National Geological Map, Division of Information System and Division Library. The main objectives of SG are participating in planning, collecting geological data, plan and adjusting measurement surveys for geological mapping, gathering and systemizing the geological, geophysical and geochemical data presented by the mining companies. SG also prepares GIS database for private companies to use geological information easily, and aerial survey drawings for management of technical documentation for geology, related fields, mines etc.

Service for Environmental Affairs (SAE) consists of Division of Environmental Studies and Environmental Information & Management System. SAE submits a proposal on environmental regulations and examines the EIA or environmental monitoring reports under collaboration with related organizations. At the same time, SAE prepares specifications for EIA in the mining sector together with the related organizations and submits a proposal for their adoption. SAE is also in charge of making quality regulations and standards related to atmosphere, water and soil as well as emissions, applied in the environmental management in mining, and also does this under cooperation of other related organization. SAE also formulates plans for basic environmental surveys and supervises its implementation in some mining districts with other related organizations; also establishes, maintains and operates the environmental management system.

The budget of MMI has been steadily increasing and is US$340,000 in 2004. The budget is mainly intended for maintenance of the ministry, consisting of labor cost and office expense.

Table 3.2.1 Budgets of MMI

Directions	2001	2002	2003	2004
Minister (1,000 MU)	42,766	45,031	43,502	45,775
DAF (1,000 MU)	1,251	1,213	1,079	1,992
DI (1,000 MU)	10,488	10,721	10,912	14,468
UCM (1,000 MU)	0	0	14,000	14,000
Planification (1,000 MU)	1,026	995	995	955
DMG (1,000 MU)	12,288	11,766	11,208	11,004
Total (1,000 MU)	67,819	69,727	81,695	88,194
Exchanging rate (MU/$)	254.987	274.233	267.053	259.017
Total (1,000 US$/MU)	266	254	306	340

3.2.2 Mining Cadastre Unit

The Mining Cadastral Unit (UCM) was established, like the DMG, on the 13th April 1999 directly resulting from the adoption of the Mining Code of 1999. The function of the unit is to issue and manage exploration and mining licenses. The establishment of a transparent mining registry system is essential for the provision of a favorable climate for investment. An efficient licensing system was completed. In December 1999, a geodetic network adjusted to the data of World Geodetic System (WGS 84) was implemented permitting the use of Global Positioning System technology to register the precise position of mining titles. A GIS has been set up to manage this licensing system.

The main functions of the Mining Cadastral Unit in carrying out the administrative duties related to mining titles are:

- To take responsibility and charge of administrative procedures relating to mining titles and exploration authorizations, including title documentation, payment of fees and submission of reports to control the validity of the titles.
- To ensure that the operators of mining titles and exploration licenses comply with mining law and corresponding rules.
- To monitor the payment of royalties and the tax returns collected according to the valid license period.
- To act as an arbitrator in disputes resulting from encroachment on the borders of the license areas.

3.2.3 Mauritanian Office for Geological Research (OMRG)

OMRG was established in 1980 under the direction of the Minister of Mines and Industry with the goal of reactivating the mining sector. Since its formation, its primary role on behalf of the state has been to survey and prospect for all minerals resources, with the exception of hydrocarbons. OMRG fulfills its role through:

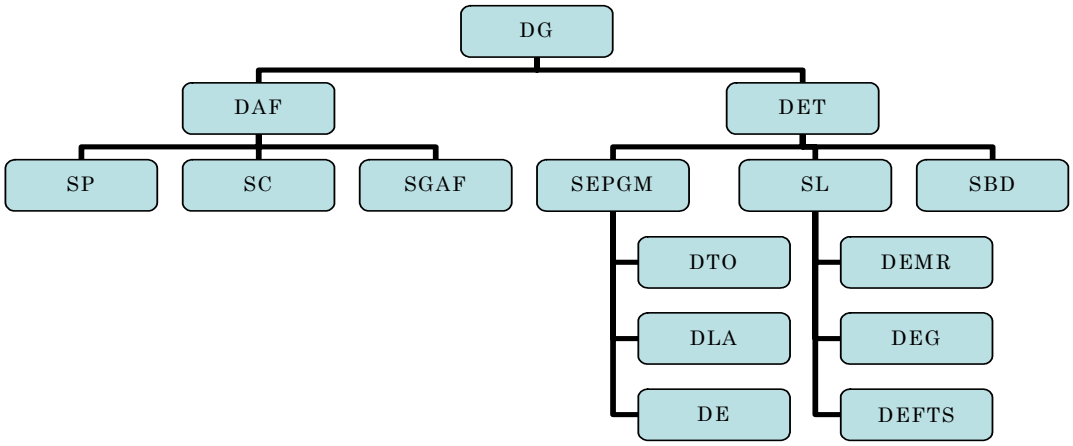
- implementation of small-scale geological mapping projects
- implementation of small-scale mineral exploration projects in the areas which are considered to have certain mining value
- evaluation of mineral resources potential
- provision of the latest information on the exploration and mining sector.

Since the implementation of the new mineral policy, the role of OMRG is to offer contracting services to incoming investors besides works mentioned above. OMRG has some machines including drill rigs, a fleet of vehicles (4WD trucks, lorries and fuel and water tanks) and so on, but most of them are generally broken and superannuated.

OMRG consists of administration department and survey department, with seventy employees (Fig. 3.2.2). In the Service of Geological Studies, there are about twenty geologists for geological and exploration works. The budget for OMRG was US$ 779,000 in 2003 which was independent from the budget of MMI (Table 3.2.2). Annual growth of the budget is approximately 5%.

Table 3.2.2 Budget for OMRG

Item	2001	2002	2003
Result in MU 1,000	179,100	200,078	208,974
Exchange rate (MU/$)	254.987	274.233	267.053
Result in US$1,000	702	730	779



(NB) DG: General Director, DAF: Department of Administration and Finance, SP: Service of Personnel, SC: Service of Accounting, SGAF: Service of Administration & Finance, DET: Department of Geological Studies, SEPGM: Service of Geological Studies, DTO: Division of Operational Works, DLA: Division of Laboratory and Analysis, DE: Division of Environment, SL: Service of Logistics, DEMR: Division of Maintenance of Mobil Material, DEG: Division of General Maintenance, DEFTS: Division of Maintenance of Drilling & Material SBD: Library and Documentation

Fig.3.2.2 Organization Chart of OMRG

3.3 Legal System of Mining

3.3.1 Mining Law

In June 1999, as a component of PRISM reforms targeted at mining industry, the Government of Mauritania enforced a new Mining Code No.99/013. The new code makes the investment climate as attractive as possible for international mining and exploration companies by simplifying, clarifying and strengthening the laws and regulatory framework as well as streamlining the procedures and processes of mining investment. To improve the investment climate and establish an efficient licensing system with clear applicant guideline, the Mining Cadastral Unit was built in April 1999 (Decree No. 99/160 on Mining Titles), which resulted in the establishment of the office that liaises with investors on issues related to exploration and mining titles. The new system also provides guarantees to all investors in terms of both technical and legal security of mining titles.

The Mining Code has categorized four types of titles applicable for exploration work and development of mineral resources in Mauritania: prospecting authorization, exploration license, small-scale mining license and mining development license. The exploration and mining licenses are initially granted for 3 years and can be renewed after the above-mentioned period. Once a viable discovery is made, it is possible to obtain a mining permit, without any interference from any discretionary powers of the Minister. Both mining and exploration companies can own 100% of the permits and the fees for prospecting and mining licenses are modest, further encouraging investment in the sector. The Mining Code, in addition to setting up the mining licensing system, determines a single set of fiscal and customs regulations applicable to all mining operations, ensuring stability of these regulations for a reasonable period. This includes benign duty and tax regimes for customers,

low royalties and taxes on commercial and industrial profits and allowances for free import and export of capital equipment for mining activities in early years of investment whilst a mine is in the phase of establishment. In January 2002, the Law 2002/02 was passed introducing a non-negotiable Model Mining Convention. This new convention did not modify the title granting process as set out in the Mining Code and Decree on Mining Titles, but further elaborated the economic aspects of the Mining Code, by including fiscal, customs, and foreign exchange agreements related to mining investment in Mauritania. Now, this agreement is entered into force at the time of mining title application and remains valid for the entire term. Characteristics of the Mining Code are as follows:

- Mineral are separated into seven groups (Table 3.3.1). Royalty and retention number of a license differ according to the groups.
- The Mining license comprises exploration and exploitation licenses.
  A survey demands the Minister's authorization for a limited period.
- Survey or perambulation by government organizations can promote exploration. The data is disclosed as a "potential zone" with indication of target extent (area) and exploration period after the expiry of exploration term.
- The development license for medium- or small-scale mines is defined.
- Validity of the exploitation license is 30 years. It can be renewed several times by a period of 10 years.
- It is possible to get an exemption in taxes and reduction in royalty during the prospecting stage and for five years after the commencement of operations.

Table 3.3.1 Groups of Mineral Resources by Mining Code

Group	Kinds of mineral
1	Iron, manganese, titanium, chrome, vanadium
2	Nonferrous metals, precious metals
3	Coal, inflammable fossils
4	Uranium, radioactive materials
5	Industrial materials, construction materials
6	Jewels (excluding diamonds)
7	Diamonds

The Mauritanian Mining Code has no problematic issues, comparing with the mining codes of other countries (Table 3.3.2). However, in case a license holder abandons the exploration license or the exploration period expires, the license holder must submit all exploration data to the MMI. All data is disclosed after three years (Article 51, Mining Code). It can prevent the developer from exploration expenditure. . The maximum area for the mining license is 1,500km^2 in the target district. It is reasonable at the given time when exploration is not fully promoted. However, after promotion of exploration in future, certain modifications to the Mining Code may become necessary, for example, yearly area reduction, large reduction of the maximum area for the mining license, small sized concession (100 ha).

Table 3.3.2 Comparison of Mining Codes

Item	Mauritania	W. Australia	Chile	Japan
Exploration License	3 years+ extension	5 years	Courts decide	2 years+ 2 years extension
Mining License	30 years+ 10 years extension	21 years	Courts decide	5 years+ 5 years extension
Contract Mining	No	No	Yes	Yes
License Procedure	Application	Application	Application	Application
Lincense Area Limit	1,500km2, perimeter of deposits	100 hectares	1,000 hectares	350 hectares
License Transfer	Yes	Yes	Yes	Yes
Ore Reserve Management			Government control	Lease owner
Ore Production Royalty	1.5 to 3% of revenue	Cu: 7.5% on ore, 5% on concentrate, 2.5% on metal. Au: 2.5% on net smelter return but exempt first 2500oz	Unknown	Mineral resource tax

The mining codes of Burkina Faso, a neighboring country, as well as Botswana and Namibia, the African mining countries, are also compared with the Mauritanian mining code in this study (Appendix I, 1.2 in the Interim Report). The above comparative study proved the Mauritanian Mining Code to be favorable for investment in the period/ renewal of the mining license, area of the mining license, royalty and concession fee. Therefore, Mauritania is “competitive” among the compared countries.

3.3.2 Laws related to Environment

The main Mauritanian laws related to environment, particularly, the laws respecting deserts, rivers, ports, water, air, ground, forests, etc. have been formulated independently since 1972. In response to the rising interest towards environment around the world since the second half of 1990, the Nature Protection Law and Environment Code were elaborated to administrate the entire field. The Mining Code was also improved in 1999 through PRISM supported by the World Bank.

Laws related to environment have been codified, but their legal improvement is still needed due to the following reasons: it is hard to elaborate adequate laws; some decrees are not applicable; many of the laws are contradictory.

(1) Legal Issues

The Environment Code of Mauritania was enforced in 2000, to show the principles of environmental protection policy and accord the sustainable economic and social development with environmental protection. PRISM pointed out several legal issues (Table 3.3.3), the most important of which are as follows: the necessary decrees lack items on legal enforcement, there are black boxes left at the Government’s discretion and too many authorities related to issuing legal permits.

German Technical Cooperation (GTZ) is trying to compile a new legal system for environment in three languages, French, English and Arabic, by registration of GLIN. Any interested

party is able to access the system since August 2000.

Table 3.3.3 Legal Instability (by PRISM)

Issues	Contents
Adoption of laws	Adopting necessary laws is very difficult.
Decrees	There is a lack of adequate decrees; the latter are not legally effective in many cases.
Discretion of Government	Government has the right to dictate the terms and regulations of the activities. Investors cannot know the applicable content in advance.
Consistency between laws	There are many laws on the same subject. Their contents are often inconsistent and contradictory.
Diversified authorities	It is necessary to visit multiple authorities like MMI, MHE, MS, Oasis Inhabitants Participating Group, Local communities, Forest Association, Agricultural Stockbreeding Association, Forest Inhabitants Group, Wild Animal Association, Local Forest Industry Office, etc. to obtain information about permits, rights and responsibilities of mining operations.

A lack of mine safety regulations is clear, along with the gaps in the legal framework related to environment. It is necessary to elaborate mine safety regulations in future.

(2) Lack of Regulations for Environmental Protection in Mining Sector

Legal framework of the mining sector consisted of the Mining Code, Law related to Model Mining Convention as well as Decrees about Mining Titles and Mining Inspection. There was no special decree for environmental protection in the mining sector, except for only a general philosophic description given in the Environment Code.

PRISM pointed out legal gaps for environmental impact in mining activities.

Table 3.3.4 Description on Impact in Mining Activities

Items	Lack points
Environmental limit	No indication for allowable quantitative limit
Protection measures for restoration as a result of mine-closure	No indication for evaluating toxicity to ecology. No regulations for protection against contamination in case of reuse in future.
Sampling of groundwater and protection of wells	There are legal means, which are not coherent.
Discharge water treatment and responsibility for getting advance approval	There are neither specific conditions nor limits for water discharge.
General specifications for industrial waste	Content of applicable regulation is not informed in advance.
Inhibition of waste disposal except for specific disposal areas.	No indication of waste disposal area.
Perpetual cases of imprisonment of importers, buyers and venders dealing with dangerous materials.	Not common internationally.
Hunting Code and Nature Protection Law	No indication of habitats to be protected.
Regulation of wild animals	No indication of a list with inhibition content
EIA survey for mining activities	No decree for mining environment and its survey.
Labor health and safety	Mining Code and Labor Code reflect relative regulations.
Process for public hearing, citizen participation and impact survey.	No decree concerning EIA. .
EIA in Mining Code	No articles on EIA procedures.
Punishment for breaching Mining Code and Environment Code.	No article of punishment for legal breach on the side of supervisors and management is considered.

Under given circumstances, a decree for mining environmental protection was prepared in 2004 and enforced in July. This decree covers the following contents:

① Environmental scheme for mining operation (in large mines, small mines and large quarries) and exploration works.
② EIA, environmental management system and process for rehabilitation of mine sites.
③ Impact announcement
④ Environmental factors for permanent deprivation of the mining right
⑤ Reserve for environmental works.
⑥ Financial guarantee for mine rehabilitation, environmental damage and risk.
⑦ Committee decision on environment
⑧ Public hearing
⑨ Environmental checks for the technical committee concerning an environmental assessment.

3.3.3 Investment Law

A new Investment Law of Mauritania was enforced in January 2002. The purpose of the law is to promote direct investment in the country, establish an investment guarantee system and simplify investment procedure. Investments in the mining and hydrocarbon sectors are excluded from the investment target. Investments in the mining sector are based on the mining law and mining convention. Characteristics of the investment law are described as follows (Fig.3.3.1):

- Mauritania guarantees any individual or corporation freedom to set up and invest in business activities in that country.
- Any enterprise firmly established in Mauritania can import whatever is needed for its activities and export its product.
- Foreign-owned businesses will not be nationalized, confiscated, or expropriated.
- There is a freedom to transfer foreign assets and profits caused by businesses.
- Dividends can freely be converted into foreign currency and repatriated. The price is the total amount for wholly foreign-owned companies, and the ratio of foreign capital for joint venture companies.
- Mauritanian and foreign individuals/corporations are treated equally under the law.
- Up to four foreign nationals can be employed for supervisory or training purposes without obtaining work permits, if local people with the same skills are not available.
- Investors must begin activities or expenditures within three years after the date on their investment certificate.
- The rights outlined in the Investment Code are transferable to the new owners of the same enterprise.

- No customs tax is charged on the import of building materials, machines, tools, equipment, spare parts, and utility vehicles

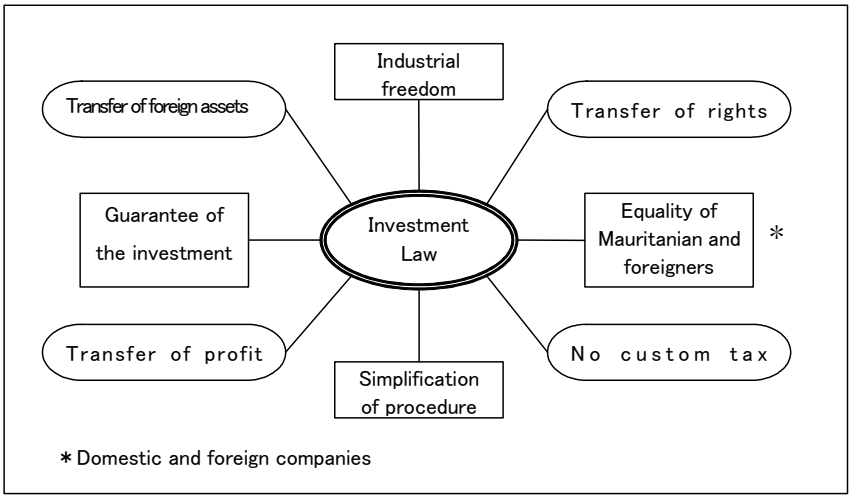


Fig.3.3.1 Feature of Mauritanian Investment Law

The Mauritanian investment law is superior compared to the same law of Mali, Senegal and Morocco. Therefore, there is not any problematic issue in the investment law. It is a future task to systemize the investment law with concrete decrees and detailed regulations according to its every article. In addition, it is necessary to establish a system for investments in medium/small companies and elaborate concrete conditions for the government investment guarantee system. In the current economic situation, Mauritania cannot help depending on foreign investments, so it is likely that limitation of foreign employees will have to be assuaged flexibly in the practical management. Furthermore, it should be noted that if a mining company incorporates peripheral business (transporting, machinery manufacturing, explosives producing, etc.) into its mining project, there will have to be a detailed investigation into whether or not it is regulated by investment law or mining law.

Promotion of investments is in charge of Department of Investment Promotion in Ministry of Economic Affairs and Development (MAED). The Deliberation Committee of Investment is open for investment projects to judge their permissions. Bilateral agreement is arranging sequentially. But Japan has not reached the agreement. Loan system (24 months loan at maximum) for private companies is also under study for the investment promotion.

3.3.4 Tax

Mauritania has a favorable tax regime for mining with income tax set at 30% on profits, with a five-year tax holiday for new mining operations. Furthermore, there is a favorable tax regime for exports. In customs regime, there is a complete exemption from customs duty at the exploration stage. At the exploitation stage, there is a five-year exemption period from customs duty after the start of production. A list of mining items can be drawn up for exemption from the start of the project

throughout its whole sequence. 5% duty is payable from there onwards with the exception of fuel and spares after five years. Income tax is 30% on profit, but corporate tax is exempted for companies without profit during exploration stage, and also within 3 years after exploitation.

Mining companies in Mauritania are subjected to mining royalties calculated at the selling price of a product resulting from the last stage of processing of a mineral. As set out in the Mining Code and Model Mining Convention 2002, all mineral product sales will be subjected to a royalty rate, fixed according to the substance group to which the mineral belongs as follows: 3% for gold, 1.5 - 2.5% for nonferrous metal, 1.5 - 2.5% for iron and 3 - 7% for gems (Table 3.3.5).

Table 3.3.5 Royalty for Mineral Groups

Group	Kinds of mineral	Royalty
1	Iron, manganese, titanium, chrome, vanadium	1.5 – 2.5%
2	Nonferrous metals, precious metals	3.0% for gold
3	Coal, inflammable fossils	3%
4	Uranium, radioactive materials	1.5 – 2.5%
5	Industrial materials, construction materials	1.0 – 1.5%
6	Jewels (excluding diamonds)	3.0 – 7.0%
7	Diamonds	

Tax regime for mining activities in Mauritania (Appendix I, 1.3) has no negative points in comparison with the world mining countries (Table 3.3.6). Accordingly, Tax regime and tax rates are internationally competitive. In comparison with some African countries (Appendix I, 1.4), there is no difference, except for advantages in the preferential treatment for income tax and export tax.

The framework for petroleum exploration and production activities is legally regulated. The rights and obligations of oil companies undertaking petroleum exploration and production activities in Mauritania are defined in a contract to be signed between the Minister of Mines and Industry and oil companies.

Table 3.3.6 Comparison of Tax Regime with World Mining Countries

Item	Peru	Chile	Indonesia	Phillipines	Mauritania
Profit tax (on profit)	30%	15% plus 35% on distribution	30%	35%	30% (subject to exempt for first 3 years)
VAT	18%	18%, credits	10%, credits	0~10%	14%
Mineral resource tax	None	Unknown	Au $225/kg <2t $235/kg >2t Cu $45/t <80,000t $55t>80,000t	sales Cu 2%, Au 4% on gross output value	Groups 6, 7 - 3-7%; Au & groups 3, 5 - 3%; Groups 1, 2, 4 (other than gold) - 1.5-2.5%. First 3 years are exempt*
Environment tax	None	None	None	mine waste: 0.05 p/MT mine tailings: 0.1 p/MT	None

* Classification of minerals. Group 1: Fe, Mn, Ti (rock), Cr, V. Group 2: Cu, Pb, Zn, Cd, Ge, In, Se, Te, Mo, W, Ni, Co, Platinum group, Au, Ag, Mg, Sb, Ba, Hg, B, fluorite, S, As, Bi, Sr, Ti & Zr (in sand), rare earth. Group 3: Coal & other combustible fossils. Group 4: U & radioactive elements. Group 5: Phosphate, Bauxite, Sodium & Potassium salts, Sulphates other than earth alkaline-sulphates & any industrial or ornamental rocks, asbestos, talc, mica, graphite, kaolin, pyrophillite, onyx, chalcedony, opal. Group 6: Ruby, sapphire, emerald, beryl, topaz and other precious stones. Group 7: Diamond

3.4 Role of PRISM and Implementation Status

3.4.1 Content of PRISM

In 1999, the Mauritanian Government in association with the World Bank started PRISM (Project for Institutional Strengthening of the Mining Sector) with the objective to improve Mauritania's capacity and competitiveness in attracting private investment to develop the mining sector. The project is related to the improvement of the present administration and organization of mining industry in Mauritania. It is jointly funded by the World Bank, the Islamic Development Bank, the French Co-operation Agency and the Mauritanian Government.

The project's overall objectives are to improve Mauritania's capacity to attract private investment in the mining sector and strengthen institutional capabilities to deliver efficient and transparent administration services. In addition to this it is planned to create an environmental management system and compile and disseminate basic geological and environmental information.

PRISM is planned and managed in two stages, PRISM 1 (1999 to 2004) and PRISM 2 (2003 to 2004), which is shown in Fig.3.4.1. The basic targets of the two-stage project are as follows:

- Rationalization of the role of the State by reducing its involvement in mining exploration and development activities
- Sustainability of the Ministry of Mining and Industry and its agencies involved in monitoring and regulating mining activities
- Environmental management capacity building
- Promotion of private sector investment in the mining sector

Total budget of PRISM is US$4,120 million, US$1,500 million allocated for PRISM 1 and US$26.2 million – for PRISM 2. PRISM 1 is planned to be completed and implementation of PRISM 2 has already begun this year. The main results of PRISM 1 are as follows (all results are shown in Appendix I, 1.5);

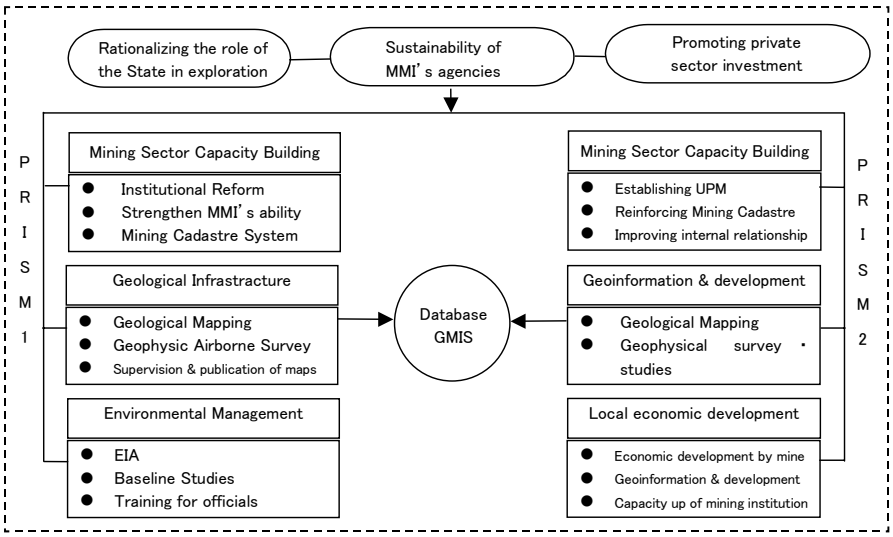


Fig.3.4.1 Concept of PRISM

a. To improve the Mining Code (1999) and establish mining decrees.
b. To enact a necessary type of mining convention (2002)
c. 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.
d. 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.
e. To make 6.5 geological maps with a scale of 1/200,000.
f. To make 6.5 geological maps with a scale of 1/200,000 between the first and second districts of the surveys.
g. To increase the institutional capacity for the management of mining environment and operational systems of information and environmental management (SIGE) (2001)
h. Hydrological works on water resources evaluation, measurement and tests of water-tables (2006)
i. To do a geophysical airborne study for Zone A (2004)
j. To develop the hydro-geological information on Mauritania (2004)

3.4.2 Results

(1) Establishment of information infrastructure

One of the subjects in PRISM is to establish and update a geological information infrastructure and supply geological and geophysical information to private investment sector. The followings are main components for creation of the database:

- Geological mapping
- Establishment of SIGM, geological and mining information system, and supply of available output for potential investors
- Data acquisition by airborne-geophysical surveys

Geological mapping is intended to produce geological maps with the scale of 1/500,000 covering the entire country and those of 1/200,000 scale covering 40% of the whole territory. The 1/500,000 maps were completed and stored in the SIGM database. Development and storing maps of 1/200,000 were completed in 2005. Geo-chemical sampling has been done during a geological survey, which will produce over 25,000 units of analyzed data.

The SIGM database comprises various kind of datasets, topographical maps, national and administrative boundaries (Wilaya, Moumata), cities, villages, rivers, infrastructure – like roads and railway, geological maps with scale of 1/500,000 and 1/200,000, geochemical data, mineral occurrences, hydro-geological maps, satellite imagery data, airborne geophysical data, concession areas, elevations (points and contours), which are stored in one of the most common GIS software, ArcView version 3.2. Furthermore, a lot of bibliography is stored in the Adobe PDF file format. To date, a wide range of information including databases, maps and bibliographic data has been

integrated into the system. Products from the ongoing PRISM projects are also entered into the system, and some of them, for instance, geological and hydro-geological maps, geochemical and geophysical data are available for foreign investors and institutions.

Airborne geophysical survey is the essential and indispensable exploration tool for countries like Mauritania, whose surface is widely covered by sand desert. In PRISM project, Mauritanian territory is divided into the following six zones (Table 3.4.1), and airborne geophysical surveys, airborne magnetic and radiometric methods have been applied in the areas of highest priority+ the northern Mauritania zone (Dorsal Reguibat Shield area), and the southern zone (near the boundary with Mali). The results will be entered in to SIGM database by the end of March 2006.

Table 3.4.1 Airborne geophysical programs in PRISM project (MMI web site)

Zone name	Present status	Surface (km^2)
Dorsal Reguibat Shield area, northern Mauritania	Survey is completed	155,000
Southern zone	Completed	125,000
Zone A (northern central area)	Promising mineral potential (next priority area): in progress	163,100
Zone B (middle area)		148,500
Zone C (desert area)	Potential for kimberlites: in progress	335,830
Zone D (eastern coast area)	Considerable potentiality of phosphates and other important industrial minerals: in progress	86,900

(2) Program to strengthen the mining management capacity

With the object to strengthen mining management capacity, PRISM has carried out a structural reform of DMG in MMI improving work functionality, developing a new mining code, establishing Mining Cadastre Unit, building a mining environmental management system, compiling and managing of the geological infrastructure.

Table 3.4.2 Tasks for Mining Management Capacity-Building and Current Status

Item	Task	Status
Organization with competent authority	To make draft policies, laws and regulations	Implemented by PRISM 1, will strengthen the capacity in the future
	To establish a monitoring system for mining promotion	Task in PRISM 2
	To clarify the responsibility to companies	Clarifying
	To simplify the administrative procedures	Simplified by PRISM 1
	To clarify mining administration	Insufficient
Administrative mining organization as a central core	To issue mining license	Implemented by PRISM 1. Mining Cadastre Unit
	To supervise mining licensed activities	Established organizations and their roles
	To make a program for mineral resources and their protection	Future task
	To build and maintain a mineral resources database	Installed by PRISM 1
	To acquire mining technologies	Insufficient
	To issue and supervise licenses for mining activities	Done by PRISM 1
	To prepare a ledger for deposits in the exploration area	Future task
	To provide information on geology, ore deposit and laws	Implemented by PRISM 1
	To manage and protect the environment	Implemented in PRISM
Cooperation between internal and external organizations	To coordinate information between Ministries	Insufficient
	To harmonize work of Ministries, discuss tasks and develop a decision-making system	Functioning internally, partially functioning externally
	To promote, manage and supervise by cooperation with ministries	Insufficient
Organization functions	To fulfill administrative functions	Implemented by PRISM 1

	To advise on and formulate policies	Future task
	To establish a system for mining licenses and concessions	Functioning, implemented by PRISM 1
	To establish an environmental approval system	Will start functioning in the future
	To add and produce basic geological information	Future task
Relationship with private companies	To advise on and formulate policies	Future task
	To simplify the management of mining licenses	Implemented by PRISM 1
	To guarantee a cooperation for environment	Future task
	To manage and control environment	Future task
	To cooperate on the infrastructure issue	Partially implemented, future task
	To develop geological infrastructure	Implemented by PRISM
	To promote investment and improve investment climate	Implemented by PRISM
Fund raising for the mining organization	To raise funds through tax revenues and concession fees for mining activities	Future task
	To allocate funds appropriately	Future task
	To provide funds indirectly (staff training, monitoring education, and monitoring tools)	Insufficient

The mining management capacity is improving largely due to the implementation of PRISM programs. In particular, the main tasks for the mining management capacity is comprised of formulating policies, formulating drafts of laws and regulations, promoting investments, licensing and managing mining concessions, managing and supervising mining activities, managing mining environment and developing the geological infrastructure (Table 3.4.2, Fig. 3.4.2), and it has already been yielding the results for the five years after PRISM was launched.

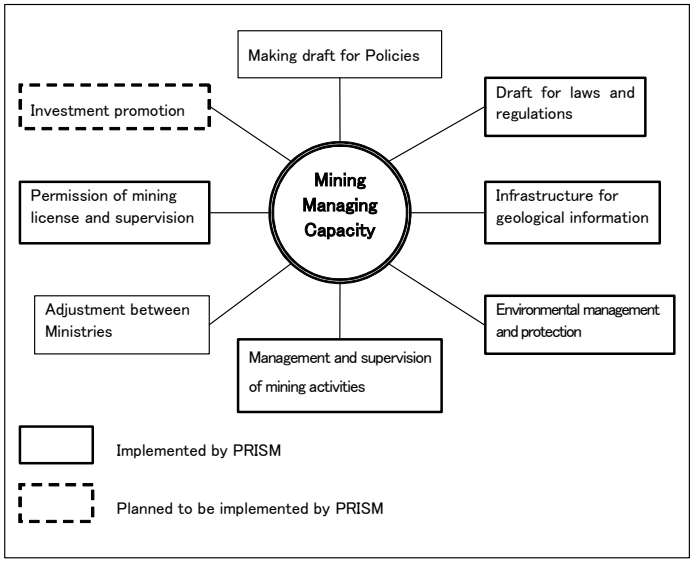


Fig.3.4.2 Main Tasks to Strengthen Mining Management Capacity

Elaboration of draft policies is not included in the program of PRISM, but implementation of PRISM is based on the mining policy. Regarding making draft laws and regulations, the new mining law and mining convention has already been elaborated by PRISM, so legislative capacity has been strengthened. Regarding investment promotion, Investment Promotion Unit will be established in 2006 by PRISM 2 and its activities will further strengthen its administrative capacity. Issuance of mining licenses and supervision has been achieved and proved successful. Approval procedures for applications have been simplified using IT systems (Fig.3.4.3). Supervision of mining activities will

be a future task for PRISM 2, because the exploration/development has not been activated so far. The mining law imposes the responsibility of management and supervision of mining activities onto and its activities have been effective. The same is the case with environmental management and protection, and the environmental management database (SIGE) has been built, and the task in future will be to define a manner to increase the amount of data for the database in order to construct a stable environmental management system. A database (SIGM) has also been built for geological infrastructure, and now the task is to further strengthen mining management capacity in future by utilizing it at a full scale.

There are many programs in PRISM and the scale of its implementation will be evaluated within 2005. Actually, PRISM is effective in its task of strengthening the mining management capacity, while the current status is at the phase of establishing the mining administration.

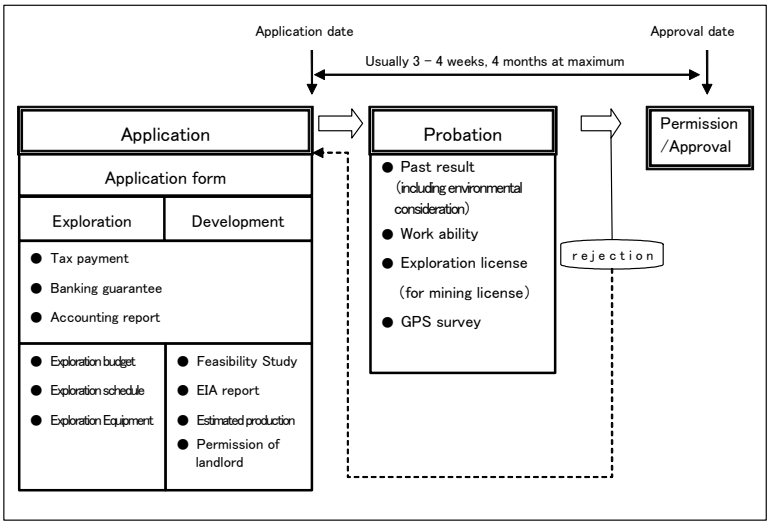


Fig.3.4.3 Procedure for Mining License

(3) Investment Promotion

With regard to investments PRISM consists of two directions a. investment climate improvement and b. implementation of direct promotion activities for investment, in order to promote the investment on the exploration and development. A program to strengthen the mining management capacity mentioned above in (2) is a core for a., and Mauritanian mining management capacity has been steadily strengthened. The main purpose of the geological information infrastructure is to collect data from geological surveys and geophysical/geochemical exploration and input them into the database. Investors have not made use of it fully up to date. The infrastructure program in PRISM is limited, intending the only hydro-geological study in the Zouerate district, though the infrastructure is very important for mining promotion. The above-mentioned b. will be implemented as a program component of PRISM 2 in 2006. The establishment of the Investment Promotion Office may be able to "flesh out" direct investment promotion activities of b.. It should be noted that in 2005, one survey to clarify impediments to exploration and development was carried out to promote exploration and

development.

Table 3.4.3 Main Tasks and Current Status for Investment Promotion

Task	Current Status
Mining Policy	No direct policy for investment promotion
Mining organization building	Implemented by PRISM 1. Systemization and functionality improvement are necessary.
Geological infrastructure	Implemented in PRISM. Inadequate in mineral resources. Necessary to study means of its utilization.
Legal improvement	Legal framework has been established. (Inadequate decrees and regulations)
Establishment of tax system	Concerned in the mining code by PRISM 1.
Infrastructure	Hydro-geological survey will be conducted in some district within PRISM framework. No infrastructure improvement program stipulated in PRISM.
Exploration system	No program in PRISM.
Staff training	Training only by OJT in PRISM. No systematic training.
Investment promotion	Planning to establish Investment Promotion Unit. Inadequate in information disclosure.

(4) Environmental management and protection

A Canadian consultant, Techsult International (hereafter Techsult), has implemented the environmental works in PRISM 1 with cooperation of SAE in DMG.

From 1999- 2004, PRISM 1 undertook the following environment-related tasks : survey of the natural environment, survey of the human environment, study of legal and institutional frameworks, interviews in the northern region, and baseline surveys.

First of all, PRISM implemented the general environmental surveys (the natural and human environment) and analyzed the legal and institutional framework, based on the current situation of the Mauritanian environmental administration.

PRISM implemented the baseline survey in the northern region where the gold and diamond explorations are enhanced by foreign investors, with the purpose to collect various important quantitative data, reflecting on the present condition that the basic environmental data are extremely brief. To collect the data on human activities, an enquete survey was also carried out in the same region where the number of nomad inhabitants is high. The staff of MMI was trained through OJT by working together in the survey which is linked with capacity building.

The data gained by PRISM 1will be a base for environmental monitoring.

The content of the environmental works in PRISM 2 (2004 to 2008) is programmed, considering the result of PRISM 1, as follows:

- To suggest environmental impact mitigation.
- To strengthen the environmental management capacity accompanying the local economical development in the corridor of Zouerate-Nouadhibou.
- To enhance environmental management institutions.
- To carry out a baseline survey in the southern Mauritaniedes Chain.
- To implement an environmental survey in the Akjoujt copper mine site and Fedrik iron

mine site operated by SNIM.

- To analyze the EIA report for phosphor development in Bofal-Loubboira.
- To train MDRE staff.
- To do an EIA for a hydrological survey in the southern Mauritaniedes chain.
- To compile a distribution map of wild animals sensitive to mine development.
- To make a program to support strengthening NGOs capacity in the environmental sector related to the mine development.

In PRISM 2, it is expected to raise the capacity to deepen into issues in the EIA reports prepared by developers through EIA surveys on mine sites. The commencement of construction to develop the Tasiast Gold Mine and the reopening of the Akjoujt Copper Mine will serve as "labs" for enhancing the ability to make environmental impact assessments and manage the environment during mining operations. When PRISM 2 completes, the capacity for mining environmental management of MMI will be considerably improved. Therefore, it will become possible to fully control the mining environment, even if the mining operation is activated. It will most probably contribute to the Mauritanian development.

(5) Influence on the local economy

Several programs are implemented also to contribute to the local development in PRISM. One of these is a technical supporting program to be carried out in the Zouerate iron mining district in 2004-2005 for a local economical development. In other words, these are means of support to the society, whose economical foundation is the mine and which is fully dependant on the iron mining industry (Appendix I, 1.5). These programs are participation of PRISM in the co finance of small projects, which have some relationship with socio-economical improvement of the mining community influenced by mining activities, and a technical support to NGOs, whose activities generate profits related to the economical development. At present, the Mauritanian mining industry is confined to the Zouerate district only, but Tasiast and Akjoujt under development are supposed to be the next candidates, whose local economy can survive by mine development only, like Zouerate. However, the Tasiast mine site will need 5 to 10 years to form the local communities. On the other hand, Akjoujt already has a permanent population of 8,000 people, so the reopening of the mine means that there will have to be some community development.

(6) Location and system of PRISM

PRISM is an organization for program making, forming, arranging, supervising and evaluating. Implementation of programs is ordered to professional consultants (Fig.3.4.4). In addition, PRISM acts as a coordinator for the government organization. Respecting the main project of PRISM, geological mapping of 1/500,000 and 1/200,000 scales a consultant is dispatched to DMG with the purpose of ensuring a smooth proceeding of the program specific contents and supervising the activities of the other consultants. PRISM has its own system to plan, implement and evaluate the

programs to build the foundation for promotion of mining activities. At the same time, it intends to carry out the programs effectively, taking advice from the World Bank.

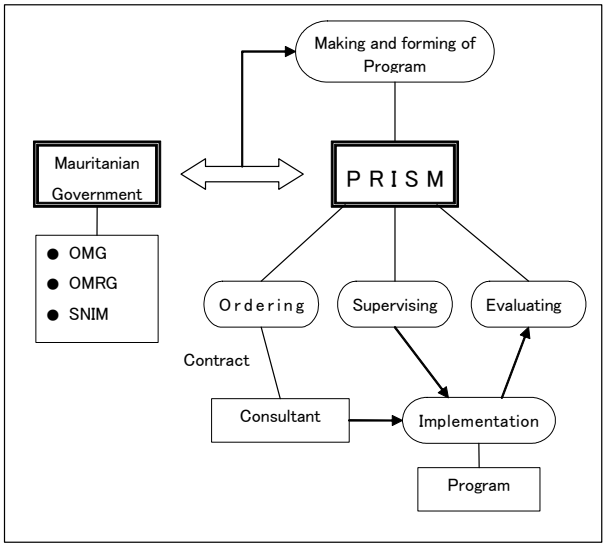


Fig.3.4.4 Location of PRISM in Implementation of Programs

3.4.3 Programs and Tasks in Future

Programs included in PRISM 1 and 2 are shown in "4.1 Content of PRISM" and "4.2 (4) Environmental management and protection". Main programs in the future are as follows:

(1) Capacity-building

- To evaluate the consulting activities for investment promotion (establishment of Investment Promotion Unit).

(2) Capacity-building for the environmental management system

- To strengthen the environmental management system.
- To make a distribution map of wild animals sensitive to the mine development.

(3) Compilation and development of geological infrastructure

- To do geological mapping in the central and southern regions with a scale of 200,000.
- To analyze the samples collected in the geological surveys conducted during PRISM 1.

(4) Local economical development

- To make a strategy for the Nouadhibou-Zouerate region (A short- and long- term implementation plan)

Realization of an additional program other than the planned, based on the evaluation of the implemented programs is possible. PRISM cannot cover all the items to strengthen the mining management capacity, which are shown in Table 3.4.2. There are still many tasks to be solved. Tasks for investment promotion are similar and are shown in Table 3.4.3.

Considering the implementation status of PRISM programs, there are still many tasks to

resolve to lead to the promotion of mining activities; they are shown in Table 3.4.4. Therefore, a follow-up mining policy (after the completion of PRISM) will be necessary to elaborate and implement in order to strengthen the mining management capacity. Furthermore, medium- and long-term environmental protection programs will be indispensable for a proper development of mineral resources. The issues related to the use of the database (SIGM) in PRISM have not been discussed yet. The database will directly lead to its utilization and information disclosing system for to the investors to add the data; this function will be fulfilled in the future. Respecting the local economical development, PRISM intends to support diversifying the economy in the mining district managed by the state company. It will lead to the promotion of private companies to study building methods for the local economy including the business opportunities related to the mine development (transportation, maintenance of machines, production of explosives, surveys, material sales, etc.) in the developed area. PRISM has had a tremendous effect and contributed greatly to the promotion of mining.

Table 3.4.4 Tasks in Future

Fields		Tasks
Mining management capacity	Capacity Strengthening	● Making mining policy ● Information disclosing method and system ● Keeping specific technologies
	Environmental Management System	● Adding the information to SIGE and its use ● Mineral resources development and protection program ● Monitoring system
Compiling the geological infrastructure		● SIGE use method ● Added information on mineral resources ● Geological maps with a scale of 1/100,000 in the potential areas
Local economical development		● Infrastructure plan in the mineral potential areas ● Compiling the water resources data in the mineral potential areas ● Business opportunities in the mine developed region

3.5 Mineral Resources Data Management and Information Publicity

3.5.1 Storage Situation of the Information and Management System and Methods

Original datasets of Mauritanian related to mineral resources, such as research reports, geological maps and so on, are stored in the information room of the OMRG. A part of the documents has been scanned and converted to PDF format, as well as maps have been converted to polygon and/or line datasets and input into the SIGM database. Almost all the reports are archived just manually, maps have not been and a certain part of the hardcopy documentation (i.e., reports) is totally abandoned in the OMRG.

On the other hand, the OMRG disposes of a GIS system based on ArcView 3.2 and comprising topographic maps, Landsat imagery data and geo-chemical data, which were procured within the framework of a joint project with BGS carried out from 2000 to 2003 and targeting Oussat Sfariates area. The system is not connected to the PCs located in the information room in OMRG, due to the absence of LAN facility in the OMRG office. Currently the data in the existing GIS are not used

efficiently. As stated above, a lot of existing survey data or reports are still in unused because they have been inadequately, due to a lack of PCs and no LAN connection in OMRG.

The research data obtained by PRISM project and a part of mineral resource data such as the past survey data stored in the OMRG are input into the GIS database and the bibliographic database in SIGM and the GIS database in the OMRG.

Geological maps, some thematic maps and spatial information in the data stocked at random in the OMRG should be managed by the ArcView GIS procured during this study, and hardcopy documentation like reports should be stored and archived using some database software, like Microsoft Access. The existing GIS database should be linked to or integrated with the OMRG/JICA GIS database by establishing a LAN connection in the OMRG office. Furthermore, the contents of OMRG/JICA GIS database should be fed back into the SIGM database or integrated with the SIGM through network, while sharing of mineral resource database should be done by a more effective and unified data management system.

3.5.2 Present Status of Information Publicity

Products from the on-going PRISM, including survey results and reports, are entered into the SIGM database, and some of them, for instance, geological maps with the scale of 1/200,000 or 1/500,000, geochemical and geophysical data and hydro-geological maps, are supplied to foreign investors and institutions.

General information, data on governmental organizations related to Mauritanian mineral resources, PRISM project, the SIGM and the SIGE database, are presented in MMI website (http://www.mmi.mr) in English and French, PDF files, including mining law can also be downloaded from the site. Various kind of PRISM's products, geological maps or relevant mineral resource information, can be ordered in the MMI site. Disclosure of information related to mineral resources has recently started and it can be obtained from the website.

3.5.3 SIGM GIS Database in PRISM

The SIGM (Geological and Mining Information System) database system, which was established in the DMG, has been constructed through the PRISM (Project for Institutional Strengthening of the Mining Sector) project supported by the World Bank. The SIGM database is set up in MMI. There are five Windows PCs, an A-0 size plotter, a digitizer, and an A-1 color scanner, which enable to operate various datasets to enter into the GIS database and produce output in the SIGM operation office. Various kinds of datasets, topographical maps, national and administrative boundaries (Wilaya, Moumata), cities, villages, rivers, infrastructure like road and railway, geology, mineral occurrences, satellite imagery data, airborne geophysical data, concession areas, elevations (points and contours) are stored in one of the most standard GIS software, ArcView version 3.2 of

ESRI, United States. The GIS platform will be changed to the latest ArcView version 8.3 or 9.0 in PRISM2. All the airborne geophysical data are treated in Oasis Montaj (Geosoft, Canada), a world-standard geo-scientific data processing software, and a part of it is stored as imagery data files in this GIS database. Furthermore, a lot of bibliography is also stored in Adobe PDF format.

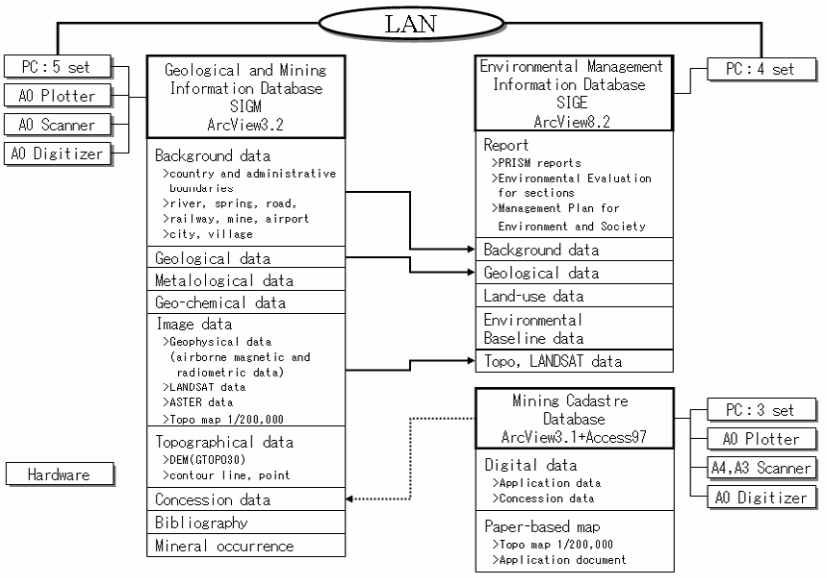


Fig.3.5.1 General Structure of PRISM Database

As of June 2005, storage of geological information with the scale of 1/500,000, covering whole territory of Mauritania, has been completed. The creation of new 1/200,000 geological maps (geophysical maps) is proceeding now in PRISM2 and 29 sheets of GIS data, geological maps with index maps and a 1/500,000 geological map and an ore deposit map were stored into the SIGM database. Airborne (aero-magnetic and radiometric) geophysical data in the southern Mauritania and metalological maps with the scale of 1/500,000 were also stored. However, more editing operation is required to complete them for final commercial products (as paper output).

Within the PRISM, SIGE (Environmental Management Information System) has been constructed and is operating in the DMG. The SIGE database is equipped with a web-style opening menu and icon buttons for document database (mainly PRISM reports) and GIS database by ArcView8.2 (as of June 2005). The system comprises a domain server, a data server, a workstation and PCs, which are connected by LAN (local area network) and is connected with the SIGM. GIS database of the SIGE consists of topographical maps, Landsat imagery data supplied from the SIGM, and the data from environmental baseline surveys conducted only in the northern part of Mauritania.

3.5.4 Database Usage Status

One of the practical usages of SIGM database has been a charged product supply to investors and institutions in the MMI website. The products comprised for instance, geological maps

with the scale of 1/200,000 or 1/500,000 currently being created by PRISM, geo-chemical data, geophysical data and some thematic maps like hydro-geological maps and so on. The OMRG starts to use topographical, geological, mineral occurrences maps and the other thematic maps supplied from the OMRG/JICA mineral resources GIS database or the SIGM for geological fieldwork. As the contents of SIGE are at their medium stage, there exists an acute shortage of usable datasets and their practical application will start in the future.

The SIGM technical staff is familiar with a series of operations from data entry to creation of the entire database. They need, however, some further training in ArcView 8.3 or 9.0 versions, which are planned to be introduced in the PRISM 2. Though satellite imagery, Landsat data and ASTER data supplied from this JICA research, is stored in the SIGM database, few data processing of the data is proceeded by SIGM staff in MMI.

The OMRG has another GIS system (based on ArcView 3.2 and MapInfo Professional 5.5) and geo-chemical data processing system (Oasis Montaj 5.1.7 for geochemistry) which were procured in a project with the BGS and the IMC through 2000 to 2003 targeting Oussat Sfariates area. There is an A-3 scanner, A-0 plotter and digitizer used as peripherals. Unfortunately there are no datasets supplied from the SIGM database, and the database covers only geological maps, Landsat satellite imagery (false color image) and geo-chemical data of the area. The OMRG staff's capacity of applying GIS and satellite imagery data are limited and still at beginner level, but they started to use the GIS database for their daily activities. Through technical transfer actions in this study understanding of GIS deepened and voluntary utilization was started gradually in OMRG. The independent usage movement for the GIS technology like oversea training (sending the OMRG staff for GIS training in BRPM in Morocco) also can be seen.

3.5.5 Present Situation with Usage of Websites

Usage of websites is expanding from government organizations to the private sector in Mauritania. However, the users mostly connect to the internet through analog lines, and actual connection speed is at several kb/sec. The poor communication infrastructure of domestic analog telephone lines makes practical usage of websites hardly possible. Cyber-cafes connecting to the web through high-speed lines are to be found only in urban area (Nouakchott). Computer laboratory in Nouakchott University has 24 PCs connected by LAN and links to Internet by high-speed (DSL) satellite connection, which was established with the support from the Canadian government. Palace Congres in Nouakchott is also equipped with a computer facility using high-speed satellite Internet connection, and foreigners are also able to use the PCs after registration as a member.

A few providers have monopolized the web market service in Mauritania. This situation may hamper improvement of information infrastructure. The limited connection speed, poor server maintenance and/or insufficient server management make web surfing of Mauritanian sites too slow

and very often result in temporally non-accessible site messages.

The number of web sites on Mauritania is increasing. Some representative sites are listed in Appendix I, 4.3 and summarized in Table 3.5.1. Almost all of the Mauritanian domestic sites are made in French or Arabic, and number of English sites is few. Quantity of supplied information is also insufficient.

Table 3.5.1 Currently Existing Websites on Mauritania

Representative websites	Contents	Links	Update
Overseas • The World Factbook, CIA • USGS, Mineral Information • The World Bank, Mauritania	• Reliable and rich in information • Mainly in English	• Few links to relevant Mauritania sites	Frequently
UN related • United Nations mission in Mauritania • Partners for development of Mauritania	• A lot of relevant project information • Mainly in French	• Several sites with many links	Frequently
Mauritania government related • Premier Ministere • Government Official Web site • Office of National Statistics • MMI, PRISM • Authority of Regulations	• Mauritania government sites do exist, but few of them present with sufficient information • Sites to download various laws, regulation information, etc. • Mainly in French and Arabic, partially in English	• Links to government sites • Few links to private sector sites (MMI site is reasonable)	There are some rarely updated
Private sector • Top Technology • MAURITEL • SNIM • CIMENT DE MAURITANIE	• Several sites presenting company, activity, and product information • Mainly in French and Arabic, partially also in English regarding mining companies	• No links at most sites	Appropriately updated
Search engines and others • University of Nouakchott • Inforim-Mauritania Online • Maghreb Union Search Engine	• Some websites with much information (university and linked site) • Mainly in French and Arabic, in English at University website	• A lot of links at Inforim as a portal site	Appropriately updated

3.5.6 Content of Database and General Concept of Website

(1) Contents of Database

The new OMRG/JICA mineral resources GIS database constructed in this study is based on the GIS database supplied from SIGM and has been supplemented by collected relevant datasets, results of supplementary geological surveys and proceeded satellite imagery data (Landsat and ASTER), which are listed in Table 3.5.2 as of June 2005. New 1/200,000 geological and 1/500,000 metalological, and airborne (magnetic and radiometric) geophysical data created in the PRISM were stored in the OMRG/JICA mineral resources GIS database as GIS data and PDF output files with index maps. On the other hand the JICA team supplied ASTER and Landsat data for the SIGM database.

Table 3.5.2 Additional Datasets for OMRG/JICA GIS Database

	Dataset	Source
1	ASTER imagery with DEM: 28 scenes	ERSDAC
2	LANDSAT imagery: 30 scenes	NASA
3	SRTM (Shuttle Radar Tomography Mission)' s DEM	NASA
4	Geo-chemical analysis data	Supplementary geological survey in this project
5	Soil distribution	Atlas de la Republique Islamique de Mauritanie, Editions Jeune Afrique
6	Concession areas (Prospecting, Exploration, Exploitation licenses)	MMI
7	Water resources map	CNRE/MHE
8	Water supply	CNRE
9	National park: 2 areas	Parc National Du Banc D' Arguin
10	Power stations: 20 stations	Ministere du Developpenment Rural et de L' environnement
11	Annual rainfall data (1970-200): 14 cities	SAM, Sociètè des Aèroports de Mauritanie
12	Precipitation change in 1950 and 2000	SAM, Sociètè des Aèroports de Mauritanie
13	Geodetic base station: 31 stations	MMI
14	JICA Report	JICA Study Team
15	SIGM database	PRISM

General features of the new mineral resources GIS database are illustrated in Fig.3.5.2.

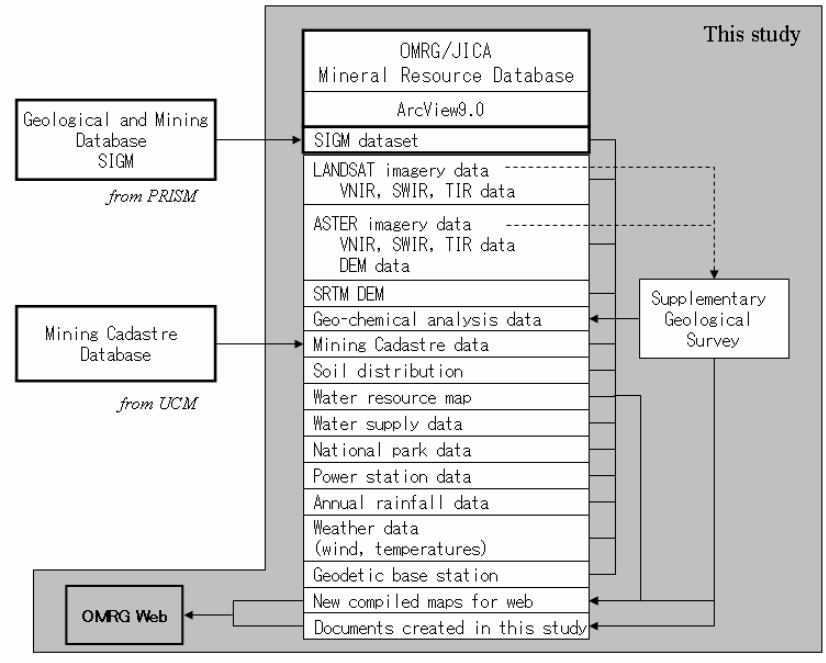


Fig.3.5.2 General Structure of Mineral Resources Database

(2) OMRG Website

The GIS database and relevant information in this study collected has used as mineral resources information for foreign investors in a new OMRG website, which is also created in this project to promote and accelerate foreign private investments. Its general concept of the website has

been discussed and approved between relevant Mauritania organizations (OMRG, MMI, and PRISM) and JICA study team. Web contents, approximate information volume, functional tools and links stored in each thematic window are listed in Table 3.5.3.

Table 3.5.3 General Features of the OMRG/JICA Website

Items	Specifications
Subject	Acceleration of foreign investments in mining sector
Contents	Mineral resource information for exploration and exploitation in Mauritania ・Reports and related documents, supplementary geological survey results, processed satellite imagery and maps created in this study ・Imagery and maps supplied from OMRG/JICA mineral resource database
Address	http://www.omrg-mining.mr/
Web server	Contents is stored the following web server, considering Internet communication status in Mauritania Main server: Office at Top Technology in Nouakchott Mirror server: Office at subsidiary of Top Technology in Virginia, USA
Web type	Dynamic web type by ASP
Language	English and French
Storage	Maximum 100Mbytes
Download service	Downloadable materials: PDF files for reports, related documents, pamphlets (OMRG, AIST)
News et al.	Government announcements, projects progressed, personnel movements and so on
e-mail	Contact us: info@omrg-mining.mr
Database retrieval tool	All contents in the web site is stored in database and managed by retrieval tools developed in this study
Counter	Counter tool for number of visitors
Maintenance	Server maintenance: Top Technology Daily update of contents:, staff in OMRG using Administrative Management Tool" developed in this study
Administrator	Two trained engineers in OMRG and a JICA expert
Links	・Mutual links with MMI and PRISM sites ・Mauritania relevant information is linked with existing government or international organization sites to avoid content overlapping as possible
Notices	Privacy and security notice, copyright
Maintenance	Duration : from July 1, 2005 to June 30, 2006 Contents : by Top Technology regarding database structural change in web

Some representative pages of the OMRG/JICA website are shown in Appendix I, 4.4-4.5. There are navigational buttons in every page, which link to each thematic page. A retrieval tool was created to make it possible to access the required information promptly using relevant keywords. The site also has live sections providing new official announcements related to mineral resources, mining policy and relevant regulations and so forth from governmental organizations for foreign investor use.

3.5.7 Technical Transfer

(1) Hardware

Computers and peripherals procured within this project are listed in Table 3.5.4. They were set up in OMRG computer room and project working space (Fig.3.5.3). All basic components for

construction of GIS database dealing with geographical information and remote-sensing datasets were procured and prepared. Analog telephone setting was also done in the computer room by OMRG, and it makes possible to install and update of various GIS database related software through Internet connection in their working room.

Table 3.5.4 List of Procured PCs and Peripherals

	System	Set	Company	Model	Specification
1	Desktop PC	1	DELL	GX270	Pentium4, 2GHz, 100Gb HD, 1Gb Memory, CD-RW, LG Monitor 17″
2	Laptop PC	2	HP	Latitude D600	Pentium4, 1.4GHz, 512Mb Memory 40Gb HD
3	Hard disk	1			120GB
4	Printer	1	HP	LaserJet5100tn	A4 Black & White
5	Printer	1	HP	DeskJet1220C	A3 Color
6	Scanner	1	HP	Design Jet Scanner 4200, Model Q1280A	A0-size
7	Digitizer	1	Cal Comp	Drawing Board IV	A0-size
8	XY Plotter	1	HP	Plotter 500 Color A0	A0-size

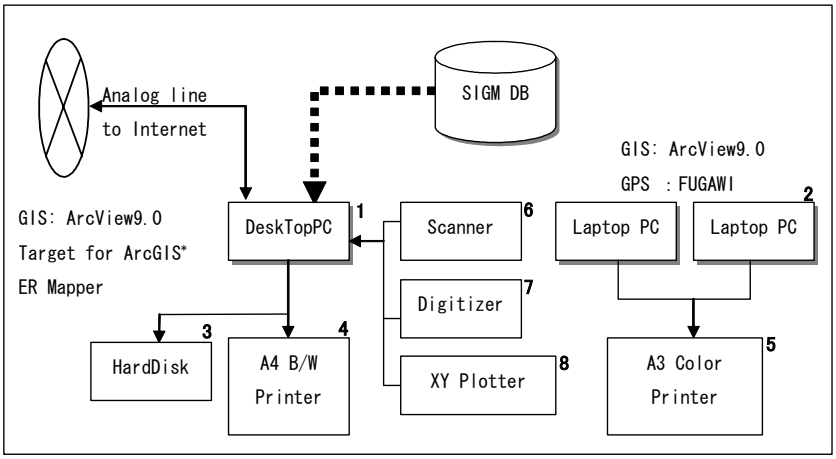


Figure 3.5.3 Procured PCs and Peripherals

(2) Software

In order to construct a database of mineral resources, ArcView 9.0 (GIS) including three extension applications, "Target for ArcGIS" (boring data handling software in ArcView) "FUGAWI" (GPS navigation software) and "ER Mapper" (remote-sensing data processing software) were procured in OMRG. The detailed specifications of the software are given in Table 3.5.5.

Table 3.5.5 List of procured GIS Systems

System	Developer	Module	Basic function
ArcView v.9.0	ESRI, USA	Basic module	GIS Basic module ArcView: English version Hardware key: Parallel port
		Spatial Analyst	Creation of raster data, Conditional retrieval function, Mapping and Analytical functions, Spatial calculation

		Geo-statistical Analyst	Interpolation function based on geo-statistics, Surface modeling, Spatial analysis, probability analysis, Analysis, Threshold analysis
		3D Analyst	Visualization of topographical data, Perspective analysis and topographical modeling functions, 3D Analysis, TIN and GRID Top data, Perspective view presentation, VRML
Target for ArcGIS	Geosoft, Canada		It enables handling of boring data in ArcView
Fugawi	Northport Systems Inc., Canada		Navigation with GPS and PC, Marking positions, data transfer
ER Mapper	Earth Resource Mapping Australia		Data processing software for ASTER and Landsat

(3) Technical Transfer

GIS technical transfer has been carried out mainly for OMRG staff possessing a certain experience in using the GIS database, satellite imagery datasets (ASTER and LANDSAT). Furthermore, a workshop was held in the University of Nouakchott for OMRG, MMI and the University of Nouakchott staff on the utilization of ArcView, Fugawi and other software (for instance, 'ArcMap GPS Support') shown in Table 3.5.6.

Table 3.5.6 Training and Education for GIS and its Related Software

	Guidance issues	Guidance status	Future subjects and policy
OJT	Basic concept of ArcView8.3	Direct guidance Training manual covering fundamental operations was created	Encouragement of self-study using tutorials in ArcView manual
	Structure of SIGM database	Creation of structural map, and explanation	Explanation of new stored data
	Basic operations, i.e. revision of GIS database	Direct guidance on using SIGM database and dataset collected in this survey	Acquisition of line and polygon data by scanning paper-based maps, and adding attributes on the data
	Introduction of satellite imagery data processing using ER Mapper	Direct guidance for a few staff	Follow-up of training and promote voluntary study
	Loading of satellite data to GIS	Organic data storage and arrangement of Landsat imagery data in hard-disk through training for a few staff	Input satellite imagery datasets for supplementary geological survey areas into GIS database Corporation with PRISM, voluntary study through OJT
	Construction of 1/200,000 geological maps and store the data into GIS database	Training for a few staff using ArcGIS	Voluntary study through OJT
	Ground-truth using FUGAI	Applied to supplementary geological survey using FUGAWI with maps and imagery produced by GIS and/or ER-Mapper Manual was created	Support OMRG staff who stared to use GPS navigation for geological survey
	Web management training	Training for OMRG staff using new developed administrator's web managing tools and also basic HTML lectures Manual was created	Follow-up training cooperated with TopTechnology and promote voluntary management of OMRG web

Workshop* On June 23	GIS basic operation using ArcView8.3 evaluation version	Creation of training manuals. Creation of a map for Akjoujt area combined with geological map and DEM dataset	Step-up to practical issues in OJT, including use of ArcView extensions
	Navigation by GPS and PC	Geo-referencing on a scanned map using Fugawi equipment Test navigation using Fugawi and 'ArcMap GPS Support' in Nouakchott Univ.	Promotion of use at actual field surveys
	Introduction of "Target for ArcGIS" which enable handling of boring data in ArcView	Numerous requests for procurement in this project	Experimental usage of evaluation version, and then donation in this project

*Held in 'Remote sensing & GIS training course'

As a result, it appeared that expectations and desire of the trainees to master GIS technology are very large. Though they have a conceptual understanding of using GIS systems, there are some gaps of GIS structural understanding and knowledge, for instance, database creation, store, revising data, which is necessary skill to the staff in charge of GIS database construction for this country. In order to overcome this situation and proceed with using GIS independently in Mauritanian side, direct guidelines by OJT would be appropriate, and a series of instructions, using data stored at the OMRG information center, are required to expand the staff's understanding and practical usage skills.

Furthermore, the following technical manuals were created in French.

- OUTILS D'ADMINISTRATION (operation manual for web administrators)
- Manuel du SIG Utilisation d' ArcMap 9.0 (GIS usage manual for ArcMap 9.0)
- Manuel de la Navigation avec GPS Utilisation de Fugawi (Usage manual for GPS navigation software FUGAWI)

3.6 Infrastructure

3.6.1 Actual Situation of Infrastructure

Mauritania has a vast area with population of only 2.8 million. Undeveloped arid deserts occupy most of the territory. Accordingly, large cities like Nouakchott or Nouadhibou and an iron mining city, Zouerate, are provided with infrastructure, but due to economic reasons the industrially undeveloped areas are not sufficiently covered. The current undeveloped infrastructure may be a bottleneck for the foreign investment aiming at the development of mineral resources.

(1) Roads and Railway

Roads have been constructed by international organizations or donor countries. There are three principal national roads, which are Route 1, from Nouakchott northward to Atar; Route 2, from Nouakchott southward to Rosso; and Route 3, from Nouakchott eastward to Nema. Also, there are many other paved or unpaved roads connecting the above-mentioned principal roads to smaller towns. At present the total length of the roads is about 2,300km, and will be 3,000km in 2005. Owing to the vast territory and small population, the road network is not still sufficient (Fig. 3.6.1). A new road

connecting the capital to Nouadhibou was completed. Also, several unpaved roads are now being paved. An international road (Ayoun-Nioro, Mali) construction is also emphasized. Total projected length of roads including plans similar to Kaedi-Gouraya route is approximately 1,100 km (Table 3.6.1).

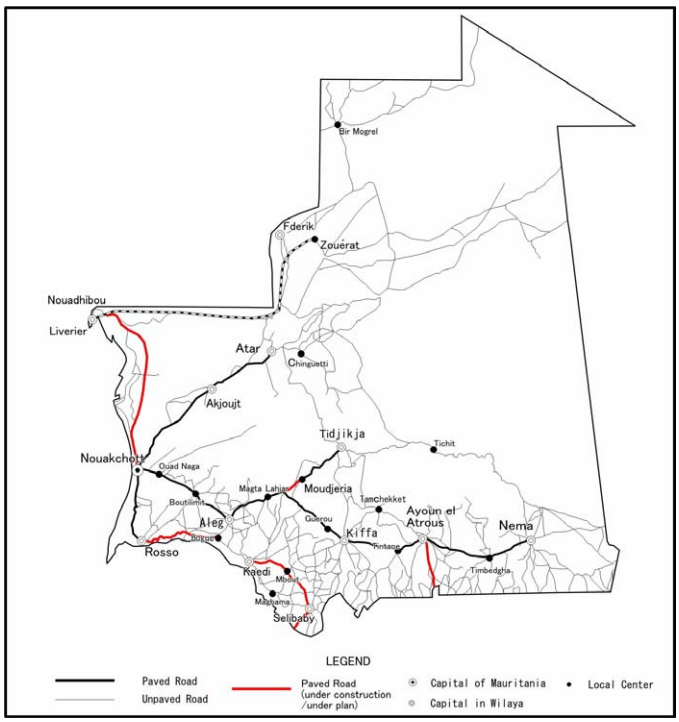


Fig.3.6.1 Road Network in Mauritania

It should be noted that construction began in 2005 on the 205km-long Rosso-Leqceiba-Bogue Highway to promote development in the western region. In addition, a survey is being planned for the construction of a highway linking Atar and Zouerat, and the survey for the road between Kaedi and Selibaby was completed in 2005. The area between Atar and Zouerat has resource potential, and the highway would be important for exploration and development. However, in this region it will be very difficult to ensure the water supply needed for this project, so it will be necessary to take groundwater surveys.

In the northern part, which is a high mineral potential area, unsatisfactory economic conditions prevent from projecting construction of new roads because there are neither many inhabitants nor major industries. New roads may be constructed if mines are developed in the future. However the burden of road construction cost may be an obstacle for mining investors. Presently, the infrastructure support system for constructing roads to mine-development companies allows exemption from 20% of the taxes related to the total cost of road construction. Other types of construction support are based on negations with the government.

The Tasiast gold mine site is located in the desolate area in the northern desert. But nomads usually appear around the site. The flora is very poor, and there are small grasses here and there (see

Appendix I. 7.1). Tasiast is located in about 300 km in straight distance from Nouakchott, and there a route going north in National No.1 road, with distance for route of almost about 400 km. There is no direct route to Tasiast, so it is necessary to get across the sand dunes area. The distance to the national road is 100km. For mining development, a developer must construct this road of 100km. Crossing distance of the dune is totally 20km. Maintenance cost for this crossing part of the dune is so large that the operation profitability would be influenced in the same manner as the construction cost of the road. Normal cars cannot pass the dune area.

Sand-protection nets are used to protect from the invasion of dunes and in anti-desertification – if the trees in them grow well. They are arranged during the construction of new roads and the cost is included in that of the latter. But trees are sometimes buried with dunes before they grow, and roads maintenance also remains a serious issue. Coal as well as gas reserves have been recently proved after an exploration work in the northern Nouakchott. Utilization of this gas in the industrialization process may help construction of road network in Mauritania.

Table 3.6.1 Road Construction Projects in Mauritania

Root	Length	Note
Moudjeria-Letfatar-Cangarafa	100km	Begun in 2005.
Nouakchott－Nouadhibou	470km	Complete in Dec. 2004.
Kaedi-Mbout-Selibi-Gouraye	275km	Begun in 2005.
Kseir Torchane-Choum		Begun in 2005.
Rosso-Leqceiba-Bogue	205km	Begun in 2005.
Ayoun-Kobenni-Gogui	100km	Begun in June 2004.
Tidjikja-Rachid-Atar	580km	Under F/S
Kiffa-Kankossa-Selibabi-Kayes	281km	Under application of F/S
Nema-Amourj-Bassikounou-Nampala	313km	Joint project with Mali, in stage of idea
Kiffa-Boumndeid-Tidjikja	270km	In conceptual stage
Choum-Zouerat	180km	In conceptual stage

Ore is transported with a railway connecting Zouerate to Nouadhibou with total length of 677 km. Iron ore is shipped to Point Central in Nouadhibou. The railway is managed by SNIM, and transports the necessary goods as well as passengers except iron ore. As the railway runs in the desert area, it is always necessary to clean sand dunes covering the rail, so there are seven stations maintaining the railway. And there are some other sand-related issues like excess rail abrasion which causes additional expenditure to SNIM. At present, there is no project for the extension of this railway. Regarding construction of a new railway, there is an idea to transport the phosphate ore to Nouakchott in the phosphate development in Bofal Loubboira which is located in the suburbs of Kaedi City. If this railway were constructed along the Senegal, it could be possible to transport the rich agricultural harvest produced in the river basin apart from the phosphate and help the mining development promotion in the southern Mauritania. It is expected as a economic stimulating policy (Fig. 3.6.2).

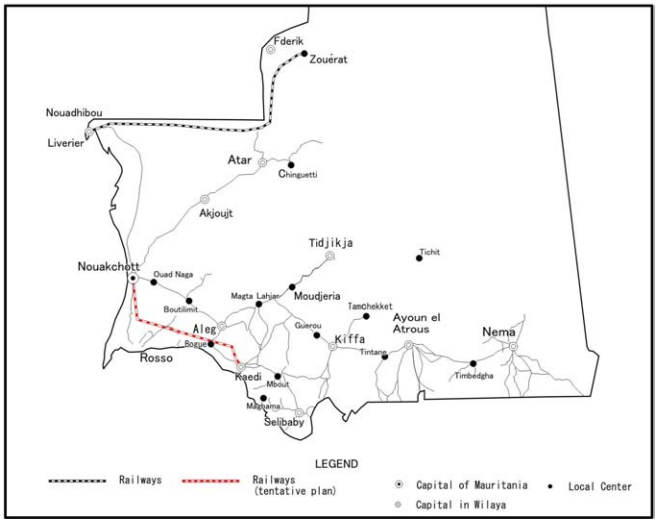


Fig.3.6.2. Railway in Mauritania

(2) Water Management and State of Water Supply

Water is managed by several organizations. Each organization (Table 3.6.2) has its independent role like water supply, utilization of the Senegal River, surface water management and research and study.

Table 3.6.2 Water Management Organizations in Mauritania

Name of Organization	Content of Main Work
DHA, MHE	Responsible authority of potable water to make policies and water supply plan.
OMVS	International organization consisting of three countries for water utilization of Senegal River, with three purposes: 1. development of irrigation systems, 2. development of energy, 3. improvement of shipping operation services
DEAR, MDRE	Management of surface water except the Senegal
ANEPA	Responsible of potable water management and repair for large villages or small cities.
SNDE	Potable water supply for main cities. Management of the Project Aftout.
CNRE	Scientific water-research organization. Management of various data on potable water.

(NB)DHA: Department of Hydrology and Sewage in the Ministry of Hydraulics and Energy, DEAR: Environmental and Rural Management Directorate in Ministry of Rural Development and Environment, ANEPA: National Agency of Potable Water and Sewage System, SNDE: National Company for Water, CNRE: National Center for Water Resources.

CNRE – a water research organization founded in 2001 – evaluates the Mauritanian water potential and discloses some information on water. It has data for 8,700 wells which are supposed to be more than 70 % of total wells in Mauritania. Those data are used in PRISM and DMG in MMI has cooperative relation with CNRE. DMG, MMI has cooperative relationship with CNRE. Data disclosure by CNRE is charged. For instance, it is possible to use it for mineral exploration and development or study on the potential water aquifer near the mine site. Various potential areas for water supply are distributed all over the country. They have a range of conditions to develop, easy or difficult, continuous or discontinuous groundwater, salt or fresh water and so on. At present, the water evaluation study in each area is carried out by technical support of international organizations or donor countries. SNIM manages water supply the region from the northern iron mining district to

Nouadhibou. From the global viewpoint of Mauritania, the current water supply is somewhat limited and finding a new water source is an important task for the mineral resources and local development.

Water is supplied from Senegal River or groundwater in Mauritania. Current water supply demands in main cities are met (Table 3.6.3), but some measures to respond to the shortage in future will be needed in order to prepare for the increment in the population or industrial promotion.

A mine developer must submit an application for water use to DHA in MHE. CNRE gives its judgement as a Government agency to the application. An important point for its approval is the amount of water consumption by the mining operation. For example, there are some regulations like $100m^3$/day in the areas rich in water or $10m^3$/day in the areas poor in water. Water royalty is monthly 100,000 to 200,000 UM per well for mining use, and 3 UM per m^3 for sale. Monthly consumption of water at the Akjoujt Mine is estimated to be 190,000 m^3, which corresponds to a medium size city. For the Akjoujt Mine, plans call for the repair and reuse of a 100km water supply pipeline that served the old mine. Therefore, if there are any municipalities near the mine site, water would have to be provided to them, with the burden to be borne by the mining company. At Akjoujt, water wells are being redeveloped and plans are being made to construct another pipeline system. At Tasiast, water resources are being developed, and plans are being made to construct a 70km pipeline.

Table 3.6.3 Water Supply in Main Cities in Mauritania (in 1,000 m^3)

City	Monthly Supply	Annual Supply	City	Monthly Supply	Annual Supply
Nouakchott	1,373	16,476	Tidjikja	22	264
Nouadhibou	246	2,952	Ayoun	18	216
Boutilimit	47	564	Akjoujt	17	204
Rosso	43	516	Timbedgha	11	132
Atar	40	480	Mederdra	10	120
Kaedi	31	372	Bogue	9	108
Aleg	25	300	Nema	5	60

(NB) These data is for Jan. 2004 presented by SNDE. Annual supply is 12 times this amount.

(3) Electrical Supply

At present, necessary electricity is generated. There are diesel power stations for twenty two major cities (Nouakchott, Nouadhibou, Zouerate, Sélibaby, Nema, Timbédra, Aïoun, Kiffa, Gérou and etc.). In the areas (Nouadhibou-Zouerate) where SNIM, operating large power plants, works it also in charge of electrical. There is another electrical source. At present, 15% (max. 120 MW) of total generated electricity is supplied to Rosso by a high tension transmission line from OMVS's Manantali Hydraulic Power Plant in Mali (800MW at max. capacity).

Capacities of the diesel power stations in 22 cities are 400kw to 28,000kw which is based on population demands for the electricity. Demand for electricity is growing at a rate of 10% a year. But it is estimated to be cut down in the future, so there are plans to construct power stations in Nouakchott and Nouadhibou by 2007. These are diesel power stations which have a higher production unit cost of MU 36 per kWh influenced by petroleum price. It is noted that the electricity needed for exploration and development in regions with mineral resource potential is being provided by the users themselves

with diesel generators.

Table 3.6.4 Capacities of Diesel Power Stations in Mauritania

City	Capacity (kW)	Starting yr.	City	Capacity (kW)	Starting yr.
Nouakchott	28,000	1989	Atar	1,080	1989
Nouadhibou	22,080	1970	Nema	960	1994
Ksar	7,600	1973	Timbedra	960	1994
Kiffa	2,400	1995	Aleg	960	1995
Kaedi	1,440	1987	Boutilimit	960	1995
Ayoun	1,400	1994	Maghta Lahjar	960	1996
Selibabi	1,360	1995	Akjoujt	800	1996
Tidjikja	1,360	1996	Boulanouar	600	1986
Boghe	1,300	1984	Guerou	560	1995
Rosso	1,280	1988	M' Bout	400	1995
Idini	1,240	1988	Tintane	400	1997

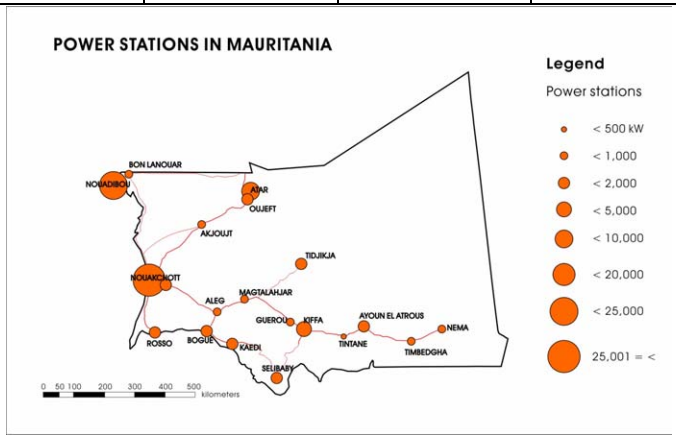


Fig.3.6.3 Generated Electricity in Mauritania

(4) Telecommunication

Mauritanian communication system was privatized in 1998 with the object of improvement and contribution to national development. Mauritel was established from a state enterprise (Mauritanian government: 46%, Moroccan and French private companies: 51% and its employees: 3%). There are two mobile phone companies: Mauritel Mobil, a subsidiary company to Mauritel and Mattel, a private company. Three million stationary telephones are used widely all over the country and all wilaya capitals can be connected to each other. Optical cable is also installed between Nouakchott and Rosso. On the other hand, mobile phones have increased rapidly up to 340,000 for only three years since November, 2000 and are commonly used in the capital and local cities. However, a relay antenna for mobile phones has not been constructed between the capital and local cities. With the rapid increase in mobile telephones in the Nouakchott area there are now restrictions on the number of lines that can be used at certain times of the day, and the state of the communications system is deteriorating. Long distance communication is also available using satellite phones, and the two mobile phone companies deliver the service. IP phone has been also available since February, 2000.

The public broadcasting network in Mauritania is nation-wide, and international TV broadcasting like European, American and Arabic-speaking programs are available via

communication satellites. It should be noted that mine development communication is done by satellite telephone and/or radio. However, emergency communication equipment must be brought along when traveling through desert regions.

(5) Airports

There are three international airports: Nouakchott, Nouadhibou and Atar. The former two airports are used for regular flights and the latter for charter flights. There are twenty four airports in total in most capitals of wilayas, which are shown in Table 3.6.5 and Fig.3.6.4. There are two airlines, Air Mauritania and CMTA.

Current main subjects in Mauritania's air transportation are to open more international airports and renovate national airports. There are many flat places like grassy plains or deserts which can be used by smaller planes to take-off and land. If flight application is permitted by the Bureau of Aeronautics, more than 200 such places are available in Mauritania. There is a project of New Nouakchott Airport about 20 km in the north from the downtown, and the construction of a double-lane road for the new airport has partially.

Table 3.6.5 Cities with Airports Facilities in Mauritania

No.	City name	No.	City name	No.	City name	No.	City name	No.	City name
1	Nouakchott	6	Rosso	11	Selibabi	16	Chinguetti	21	Letfata
2	Nouadhibou	7	Aleg	12	Kaedi	17	Boutilimit	22	Timbedgha
3	Akjoujt	8	Kiffa	13	Zouerat	18	Mbout	23	Tamchekket
4	Atar	9	Ayoun	14	Bogue	19	Tichit	24	Bir Mogrein
5	Fderik	10	Nema	15	Tidjikja	20	Magama		

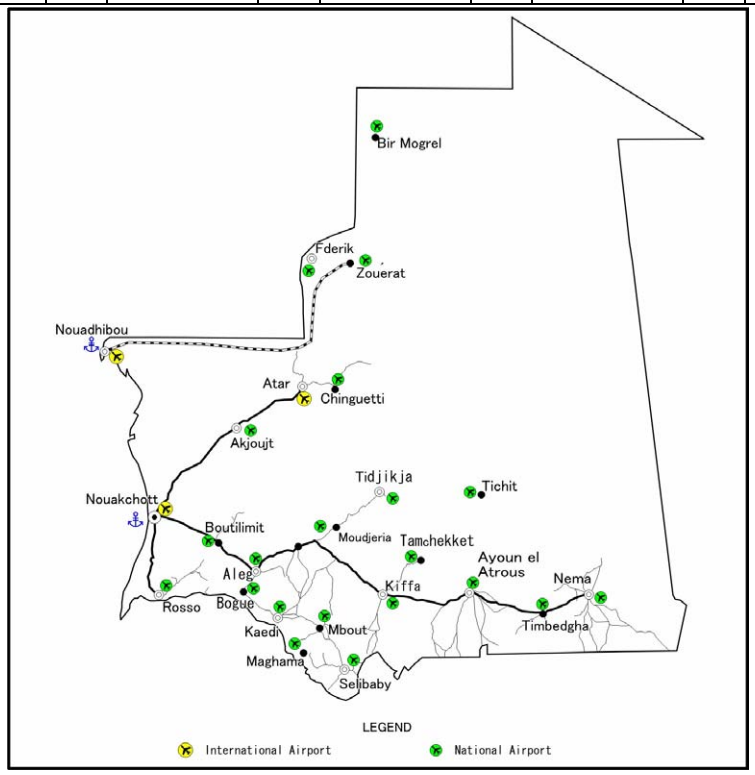


Fig.3.6.4 Location of Airports and Ports in Mauritania

- For mine development in the northern districts, it is easy to construct a simplified airport because there are many flat deserts for emergency. For example, an airport for small plane was constructed for exploration in Tasiast and is still available for use.
- Half finished products from dored-metal (gold) and diamond are transported by air. It bears no problems in current air port facility.

Furthermore at Tasiast, small plans have been made to charter with oil and other companies to transport employees and products (gold dore) and to respond to emergencies. Therefore, plans call for the construction of a 2,500m runway at the mine site.

(6) Ports

In Mauritania, there are two large ports; Port Nouadhibou and Nouakchott (Fig. 3.6.4). The wharfs of these ports are shown in Table 3.6.6.

In Port Nouadhibou, there is sufficient space for the construction of a new wharf. Therefore, construction of a wharf to load concentrate from nonferrous metal mines will be possible, but shallo water depth at Nouadhibou port will make it problematic for large ships to use the wharf. In Port Nouakchott, there are several problems: the sea runs high at the current wharf; water becomes shallow due to the accumulation of scattered sand; and the coastline is eroded by high waves. The construction of a new wharf is possible north of the current port location.

Table 3.6.6 Wharfs of Main Ports in Mauritania

Port	Wharf	Responsible Ministry
Nouadhibou	For iron ore	Ministry of Mines and Industry (MMT)
	For petroleum	
	For industry and fishery	Ministry of Equipment and Transportation (MET)
	For small fishery	
Nouakchott	For industry	Ministry of Equipment and Transportation (MET)
	For small ships	

The construction of a common wharf is to be authorized by MET with the construction plan, environmental survey and feasibility study for the new port, but the construction of a wharf for ore or metal concentrate transportation is within MMI authority. The key point for authorization is an appropriate location for construction, exact actions for environment, legal rationality in the feasibility study and fulfillment of international requirements. There is a project to construct a new wharf in Nouakchott. Nouakchott has a port with 3 wharves that is handling 1.5 million tons of cargo a year, but this is fast approaching the port's capacity. Therefore, with assistance from the Chinese government, a fourth wharf was contracted at a cost of US $80 million, with contract finalization scheduled for July 2005 and 2 year-construction in December 2005. Funding is provided by a combination of Chinese government loans, assistance grants, and loans from private sector banks. While the new wharf is expected to increase port capacity by 500-600,000 tons/year, it is not being designed to accommodate loads of bulk concentrates for export, so goods will have to be in containers. Therefore, in order to explore and develop medium to large-scale base metal deposits, either special facilities or a special

wharf exclusively for loading mineral resources will have to be constructed. However, it should be noted that the copper concentrates being produced at Akjoujt will be loaded into containers, so they can be shipped from the Nouakchott port.

One of the problems related to the port is lack of international competitiveness owing to excess labor and inefficiency due to inadequate management. A contributing factor is that landlocked Mali formerly imported through both the Nouakchott and Dakar Port. However, since the Nouakchott Port had become inefficient and very costly, Mali shifted its business to the much cheaper Port Dakar. Currently there is a SNIM's project of the new berth for 240,000 t iron ship in Nouadhibou to be financed by EU. The existing berth is capable of serving a 150,000 t ship.

There are simplified ports in Rosso, Kaedi and Gouraye along Senegal River. Boats can pass through the Senegal only in the rainy season because the river is too shallow in the dry season. The Organization for the Development of Senegal River Valley (OMVS) intends to dredge up the river from St. Louis to Ambidebdi for the boats to pass in the dry season. OMVS has finished its study and is looking for financial supporters.

The Mauritanian shore is generally shallow so opportunities for the construction of a new port are limited; however export of mineral products except iron or oil requires a new port where the large ships could berth. It is an important point for mining promotion.

(7) International Support

Mauritania has had chronic financial problems. Accordingly it cannot avoid international support in the development of infrastructure, which is a capital intensive sector. The biggest portion of the construction of infrastructure in Mauritania is done by the financial support of international organizations and donor. The international organizations supporting this sector are: the World Bank, BAD (African Development Bank), EU, IDB (Islamic Development Bank), OPEC (Organization of Petroleum Exporting Countries), FADES (Arab Development Funds), GAFD (French Agent Group for Development), GTZ (German Technical Cooperation), CE (Spanish Cooperation), JICA and so on. Donor countries presented here are Japan, France, Germany, China and etc.

Table 3.6.7 Main Investors (1996～2000)

Main Investors	Investment ($M.)	Rate (%)
World Bank	40.622	25
EU	29.327	18
Japan	23.292	14
FADES	17.624	11
BAD	13.910	8
UNO	7.157	4
France	6.458	4
IDB	6.283	4
Germany	6,057	4
Others	13,988	8
Toatl	153,818	100

Above all, EU occupies an important position in the construction of infrastructure,

especially in construction and maintenance of roads. EU has given funds for infrastructure of transportation based on the long term cooperation strategy for 2001 to 2007, taking into account the current situation in Mauritania. Furthermore, the planes for the next support from 2008 will be concretized in 2006.

(8) Future Planning of Infrastructure and Issues

Mauritania needs to make a financial base and reform its organizations in order to improve the national finance by making investments possible in the large scale infrastructure. There are some ideas and plans on the short-term development of infrastructure represented by roads, railways, electricity, water, ports, etc., but the most difficult problem in infrastructure is to find the international organizations or donor countries because, Mauritania cannot construct them by itself owing to deficit of national finance. Considering economical effect, the large investment in the local infrastructure is more difficult because there is no basic industry. However, promotion of mineral resources development in inadequate infrastructure may make it difficult for the investors to attain the reasonable profit. Therefore, the government needs to invest in infrastructure according to the economical priority in the development target areas with a serious consideration of mineral potentialities. This kind of attention to infrastructure makes a shortcut to the promotion of the foreign investment.

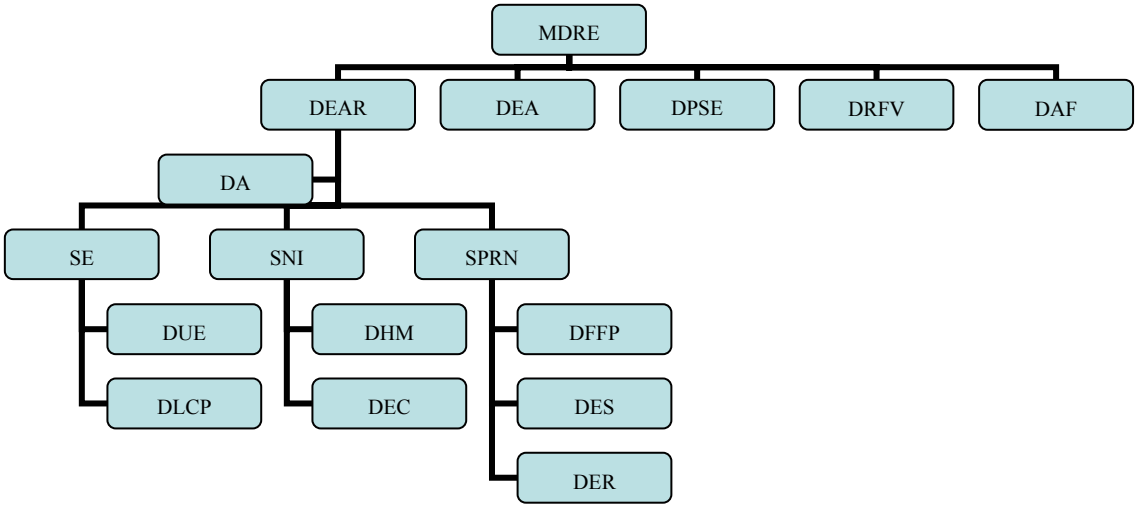
The government intends to involve the private companies in infrastructure, but the excess burden to the private companies makes Mauritania less attractive for the foreign investors. In particular, the infrastructure for the development of nonferrous metal resources is estimated to be comparatively large because most of the resources are located in the inland with a long distance from the existing infrastructure. On the other hand, the infrastructure for the precious metal resources is smaller than that of nonferrous metal, because they are profitable given even in smaller production scales. In general, amount of their transportation by means of airplanes is small enough to be profitable. As reported earlier, the support system for infrastructure will include a partial tax exemption for total costs associated with road construction. In the future, the infrastructure support system will have to be expanded and tied to mining development promotion. It is also necessary to invest in infrastructure that is tied to mineral development, water resource development, and road construction.

3.7 Environmental Consideration

3.7.1 Actual Status of Environmental Administration

In 1993, when the Direction of Environmental and Rural Management (DEAR) was established in the former Ministry for Rural Development, the name of the ministry was changed to MDRE. The organization of MDRE covers the total environmental management (Fig.3.7.1), including rural and urban environment, pollution, natural resources protection, natural infrastructure, agriculture and brazing. Development of a new organization is under consideration according to which the

Direction of Environment will be separate from the Direction of Rural Management. However, the new organization is not functioning yet.



(NB) MDRE: Ministry of Rural Development & Environment DEAR: Direction of Environmental & Rural Management DA: Deputy Director DEA: Direction of Agriculture & Brazing DPSE: Direction of Policies, Evaluation and Follow-up DRFV: Direction of Research, Training and Popularization DAF: Direction of Administration & Finance SE: Service for Environment DUE: Division of Urban Environment DLCP: Division of Pollution Protection SNI: Service of Natural Infrastructure DHM: Division of Hydrology & Maintenance DEC: Division of Studies & Control SPRN: Service of Natural Resources Protection DFFP: Division of Fauna, Flora and Park DES: Division of Water & Soil DER: Division of Renewable Energy Detailed organization except DEAR is omitted.

Fig.3.7.1 Organization of MDRE

Two kinds of the budgets are shown in this table. The normal administrative budget (US$1.858 million in 2003) implies budget for ordinary administration works in MDRE, and the budget for the international projects (US$0.384 million in 2003) refers to the Mauritanian expenditures for the projects being carried out by cooperation of the World Bank. The 2003 budget rose sharply in the normal administrative budget because of increase in the incidental expenses like extermination of harmful insects, measures for wildfires, protection from desertification, etc. Environmental administration is not still established due to a shortage of technology and data on Mauritanian environment. Some problems have occurred owing to a lack of communication and unclear jurisdiction limit between ministries related to environmental issues.

Main environmental protection work conducted by SE of DEAR was forestation. From 1976 to 1990, “Green Belt” action was carried out as a means of protection from desertification, and trees were planted in the area of about 1,700 ha around Nouakchott. This action has been restarted and the forestation in the area of 300 ha has been done by 2004. The green belt action has been carried out in the local cities like Boutilimit, Magta Lahjar, Kiffa, Kaedi, Tichit etc. during 1984 to 2004. The classified forest has been also protected recently and the area of approximately 200 ha has been planted since 2001. Mauritania has approved many international conventions.

There are two international cooperation projects, which MDRE is currently implementing: PGRNP (Project for Development of Natural Resources in the Rainy Areas) and PDIAIM (Project for Development of Irrigable Agriculture in Mauritania) by the World Bank. Departments related to

agricultural development are in charge of these projects.

3.7.2 Actual status of Monitoring and Environmental Issues

Neither environmental monitoring nor environmental protection has been implemented so far in Mauritania. There is a suggestion at DEAR to accomplish an environmental project to create a national strategic action plan under the cooperation of the World Bank, which is preparing a draft now. This will be a total environmental plan covering all sectors. There are several concrete environmental issues in MDRE as follows:

- There is no laboratory which can analyze wastewater, surface water, groundwater, soil and atmosphere to ascertain the data submitted by mine developers.
- There is not any environmental regulations and standards yet. There is no law protecting specific vegetation areas like classified forests.
- Environmental protection is limited to agricultural and grazing sector.
- There is no strong governmental leadership for the environment. There is no consistent environmental protective policy and action plan.
- Administrative responsibility of decision making in environment like wetlands is not clear, so priority for wetland protection is determined by international organizations like UICN or RAMSAR association.
- The personnel are insufficient as well as is the budget in comparison to its large area. No IT equipment has been introduced to help resolving this problem.

In this study, a survey is being taken of the state of the Environmental Monitoring Center in Senegal. If, like Senegal, Mauritania can use LANDSAT and other satellite images to monitor water wells, the environment, etc., then the country will be able to get regular information about the states of vegetation, surface water, desertification, urbanization, and other geographical phenomena. This could be done with relatively little capital investment.

Mauritania is characterized by a huge territory with small population and economic activities are not currently so large. Accordingly environmental contamination caused by human economic activities is low. Environmental issues are described as follows:

(Detailed description on natural and human environment is attached in Appendix I, 5.1)

- Series of environmental problems have arisen by desertification caused by the Sahara Desert advancing southward; sandy dust problems, sand accumulation, decrease of flora and inhabit and etc.
- Aquatic trees called Tifa have grown thickly in Senegal River and changed its ecosystem since the river flow was hampered by the St. Louis Agriculture Dam.
- Water supply depends on the groundwater in the northern territory. Some groundwater is damaged by fecal pollution of domestic livestock owing to inadequate management of wells.

- In Nouadhibou, the sea is contaminated by iron powder dropped from the belt conveyors by wind when iron ore is shipped.
- In Nouadhibou, the sea is partially contaminated by the waste water from the industry and ships.
- In F'derik and Zouerate, the ore powder pollution occurred by the operations on adjacent pits.
- In Zouerate, large amount of waste oil leakage occurs from the operating mine.
- In Zouerate to Nouadhibou, heavy metal contamination is caused by powder ore dropped from wagons when the ore is transported.
- A large population has concentrated into the large cities like Nouakchott or Nouadhibou after series of hard droughts and the domestic waste is not properly managed in the cities.

If progress is not made in resolving environmental problems, then environmental problems unrelated to mining activities may hamper investment in development.

3.7.3 Administration of Mining Environment

The mining environment is administrated by SAE (Service for Environmental Affairs) and DCE (Division of Environmental Control) belonging to SM (Service for Mines), in cooperation with DEAR (Direction of Environmental and Rural Management) belonging to MRDE (Ministry of Rural Development and Environment). Assignment tasks for each service and division in MMI are as follows;

SAE comprises SIGE (Environmental Information and Management System) and DEE (Division of Environmental Studies), and is in charge of PRISM. SIGE is responsible mainly for managing the baseline database as well as collecting information, inputting data, managing the network and maintaining equipment. DEE is responsible for examining and evaluating Environmental Impact Assessments (EIA) submitted by private companies. Both SIGE and DEE are also responsible for preparing draft laws and regulations regarding the environment.

DCE in SM is responsible for the environmental study at the mine sites by sampling and analyzing soil, water and atmosphere and comparing the data with the baseline data of SIGE.

Whereas there had not been any decree to investigate and evaluate environment by 2004, SAE, DCE and DEAR did not take any definite environmental actions. In 2001 they attempted to conduct environmental surveys in the oil exploration areas and SNIM mines by extension of the decree related to the mining inspectorate (that regulates health care, buildings and labor safety on mines.) but it was inadequate because no environmental experts joined the surveys.

On the other hand, MRDE recognizes that it is responsible for all environmental matters. Therefore, MMI implements its function under MRDE according to the law. MRDE participates in every matter like not only acceptance of MMI reports, but also site surveys or environmental studies and evaluations. However, this sometimes causes inconvenience due to the lack of MRDE officials'

mining technical knowledge.

3.7.4 Environmental Protection Measures for Mining Sector

There has not been so far any decree for environmental protection in mining activities, so no environmental measure has been taken for mining. However, a decree for mining environment was passed in June 2004 and it became a legal base for environmental protection in mining sector. Environmental management plans will be prepared within two years after promulgation of the decree. Currently, the SNIM's Zouerate iron pit is the only operating mine in Mauritania along with the Akjoujt Copper Mine (Appendix I, 7.3) in the past. Baseline surveys for actual environment in these two mines will be carried out in PRISM2 programs. Environmental protection measures will be formulated based on the results of the surveys. At the same time, environmental management plans will be made including these protection measures. The environmental protection measures and environmental management plans for the Zouerate and Akjoujt mines may become the models or guidelines for the Mauritanian mines in the future. Furthermore, if the Tasiast Gold Mine (Appendix I, 7.1) which has begun its development construction is added, each mining stage in development, operation and re-development will give useful data for the environmental protection measures. Tasiast is located in the point which is at a straight distance of 300 km from the Banc d'Arguin national park located on the Atlantic coast. The park is registered in the world heritage, designated as the wetland under the Ramsar Convention and is famous for the numerous species of wild birds and fishes. The distance of 50km is over the impacting limit of mining operation in Tasiast. However, the movement of groundwater has not been resolved yet, so it appears that mining operation like boring must be carried out carefully.

3.7.5 Environmental Impact Assessment (EIA) in Mining

In the Environmental Basic Code implementation of EIA is mandatory. Accordingly, EIA is indispensable for all large-scale projects, but there have not been many examples in Mauritania. No EIA in mining has been implemented in Mauritania so far. For gold development in Tasiast, the EIA is carried out. On the other hand, offshore production of petroleum in Well Chingetti will be started by Woodside, an Australian company in 2006. An EIA was already submitted.

EIA systems for mining development are different for metal mines and offshore petroleum wells. Each system is described below.

a. Metal mining development

After a private company submits an EIA to MMI, MMI and MDRE form an EIA committee to discuss the summary of the EIA prepared by the company. The committee consists of members representing MMI (SAE), MDRE (DEAR), Ministry of Hydraulics and Energy, Ministry of Interior and Ministry of Public Health. This is regulated by the article in the "Environment Basic

Law “on organizing a committee composed of related ministries. The discussion takes three months and three more months are then needed for a questionnaire survey for inhabitants around the mine site. This questionnaire informs the inhabitants of the mine development and collects their opinions. In Mauritania, a mode of questionnaire is needed for nomadic people who come periodically to the mine site during the rainy season.

As there is no expert for an EIA in Mauritania, experienced experts for mining environment will be employed by an international tender when the Tasiast Project is realized. EIA training for SAE is implemented through practical works by on-the-job-training.

b. Petroleum development

The impact by offshore petroleum development is supposed to be more serious than metal mining. The form of the EIA committee sessions correspond to direct conversations. After a developer prepares the EIA, he must explain the detailed operation of petroleum production, environmental risk by the production and environmental protection measures at meetings with MMI, MDRE, Ministry of Fisheries, Ministry of Equipment and Transportation, Ministry of Public Health, Ministry of Defense, fishermen and environmental NGO, and attain acceptance and consensus of all groups. This is not regulated legally, but set up for the Woodside’s petroleum development by SAE.

3.7.6 Tasks for Environmental Consideration

There are several serious impacts on the Mauritanian environment so various environmental issues need to be studied. The natural environment in Mauritania has two typical regional characteristics by climate: the northern vast dry region and southern wet region in Senegal River basin. Therefore, there are two main types of vegetation, fauna and soil according to this characteristic. Currently, there are many environmental impacts, such as desertification, bad management of ground water, marine contamination by iron ore in Nouadhibou, bad treatment of the urban waste, etc. Careful consideration of the environment is necessary when a mine is opened because mining activity has serious impact on the environment. Present mining activities are concentrated in the northern regions with the harder natural environment. Therefore, there are a few inhabitants who suffer from impacts caused by mining activities. However, legal and institutional improvement for the environment management is needed at this time. Some cheaper and effective methods are necessary to be begun for environmental supervision, like remote sensing for macro monitoring.

Administration jurisdiction should be clear. For instance, MDRE administrates natural and human environment from a broad viewpoint for the entire territory of Mauritania. On the other hand, MMI administrates mining activities including the environment, which demands specific technical knowledge. Limited administration capacity should be utilized effectively. This system is adopted in

the Philippines, Costa Rica and Japan. Environmental standard is a base for evaluation of the EIA before mine development. There is the EIA law in Mauritania and decree for mining environment, which regulates the law to put it into practice, but there are no environmental standards. At present, a mining developer can easily adopt other countries' regulations, which are not necessarily suitable for Mauritanian situation. The environmental standard must be urgently made. When an environmental standard is established, multiple standards according to the population density should be considered taking into account the Mauritanian characteristic of its vast territory and small population.

3.8 Actual Status of Mining Activities

3.8.1 Mining Activities of National and Private Companies

(1) SNIM

SNIM has its head office in Nouadhibou (Appendix I, 7.2), and its mine site is located in Zouerate (Appendix I, 7.4). Annual production of about 10 million iron ore is transported 650 km to Nouadhibou by railway, and all ore is exported in annual amount sale of US$ 200 million (Fig.3.8.1 and Table 3.8.1).

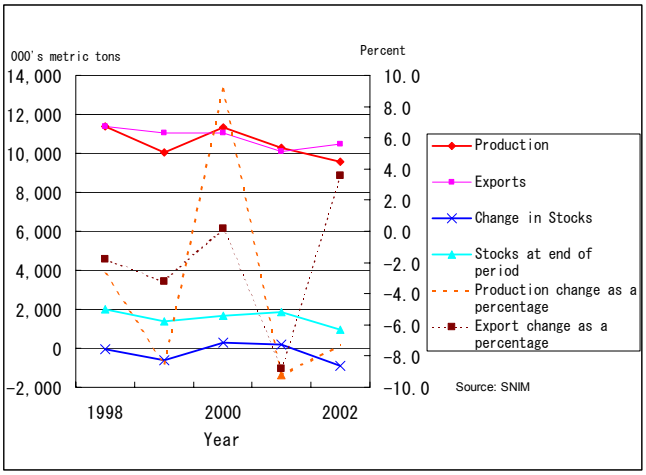


Fig.3.8.1 Main Production Indexes for SNIM

Table 3.8.1 Principal Exporting Countries for SNIM (as of 2002)

Country	Amount of sale (kt)	Share (%)
France	3,026	28.9
Italy	2,653	25.3
Belgium	1,932	18.5
Germany	1,480	14.1
Spain	686	6.5
Pakistan	264	2.5
Others	439	4.2
Total	10,480	100.0

SNIM's capital is shared by seven organizations; (1) Islamic Republic of Mauritania 78.35%, (2) Kuwait Real Estate Investment Syndicate 7.17%, (3) Arab Mining Company 5.66%, (4) Iraq Fund

Heart Extemat Development 4.59%, (5) Office of Research and Mining Involvements (Morocco) Mining activities in Mauritania are presented by iron mining business conducted by a state enterprise, SNIM. Exploration is implemented by foreign companies with gold and diamond as targets; however, it is not yet fully activated. Exploration is hindered by shortage of infrastructure, manpower, and information. 2.30%, (6) Islamic Bank of Development 1.79%, (7) Private Mauritanians 0.14% (Appendix I. 1.6). Total number of employees is 3,782 (1,341 in Nouadhibou, 2,441 in Zouerate) as of 2003.

According to the loss and gain statement (by annual reports), SNIM had a deficit in 2002. SNIM enhanced the mineral processing plant to increase exportation by the loan of 13,687 million MU, supporting from EU during 1997 to 2002. Also, SNIM has a plan to renovate and increase the berth in the port by a loan of 10,687 million MU. This objective is to strengthen the competitiveness to improve the management practices. Otherwise, IT, workers training and quality control etc. are proceeding. A financial processing system (SAP) has been introduced to integrate management with a computer (Fig.3.8.2). SNIM was established by French and English investors in 1955, and then nationalized in 1974. Mine operation has been managed by Mauritanians since 1980 (Table 3.8.2).

Table 3.8.2 Main History of SNIM

Year	Historical Development
1955	French & English investors established an iron mining company, Miferma.
1963	Exportation of iron ore was begun after setting up the infrastructure for the mine.
1972	Mauritanian government established SNIM.
1974	Miferma was nationalized and management was transferred to SNIM.
1980～1982	Mine operation was shifted to Mauritanians.
1984	Production of El Rhein was started.
1994	Production of M'Haudat was started.
1997	Production of TO14 was started.

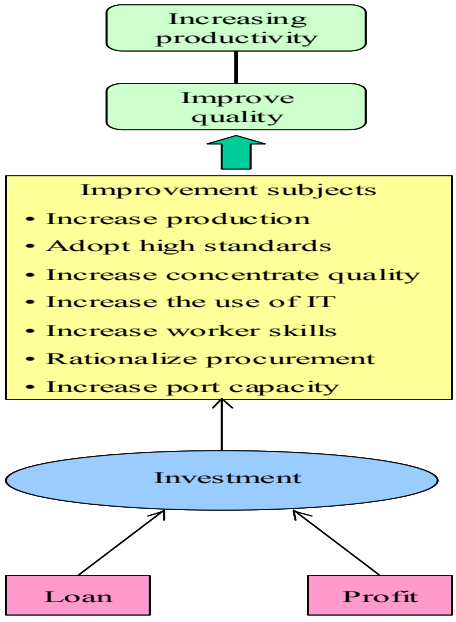


Fig.3.8.2 Improvement of SNIM's Competitiveness

SNIM consists of Nouadhibou facilities with the head office and port and Zouerate facilities with the mines and mineral processing plants (Appendix I, 1.7). Environmental management and exploration activities are contained in the head office facility.

(2) Current Status of SNIM Iron Mines and Related Facilities in Nouadhibou

1) General Description of Zouerate Mine Site

Zouerate (Fig.3.8.3) is located in the eastern inland rocky area by about 700 km far from Nouadhibou which is an exporting port at the Atlantic coast. Just before opening the mine Zouerate was in severe natural conditions and without any infrastructure. The infrastructure like roads, railway, electricity, water etc was constructed for the mine operation. The current population of the city is about 30,000. 20% of it has relation with SNIM and others engage in commercial pursuits.

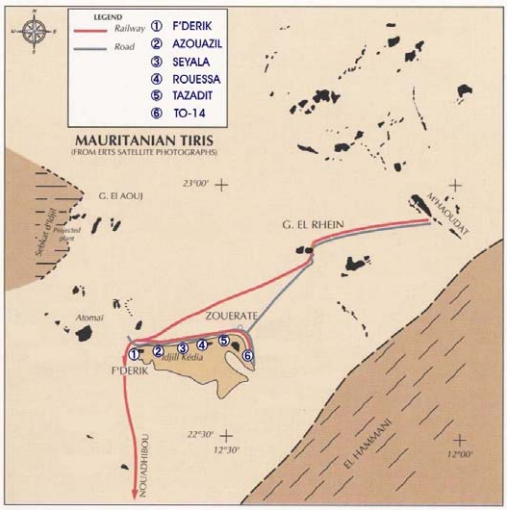


Fig.3.8.3 Location of Zouerate

The iron ore deposits of Zouerate are roughly divided into two groups: the Tiris Group which is coarse-grained (0.2-3mm in diameter) magnetite in an Archean metamorphic formation and the Idjill Group which is fine-grained hematite in Precambrian weak metamorphic rocks.

The SNIM iron mine is located in the Zouerate region of Tiris Zemmour Wilaya. Current working deposits in this region include Kedia, Guelb El Rhein, and M'Haoudat. There are two deposits for which FS are currently under consideration, El Aouj and Atomai.

Table 3.8.3 Brief Summary of Ore Deposits in Zouerate

Ore Deposits	Summary
Kedia	Pits belonging to this ore deposit are F' derik, Azouazil, Seyal, Rouessa and Tazadit, from west to east. F' derik finished its operation, and others intermittently operate in small scale (400,000t/y). The current main pit is TO14 in Tazadit. It contains fine hematite, and ore reserve is 170mt.
Guelb El Rhein	Coarse-grained magnetite, and ore reserve is 342 mil. t with a grade of 37% of Fe.
M' Haoudat	Fine hematite, the annual production is 14 mil. t.
El Aouj	Coarse-grained magnetite, and the ore reserve is 287 mil. t with a grade of 40% of Fe.
Atomai	Coarse-grained magnetite, and the ore reserve is 616 mil. t with of a grade 36% of Fe.

Table 3.8.4 Classification of Mining Ores

Kinds of ores	Pit	Classification of Ore
Fine Hematite	TO14、M'Haoudat	Fe＞59% : high grade ore 59%＞Fe＞45% : low grade ore 45%＞Fe : waste
Coarse-grained Magnetite	El Rhein	Crude ore grade : 35%～42% →concentrate grade 66% Occurrence a. Isotropic, b. Lineation banding, c. Layer

At the Zouerate mine site there is Departments of Mining and Mineral Processing, branches of Exploration, Information System and Railway maintenance divisions (Appendix I, 1.8).

The Zouerate mine site has total 8 mines with 17 pits; 6 closed pits, 6 pits in shutdown and 3 mines with 5 pits in normal operation. Normal full operation is carried out in the three main mines with five pits, TO14, El Rhein and M'Haoudat.

2) Production

The Mining Department covers mining service (consists of 7 divisions like main 3 mines, blasting, production planning, tires plant, etc.) and machine service (mechanical and electrical divisions). All the operating pits work in three shifts, working 365days/year. Production has not been constantly stable (Fig.3.8.4).

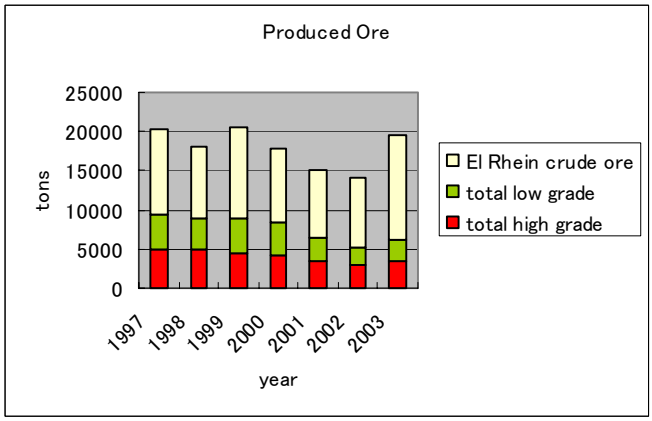


Fig.3.8.4 Ore Production Results in Zouerate

The production scale improved in 2003, 20% up for the hematite and 51% up for the magnetite, compared with the indices of the previous year. This was related to the movement of the iron market, and production of low grade ore increased according to the market's demands. Total mined amount of the three mines has decreased since 2000 to 13% of 1997, but improved to 50% of the previous year in 2003. Stripped amount of the three mines increased dramatically in 2003 (Fig.3.8.5), but delay in stripping is still evident with the steep pit slope and the narrow bench width.

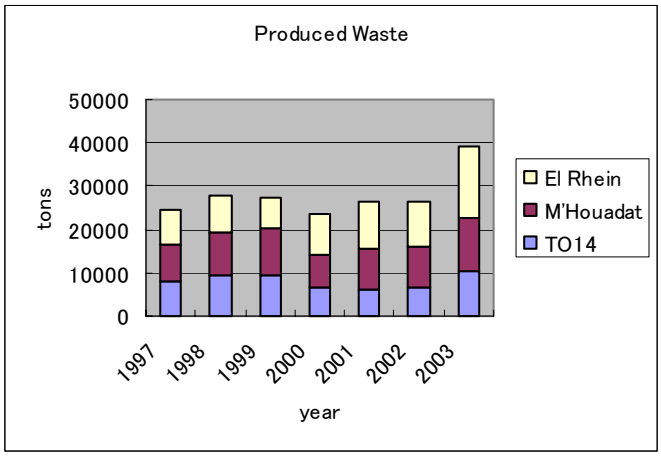


Fig.3.8.5 Stripped Waste

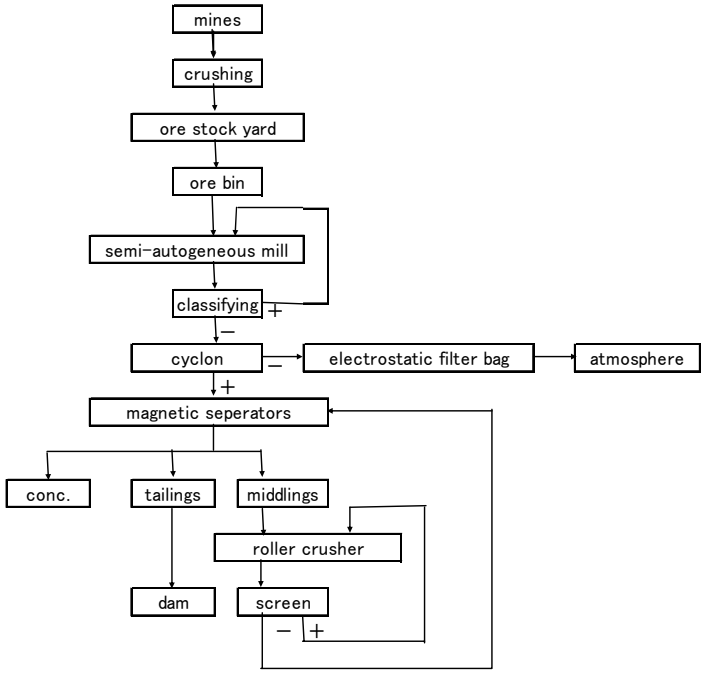
This was the result of rapid mining caused by the good market price. The rapid production following the market demands without consideration of the long-term production plan might have serious impact on the stable production in future.

Therefore, stripping must advance more energetically for more stable production in future. The principal explosive used at the mine is AN-FO, even though slurry explosives are sometimes used in the groundwater. AN-FO is prepared in the mine site. The operation is controlled by radio communication system. Each transportation machine (shovels and dump trucks) is equipped with a radio. Mining machines consist of the large scaled drilling machines, shovels and dump trucks in function combination. Principal machines used in the main three mines are listed in Appendix I, 1.9. Training in mechanics is an obligatory term in contracts with manufacturer when SNIM purchases new machines such as drills, shovels, bulldozers, etc. Repair and maintenance skills have accordingly improved steadily. Object of occasional operation except the main three mines is to help production in case the three mines can not keep their scheduled productions. First of all, the stable production of the three mines is necessary, and especially a plan to increase an amount of waste is urgently needed, taking into account of increasing production. Generally speaking, when machines and labors are dispersed, global working efficiency worsens. Therefore, machines and labors should rather be put together.

The Department of Mineral Processing provides five services for processing, production, mechanical maintenance, electrical maintenance and engineering. Total number of workers is 440. Beneficiation is done in El Rhein mine, and only ore-crushing operation is in progress in other mines. All plants are operated by three-shift system with 24 hours/day. Periodical repair is carried out in eight hours per week, and annual working days are approximately 320 on an average due to accidents and breakdowns.

In case of the hematite, ore grade is about 60 to 65% for the high grade ore and 55 to 58% for the low grade ore, which is crushed and transported directly to Nouadhibou. In case of magnetite, the crude ore with grade of 35 to 40% is beneficiated by magnetic separators to receive concentrate with 65% which is afterwards transported to Nouadhibou.

In the technological process in El Rhein plant, the magnetite ore is crushed, milled and beneficiated by magnetic separators (Fig.3.8.6) using its magnetization characteristic. Working condition in the plant is very bad because a lot of dust is emitted due to the dry separation system. Currently wet separation system is under construction to increase the recovery (85% to 92%) and prevent from dust. It is expected to improve the working condition in the plant.



The high grade ore production of the hematite (TO14 and M'Haoudat) decreased to 40% of 1997 in 2002 since 1997. And the production of the magnetite ore (El Rhein) could make up only 15% of 1997 in 2002. The operation rate of the plant is also low, and should be increased up to 70% at least (Fig.3.8.7 and 3.8.8).

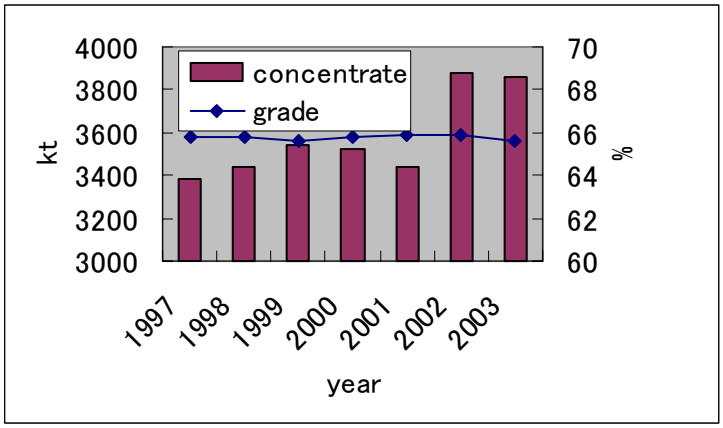


Fig.3.8.7 Production of Magnetite Concentrate and its grade

The tailing dam located in the corner of the mine site is in about 5 km from the dressing plant, and the tailings are transported on conveyors. Tailings of wet separation system which is now under construction are planned to be pumped up to the same tailing dam, so it is expected to refrain the dust production in the dam.

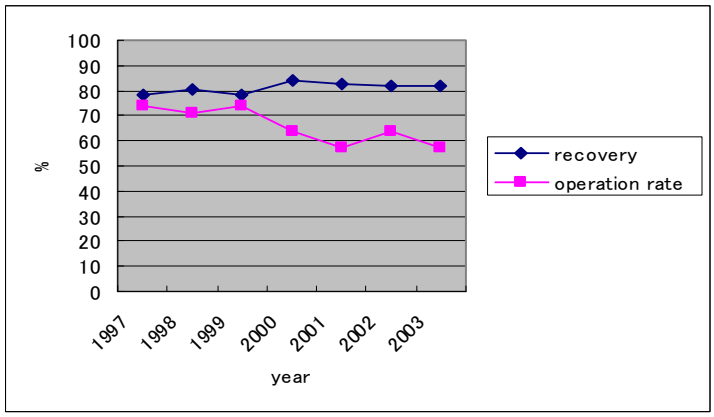


Fig.3.8.8 Recovery and Availability of Magnetite Processing

3) Environment

Environmental management system has not been established but the periodical patrol from

the Nouadhibou head office is in charge of the environmental control at the mine. Therefore, SNIM has not taken any concrete action (management organization, management facilities, measuring tools, monitoring etc.) about the environment.

The most problematic environmental issue in Zouerate is supposed to be dust. However, there is no dust pollution in the city at present because the nearest operating mine, TO14, is in 15 km from the city. However, some mine workers still suffer from respiratory illness caused by the inhalable dust. Therefore, dust is not the environmental problem, but labor condition problem. Water showering, wearing masks in dusty places outdoors and installation of powerful dust collectors inside of the plant are the appropriate countermeasures against it.

A large mount of waste oil from the heavy machinery used has been abandoned in the mines. The nearest pond is used as a disposal area for waste oil. Waste oil is said to be scattered in the pits for dust protection purpose, but it could contaminate groundwater. AN-FO explosives are another source of groundwater contamination, but exact data could not be ascertained in the mine site because no survey has been carried out so far.

4) Infrastructure

The road distance between Nouakchott and Nouadhibou is about 650 km. 450km in its route is paved (National Route No.1: Nouakchott-Atar). The route loses the paved road around Atar, apart from Route No.1. Currently, EU has a plan to survey for road construction. However there is no supply of water between Atar and F'derik, so water would be a bottleneck for construction. From F'derik the route is paved about 30 km to Zouerate. This paved road continues about 60 km to the M'Houdat Mine for SNIM's operation.

In each mine, there is a specific ore-loading hopper for the train wagons transporting ore to Nouadhibou. Rail-roads are maintained by seven stations in Zouerate to Nouadhibou. Thickness of rail is measured periodically by a measuring car and rails are replaced as required.

There are three water tanks in El Rhein for water supply in the mine site. 473 m^3 of water is sent monthly through a conduit 300 mm in diameter from Srey which is located in about 80km from the mine site. There are the wells in TO14 and M'Haoudat Mines to meet their demands, but water in El Rhein contains salt so water is supplied from Srey.

There are two power stations in the mine site, one in El Rhein (output: 192.06GWh) and another in Zouerate (output: 1.94GWh). Problems in the power stations are breakdowns in summer season (June to September) due to high temperature. Powerful coolers are fully working, but sometimes breakdowns occur and electrical supply stops.

5) Issues

The largest issue in production of iron ore is to build a system enabling scheduled production. The efficiency of supplementary pits has some influence to total production, and also has some relation to the increase in the production. The important issue in mineral processing is to

stabilize the recovery and availability of the plant. The environmental problem has not appeared so far, but some countermeasures should be taken. Main issues in Zouerate are summarized, as follows:

- Scheduled production by advanced stripping and production increasing measures.
- Increase the production efficiency by appropriate integration of machines and labors.
- Improvement of the concentrate grade, recovery and availability in El Rhein plant.
- Improvement of working environment by implementation of the dust protection.
- Implementation of environmental management including waste oil treatment.
- Stable electrical supply.
- Increasing the water sources.

PRISM started development of water resources to increase their sources.

6) Related Facilities in Nouadhibou

Nouadhibou is equipped with relevant railroad and port facilities.

Main facilities for the railroad transportation consist of the periodical maintenance shop for locomotives, the locomotive daily check shop and wagons repair shop. Locomotives need special facilities for protection from the sand dust and their maintenance costs are slightly more expensive, and rails are easily abraded by the sand so constant rail check and modification of rail shape are needed. These problems can affect the total production cost to the maintenance of the iron mine in future. TQC activities included efforts to improve the efficiency, but above mentioned crosscutting measures should be taken as well.

Main port facilities consist of a wagon tippler, an ore stock yard (1 million tons for crushing and 1 million tons for shipment), six classifiers (0～200mm), four crushers (possible under 1.6mm), three reclaimers (one for classifying and crushing, one for shipment, one for backup), two samplers, one berth for ore shipment (for 150,000t ore carriers). As the water depth is shallow around the port, ore carriers need sometimes more time to anchor to the berth according to the sea condition without a tug boat. Feasibility study for renovation of berth for 240,000 ton carrier has finished and its construction will start in 2005 by EU investment, because the existing berth for 150,000 ton carrier became too old and loading efficiency should be increased. Conducting of dredging works in the port is necessary every several years.

As mentioned above, one person is in charge of environmental management for the mine site in Zouerate and the port site in Nouadhibou. No monitoring system exists. The ore dust from the tippler or the belt conveyors for shipment causes the sea contamination by heavy metals. Therefore, taking some measures at this phase will reduce the environmental cost in future and maintain environment impact at the minimum level.

(3) Mining Activities of Private Companies

Almost all the mining activities of private business are carried out by foreign companies (Appendix I, 1.4 in the Interim Report). SOPHSMA is a local private company which has a project of

phosphor development near the Senegal River. The project is at the phase of feasibility study, partially supported by German finance. Furthermore, SAMIA, a subsidiary company of SNIM, is excavating gypsum in Nouakchott suburbs.

The foreign mining companies are from England, Canada, Australia and Spain. Total of 12 companies are conducting exploration/development activities for diamond and gold. There is a reopening project for copper/gold and also a gold development project. Other activities are at the phase of perambulation. However, five companies, half of the active developers, are currently continuing their activities, but the rest is stopping activities or drawing off. Acting companies (Table 3.8.7) are pointing out the following issues in the exploration/development in Mauritania.

- Shortage of infrastructure.
- Water supply for boring is expensive because it must be transported from 50 to 200km.
- At the development phase, the infrastructure construction expenses are taken by the project and this makes it unprofitable.
- Government organizations do not disclose geological information.
- There are few experienced workers for exploration/development in Mauritania.

Guelb Moghrein is ready to re-develop the mine in 2005. A management company of the mine is the Mauritanian Copper Mine (MCM), financed by Canadian and Arabian investors. The project, which was located within Mining Concession at Akjoujt, focused on copper and gold resources that were estimated to be 23.7 Mt at a grade of 1.88% of copper, 1.41 g/t of gold, and 144 ppm of cobalt based on 1% cut-off grade for copper. A copper mine had been operated on the concession area from 1970 to 1978. General Gold's pilot plant, which was built for the leaching of gold from the old copper mine tailings, was owned. In addition to the Guelb Moghrein Project, General Gold held 7,600 km^2 of exploration permits in the Inchiri region near Akjoujt.

Table 3.8.5 Summary of Mining Activities by Foreign Companies

Item	Rio Tinto	Tasiast Gold	Strata Mining
Country	England	Canada	Australia
Company	Rio Tinto/BHP	Defiance Mining (Toronto) 100%	Australian junior
Exploitation target Exploration area	● Diamond ● Northern area	● Gold ● Tasiast	● Gold ● Stop exploration
Licenses (concession)	4 exploration licenses	14 exploitation licenses	14 exploration licenses
Phase	Perambulation, boring	Started construction for development.	Perambulation
Issues in exploration and development	Shortage of infrastructure (Road, water, electricity) /water supply for boring (170km transportation) /shortage of geological information	Shortage of geologists and engineers /shortage of infrastructure (Shortage of road 100km) /water supply (70km transportation)	Shortage of experts /difficult water supply /unfriendly environment for foreigners /shortage of experienced workers

Rex Diamond and Rio Tinto are implementing the exploration for diamond. Rex Diamond discovered the first diamond-bearing kimberlite near the Tenoumer and the Touajil properties in November 1999. In Rex Diamond's 100% owned exploration permits in Mauritania, the company

began the drilling program at Touajil, where micro diamond and macro diamond concentrations had been found. Ashton, which initiated diamond exploration activities in Mauritania in 1995, had discovered kimberlite with diamond indicator minerals in the Reguibat Shield area in 1998. At present, Ashton continues diamond exploration as the owner and operator, but has not discovered economical deposits yet.

Many international oil companies have been also involved in offshore oil exploration in Mauritania since the second half of 1990s. At present, oil has been discovered in the Chinguetti concession, and production is planned to begin in 2005.

3.8.2 Actual Status of Exploration and Development

(1) Approval of Licenses

The number of exploration/development licenses (Mining Licenses) issued is not big, because mining activities are not yet fully activated. As mentioned in "2.3 Mining Activities of Foreign companies", the current explorations (licenses) are mainly on gold and diamond. As of 2003 August, 92 exploration and 5 exploitation licenses were permitted. There are only 18 license holding companies, because some of them have more than one permit, for instance 17 licenses. Among the 92 licenses issued, there are 37 licenses for diamond (40%) and 52 licenses for gold (57%), the current status being shown in Table 3.8.6.

Table 3.8.6 Issued Licenses in Mauritania

Group	Kinds of Mineral	Exploration	Exploitation
1	Iron, manganese, titanium, chrome, vanadium	3	1
2	Nonferrous metals, precious metals	52	3
3	Coal, inflame fossils	0	0
4	Uranium, radioactive materials	0	0
5	Industrial materials, construction materials	0	1
6	Jewels (excluding diamond)	0	0
7	Diamond	37	0
Total		92	5

(2) Actual Status of Exploration

1) Foreign Investors

There are five foreign companies currently implementing exploration activities. All the activities are still at the initial stage of grasping the mineralization characteristics. Among the companies (Table 3.8.7) registered in Mining Cadastre Unit, Rio Tinto (diamond), BRICK Capital (gold and diamond), Lonart (gold), Rex Mining (diamond) and BHP Billiton (gold) are carrying out the exploration. Any result has not been acquired yet, however, and recently the exploration activities of these five companies have been suspended. The exploration cost for Rio Tinto is about US$ 2 to 2 million per year including the office cost. If prospecting works do not advance to the detailed survey stage, the exploration cost will remain the same. Under the circumstances of scarce geological information, inadequate infrastructure and severe natural environment, exploration risks are large for

the foreign companies. In order to expect a more active exploration from the foreign companies. It is vital to solve problems indicated in Table 3.8.5. These matters are described in **3.8.6 Tasks for Exploration and Development** in more detail.

Table 3.8.7 Registered Foreign Companies in Mauritania

Name	Country	Address	Object of Mining
RIO TINTO/ASHTON	UK	ZR E Nord N 448 B.P. 5083 - NKTT	Group 7
B.H.P./Billiton	Australia	Zone des Ambassades, Tevragh - Zeina	Groups 1 & 2
BRICK CAPITAL CORPORATION	Australia	ZR B 462 B.P. 50551 - NKTT	Groups 2 & 7
DIAMET MINERALS AFRICA	UK & Australia	ZRE Nord N 448 BP 5083 - NKTT	Group 7
GENERAL GOLD INTERNATIONAL		ZR E Nord N 53 BP 5576 - NKTT	Group 2
FIRST QUANTUM MINERALS LTD.	Canada		Group 2
TASIAST GOLD Ltd.	Canada	ZR E 53 BP 5051 - NKTT	Group 2
LONART PTY LTD.	Australia	ZR E Nord N 448 B.P. 5083 - NKTT	Group 2
REX MINING CO. (REX DIAMOND)	Canada	ZR A N 697 BP 5383 - NKTT	Groups 2 & 7
SOPHOSMA/SIPIA S.A.	Mauritania	Zone Garage Av. Bourguiba Ksar BP 3456 - NKTT	Group 5
SNIM	Mauritania	Ilat V 6162 BP 40 259	Groups 1, 2 & 7
DE BEERS	South Africa	ZR A N 601 BP 5383 - NKTT	Group 7
LUCHOSOL SL	Spain	Paseo-Verdun 11 Barcelona Spain	Groups 2 & 7
FRANJUAN	Spain	CRTA de Sellert km 1,2 Valencia Spain	Groups 2 & 7
SOMISEL	Mauritania	KSAR	Group 5

2) Exploration Targets and Areas

Targets for exploration are currently selected mainly for gold and diamond in Mauritania. These are places such as Tasiast-Tijirit district, Ouassates-Sfariate district and the south of the Mauritanides where reconnaissance survey and basic prospecting have been implemented by Mauritanian Office for Geological Research (OMRG), National Exploration Agency. The areas surveyed by OMRG for the 20 years are as follows;

- From 1983 to 1991, the geological, geochemical and geophysical explorations were systematically carried out in the south of the Mauritanides for copper and gold under the budget allocation of EEC and Mauritanian government to reveal the potential zones for gold and copper like Diaguily, Kadiar and so on.
- Geochemical exploration was carried out for gold in the Archaeozoic green rock zone in the Tasiast-Tijirit district for three years starting in 1994 under the budget allocated by EU and Mauritanian government. This exploration resulted in the identification of gold anomaly zones and following trenching and boring surveys to narrow down the gold potential zone.
- In 2001 a gold exploration project started in the Ouassates-Sfariate district, which is located in about 200 km in northeast of Zouerate city, in the Archaeozoic green rock zone with the same geological background as the Tasiast-Tijirit district and is planned for five more years. Soil geochemical exploration has also been carried out in the same area to reveal several gold anomaly zones.

In the Ouassates-Sfariate district, additional exploration has been implemented by foreign

investment based on results of exploration carried out by OMRG, and some foreign mining companies have attained exploration licenses and continued surveys on gold. In the Tasiast area, the Tasiast Gold Mine started the construction work for the mine development. Another GGI gold exploration project started in the Inchiri district around the Akjoujt city in 1991, which was followed by a boring survey in the geochemical anomaly zones to the east of Akjoujt in 1997. In addition, as reported earlier, Rio Tinto and other companies have been prospecting for diamonds (Table 3.8.5).

SNIM has implemented its own exploration activities, targeting the following areas:

- Focusing on non-ferrous minerals, especially diamond and gold.
- Recently concentrating on gold, diamond, platinum (to the south of Kedia), kaolin (to the south of Magta Lahjar), gypsum (to the north of Nouakchott) as well as iron around the Koedia-Tiris district.
- the grass-root exploration for diamond and platinum

Table 3.8.8 Exploration Targets and Areas

Target	Exploration area		Target deposit
	Geologic province	Area	
Gold	Reguibat shield	Tasiast-Tijirit	Vein and network type deposit in BIF
	Reguibat shield	Ouassates-Sfariate	Vein and network type deposit in BIF
	Mauritanides	Akjoujt	Carbonate replacement
Diamond	Reguibat shield	North Reguibat shield	Kimberlite

Only gold and diamond are the target elements, so the exploration will be limited to the areas where efficient data is available from the exploration activities of OMRG and Bureau of Geological and Mining Research (BRGM). Kinds of elements and areas aimed at during exploration cannot be increased as a result of the grassroot survey as far as the exploration data and infrastructure in the whole country are insufficient for a wider investigation. Foreign investments have recently targeted exploration on network-type gold deposits leading to large-class to medium-class mining in gold promising districts. However, specifications of exploration projects will be planned in the future.

3) Exploration Methods and Technologies

Exploration methods applied by OMRG are as follows;

a) Geochemical exploration in soil

b) Geochemical exploration in stream sediment

c) Geochemical exploration in rock

d) Pit exploration

e) Trenching

f) Geological exploration

OMRG currently implements exploration mainly by geochemical method. In the past, explorations were carried out using several methods accompanied by instructions of geologists from BRGM, France and the former Soviet Union. However, no leading engineer and insufficient equipment due to shortage of funds are disincentive for continuous surveys.

OMRG owns several exploration machines, two boring machines (Longyear24 with max. depth of 100m and Longyear34 with max. depth of 800m), one water tank truck, one fuel truck, eleven vehicles for exploration. However, all the machines are superannuated; for instance, the boring machine is now not capable of working.

Concerning geophysical survey, OMRG carried out electronic prospecting method in the past. At present, however, there is no geophysical engineer, and there is no available equipment to use. The organization does not have any geophysical technology.

SNIM has 19 geological engineers. SNIM has a large boring machine made by Longyear with capacity of maximum depth of 500m and boring cores attained from various boring fields. The weathered rock samples from the surface or the trench are panned to select and appraise the heavy minerals. Final laboratory analysis is done in Canada for diamond, in Ireland for gold and Western Australia for PGE.

4) Laboratory and Its Capacity

There is a chemical laboratory in OMRG with a staff of fourteen people. The laboratory facility consists of sample depository, sample preparation and chemical laboratory houses. The sample depositary has space enough for 50,000 rock samples and about 30% is currently occupied. There are two jaw crushers and two vibrating mills in the sample preparation house whose capacity is 50 samples per day. In the chemical laboratory house there are two Australian-made atomic absorption analyzers, but one of them is too old to use and another (Spectra AA-20 Plus made in 1992) is impossible to be used on Ag, Cu, Pb, Zn, Co, Ni, Co and Mn for it lacks spare parts, but only Au. Detection limit is 5ppb and gold analyzing capacity is 50 samples per day. There are also three polarization microscopes, a diamond rock cutter, a cropper for rock tip, two polishing machines, one set of heavy liquid separator and one dynamic separator in the laboratory house. Specific analysis using the atomic absorption analyzer in OMRG is carried out on gold only owing to the superannuated equipment and inadequate replacement of parts. Some foreign companies request OMRG to prepare samples and analyze them for gold content by the atomic absorption analyzer.

SNIM has a chemical laboratory in Zouerate, which analyzes the ore for iron content. Finally, component analysis is carried out mainly for iron oxides by a fluorescent X-ray analyzer. Other metals cannot be analyzed in this laboratory because the crushers and mills are contaminated by iron oxides and are not cleaned sufficiently.

5) Financing and Its Sources

Exploration projects are financed by foreign companies from sources abroad. Therefore, they have no inconvenience in financing. Mauritania has adopted a financial liberalization system, so there is no limitation for money flow into the country. However, there is an exchange risk, because it is prohibited to pay in hard currency.

The domestic companies can obtain finance only from domestic banks, and loan is the sole

financing system. Currently short-term banking loans are. The interest rate is 13% for 1 year at maximum, and is too high to apply in exploration. Generally speaking, exploration needs a period of 3 to 6 years to take, and should be started from grassroot prospecting. Right now it is difficult for the domestic companies to attempt exploration activities with risk and without favorable financing means. Therefore, as far as long-term loan system with low rate of interest is not established, domestic exploration cannot be promoted.

(3) Activities of OMRG

OMRG has implemented the geochemical and geophysical exploration in areas which have mining potential, and also evaluated known or newly discovered mining occurrences through detailed work e.g. regional trenching and drilling.

The goal of the work carried out by OMRG is to "provide up to date and complete geological data to the exploration and mining sector."

OMRG is rich in experiences of exploration with more than twenty years and has carried out the mineral resources survey, with international organizations like EU, the foreign research agencies like BGS and BRGM and the international mining companies like Rio Tinto and etc. Recent activities are as follows; gold exploration in the Tasiast-Tijirit district, gold exploration in the Ouassates-Sfariate district, copper and gold exploration in the southern Mauritanides, sulfur survey to the north of Nouakchott and peat survey in the southwest of Mauritania, as mentioned before.

OMRG has not carried out any environmental works so far, but the Division of Environment was established by motivation of this study. OMRG will bring the mining environmental works into its view, but the mining environment is in charge of DMG in MMI. Therefore, OMRG will manage the environmental works in the exploration operations and the baseline survey in future. However, if the exploration and development will be activated more by the foreign investors in future, OMRG will be able to increase the field works for EIA or environmental surveys in the mines and the site works like sampling or monitoring, because OMRG has the rich cooperation experience in gold explorations with the international organizations. OMRG needs acquiring steadily the wide range of various environmental skills, like the basic sampling and data collection to EIA technology for the future necessity.

OMRG has its own medium and long term program for gold, platinum, nickel, chromium and other industrial materials (Table 3.8.9 and 3.8.10).

Table 3.8.9 Medium and Long Program for OMRG

Mineral	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Gold (Base Metal)										
Platinum										
Nickel										
Chromium										
Clay and Kaolin										
Black Sand										
M. C.										

Barite										
Fluorite										
Salt										
Regional Maps										

NB M.C is Materials for Cement

Table 3.8.10 Necessary Cost for Medium and Long Program (in million MU)

Mineral	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Total
Gold (Base Metal)	12	36	46	46	36	12					188
Platinum	12	36	46	46	46	32					218
Nickel				26	26	12					64
Chromium						7	14	14	7		42
Clay and Kaolin				11	16	7					34
Black Sand						7	14	14			35
M. C.	7	16	8								
Barite						7	14	14	4		39
Fluorite						7	14	14	4		39
Salt	7	16	16	8		7	2				56
Regional Maps	29	28	30	30	30	26	28	29	28	33	291
Total	67	132	146	167	154	124	86	85	43	33	1,037

3.8.3 Mining Development Situation

Except iron production by SNIM in Zouerate, there is copper production. Copper was produced in the Guelb Moghrein district. The Guelb Moghrein is located at Akjoujt in the Precambrian Mauritanides, in an area where copper had been found in Neolithic times. During the 1960s the British company carried out exploration in a major copper anomaly zone and proved an oxide copper resource containing gold and small amounts of recoverable cobalt and nickel. SOMIMA (Mauritanian Mines National Company) commenced operation in 1971 using TORCO (Treatment of Refractory Copper Ore) process. However, the 1973 oil crisis resulted in increased energy prices which, together with decreased copper price and ore processing problem, led to the mine's closure in 1978. From 1971 to 1978, SOMIMA produced 141,000 tons of the copper concentrate. The tailings of the TORCO treatment activities, which treated 2.5 millions tons of the ore at 3.5 g/t Au, were retreated from 1992 to 1996 by MORAK (the Akjoujt Gold Mine) to produce five tons of gold. The stocks of MORAK were owned by SAMIN (45%, the Arab Company for Mining at Inchiri), by Australian company, General Gold (42.5%, GG) and SFI (12.5%). After the completion of the tailings treatment, SAMIN and GG established a new mining company called GEMAK (the Guelb Moghrein Company at Akjoujt), for the exploitation project of the copper, gold and cobalt. The proven and probable reserve for the project is 23.7

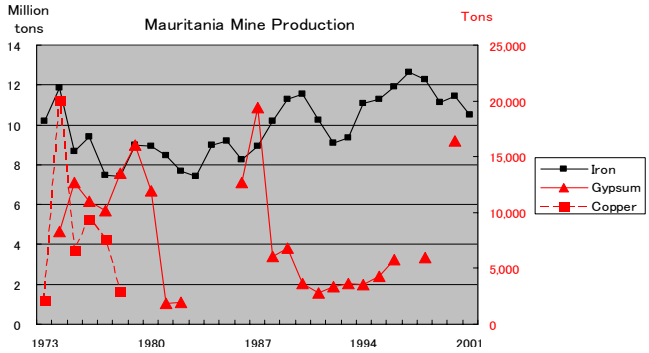


Fig.3.8.9 Result of Mineral Development in Mauritania

million tons averaging 1.88% Cu, 1.41g/t gold and 144g/t Co with a 1% cutoff grade. Guelb Moghrein is just under re-development by above-mentioned MCM. Checkup and engineering of machines and equipment in the old mine have been implemented now for re-development. In addition, the ore reserve is intended to be increased by exploration nearby the deposit. Production will start in December, 2005, with a plan of copper concentrate of 12,000t a year under initial investment of US$ 50 million.

The Tasiast Gold Company financed by the Rio Gold Mines (Canada) are just implementing development works such as water supply pipeline with length of 70km, wells boring, access roads, an airstrip, a mineral processing plant, camps, etc. The initial investment is estimated about US$ 60millions. Operation will start in September, 2006. Annual gold production is planned to be 120,000 ounces and the dore with Au grade of 85% to 90% will be produced at the mine site and be refined in Europe. They employ foreign engineers (Canadians or Spaniards) for engineering works.

The mineral resource with production result for thirty years same as iron ore is gypsum. Gypsum is mined by SAMIA which Mauritanian government established in 1975 as a 60 % shock holder. Privatization was done in 1994, and current stock holders are SNIM by 50 % and Koeit (an investment company) by 50 %. There are three gypsum ore deposits, the Tweila ore deposit located in the dune area by 50 km to the north of Nouakchott with reserve of some hundreds million tons, another reserve of 10 million tons and the crystallized deposit with high grade reserve of three million tons. Current annual production is 20,000 tons, 16,000 tons for domestic demands and 4,000 tons for exportation. Amount of three 30t trucks (total 90 tons) is produced everyday in one shift system by nine persons, 2 supervisors, 2 operators for loader and bulldozer, 3 drivers for trucks and 2 guards. The most serious problem for SAMIA is marketing because of several reasons. Domestic demands are small and limited, but there are several issues like unstable exchange rate and so on for exportation to the neighboring countries. Exportation to Europe is not profitable by the high freight cost. Therefore, increasing profit by production expansion is difficult. But, the company has kept a profitable line of business for the last two years.

As mineral resources except metal, the phosphate in the Bofal-Loubboira district is currently under feasibility study.

3.8.4 Current Situation of Environmental Management

Full-scale mining operation in Mauritania is implementing only at SNIM's iron mines in Zouerate. Environmental measure in the iron mine in Zouerate is described before. Environmental measure is the task in future because mining development has not promoted in Mauritania. Mauritania is a dry country as a whole and there is no surface water except the Senegal River. Therefore, it seems that the river contamination is not so serious, even if the development will be activated. However, development of groundwater is an important task in Mauritania, and some measures will be necessary

for treatment of drilling water and mad water of boring for exploration. However, Zouerate and F'derik are cities surrounded by closed pits and sometimes much dust flows from the pits into the cities, but awareness of environment related to mining is comparatively law in Mauritania. There is no environmental standard, which is a base for assessment in EIA. Accordingly, it appears that some mining developers may adopt favorable standards for themselves. Environmental Service in DMG has simple measuring tools for air and water. They were provided by PRISM, but have not been used so far. And also, their technical level is not still adequate.

3.8.5 International Assistance

There are two international assistance opportunities to mining activities: improvement of the iron mining through SNIM by EU cooperation and to strengthen the mining foundation in MMI for promotion of the investment through PRISM, by the World Bank support. These are loan projects. As technical cooperation, there are certain cases of EU support to OMRG for gold surveys and a technical support to OMRG for document database and construction materials surveys by the Spanish International Cooperation agency. Furthermore, this study is also implemented by JICA as a technical cooperation, and will be completed in March, 2006 (Table 3.8.11).

Table 3.8.11 Recent Cases of International Assistance in Mining Sector

Organization/countries		Type	Target	Project
EU		Loan	SNIM	Processing plant Renovation of berth for iron ore shipment
		Technical cooperation	OMRG	Gold survey in Tasiast (1993 to 1996) Gold survey in Ouassates ('01 to '04)
WB		Loan	MMI	PRISM (1999 to 2008)
Donors	Spain	Technical cooperation	OMRG	Document database (2004) Construction survey (2003)
	Japan (JICA)	Technical cooperation	OMRG	Strategic plan of mineral resources development (2003/2006)

Main core of international assistance is to strengthen iron mining industry and build a foundation for nonferrous metal mining, considering the mineral potentiality. The current status of assistance is steadily proceeding for mining promotion under the above mentioned two purposes. However, there is not sufficient assistance from international organizations for relevant infrastructure arrangement and staff training, which are necessary items for the promotion of mining. As a matter of fact, the infrastructure, i.e. the roads, water supply, electricity etc. is supported by international organizations, funds and donor countries, but mining-related support is still necessary, considering that mining is an economic basis for Mauritania (Fig. 3.8.10). The same is the situation with staff training, with a training center already built and supported by USAID, as well as establishment of supporting funds for occupational skill by the World Bank. In stuff training it is necessary to focus on survey capacity, specific knowledge and management capacity in the mining sector in the future. Currently, the mining industry is to be strengthened by the support to the state enterprise, SNIM, but in the future it will be necessary to support privatization by restructuring the management of the national

company.

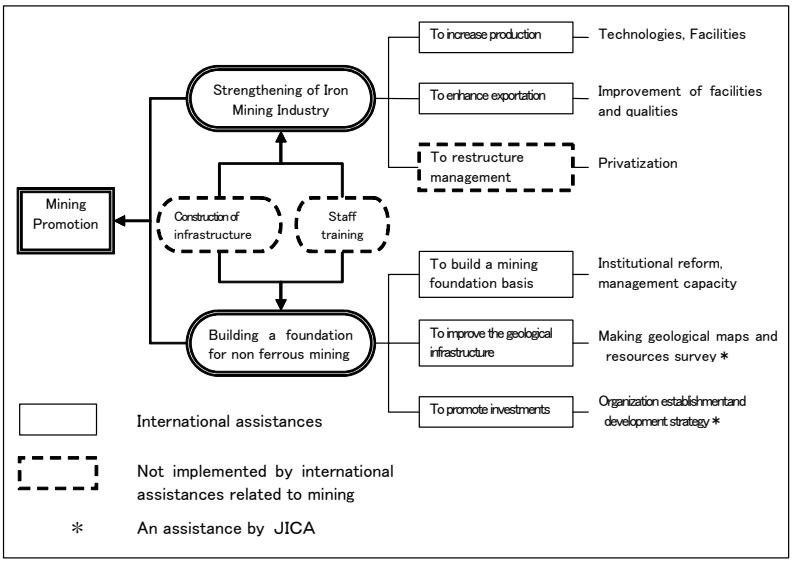


Fig.3.8.10 International Assistance for Mining Promotion

3.8.6 Tasks for Exploration and Development

There are many tasks to promote the exploration/development providing the current situation in Mauritania. At present, foreign activities are not sufficient, while number and capacities of domestic companies hardly grows. First of all, it is necessary to introduce foreign companies to promote exploration/development; and then promote actual mining by the domestic companies.

As mentioned before, the activities are not sufficiently activated and the situation requires to eliminate the obstacles hindering promotion of mining. This concerns infrastructure, presentation or disclosure of information, and staff training (Table 3.8.12). Main tasks are described as follows:

- To show an infrastructure arrangement plan, and identify opportunities for government supports.
- To obtain more information related to financing and environmental protection.
- To train manpower to support the activities led by foreign companies.

Above all, water supply is one of the key items for exploration-related infrastructure. Basic information on mineral resources has been accumulated and its presentation is possible. However, the total amount on mining is limited as far as it does not cover the entire territory. To reduce the exploration risk, it is necessary to replenish the mineral information by own means for its presentation.

Table 3.8.12 Tasks to Promote Foreign Companies' Activities

Item	Exploration	Development
Infrastructure	● Government support to water supply ● Plan of infrastructure for medium and long term	● Plan of infrastructure for medium and long term ● Construction of exporting port ● Government support/subsidy to water supply

		● Government subsidy to road construction
Presentation of Information	● Enhancing/replenishing of information ● Geological map in 1/100000 ● Utilization of database ● Submission of exploration data to the government, when the license is lost. ● Disclosure of information	● Replenishing environmental management data ● Baseline data survey, monitoring data
Manpower	● Training of experts and engineers for geology, ore deposits and evaluation. ● Improvement of English capacity	● Training of engineers for mine development, operation management ● Improvement of English capacity ● Training of technical engineers
Funds	● Exchange risk ● Domestic financing	● Domestic financing for operation etc. ● Exchange risk ● Government guarantee for capital
Others	● Mineral analysis and laboratory center ● Policy to promote exploration	● Environmental monitoring system ● Laboratory center ● Technical development center

In respect of domestic companies, first of all it is necessary to promote their growth, which can be followed by exploration activities conducted on their own. These are the tasks to solve (Fig.3.8.11):

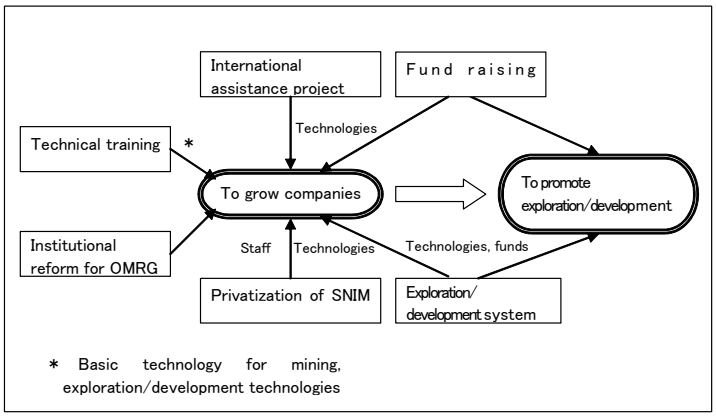


Fig.3.8.11 Tasks for Promote Exploration Activities by Domestic Companies

- To master general mining and specific technologies.
- To exert OMRG function as a survey organization and instruct private companies.
- To transfer technologies/engineers of SNIM to domestic companies through privatization.
- To acquire practical technologies by participating in international assistance projects.
- To establish a financing method and system.
- To support private companies financially and technically by exploration and development system.

Chapter 4 Summary of the Results of Supplementary Geological Survey

4.1. Overview

The supplementary geological survey was implemented during the second site survey (1st phase geological survey, January to March 2004), the forth (1) site survey (2nd phase survey, October to December 2004) and the forth (2) site survey (3rd phase survey, January to March 2005), in the areas with mineral potential with the purpose of promoting domestic and foreign private investments in the exploration of mineral resources; this particularly concerned attraction of foreign investments, which have important objectives in the strategic plan. A preliminary geological survey was carried out during the first site survey (November 2003). A follow-up geological survey was implemented during the fifth site survey (June 2005). Before the above-mentioned survey the draft plan for the supplementary geological exploration had been also made and discussed with OMRG, agreeing on survey areas and method of survey.

From 28 mineral deposits including the manifestations listed in M/M, survey areas were selected considering the location of four geologic provinces in Mauritania, previous data on geology and mineral deposits, remote sensing analysis, PRISM database and infrastructure (Fig. 4.1.1 and Appendix I-2-1).

In the selection process, attention was paid to the four following points:

- Survey areas should have been selected from the four geological provinces so that they reflected characteristics of different types of mineralization in the whole territory of Mauritania.
- The areas clearly showing mineral potential in the existing survey data and the promising areas suggested by results of remote sensing analyses should have been given a higher priority.
- Banded iron formation and gold deposits in the Reguibat Shield and copper-gold deposits in the greenstone belt of the Mauritanides should have been regarded as important due to their high mineral potential.
- Various geological elements such as stratigraphy, geological history, geological structure including fracture system, igneous activity, mineralization (especially type and ore grade) and sedimentary basin should have been taken into comprehensive consideration.

The supplementary geological field survey conducted in three phases is described in detail in Table 4.1.1. and Appendix I-2-1.

Table 4.1.1 Supplementary Geological Survey Details

Survey period	Position	Objectives
1st phase survey (Jan. to Mar. 2004)	・General geological reconnaissance in selected areas	・Improving interpretation accuracy of remote sensing analysis
2nd phase survey (Oct. to Dec. 2004)	・Survey considering mineral deposit models ・Selective survey of ore deposits and manifestations	・Ground truth of remote sensing analysis ・Grasping the characteristics of alteration zone and mineralization
3rd phase survey (Jan. to Mar. 2005)	・Complement 1st and 2nd survey ・Specifying mineral deposit models	・Specifying mineralization ・Selection of promising area showing mineral potential
Follow-up survey (Jun. 2005)	・Follow-up of 3rd phase survey	・Conformation of platinum group mineralization

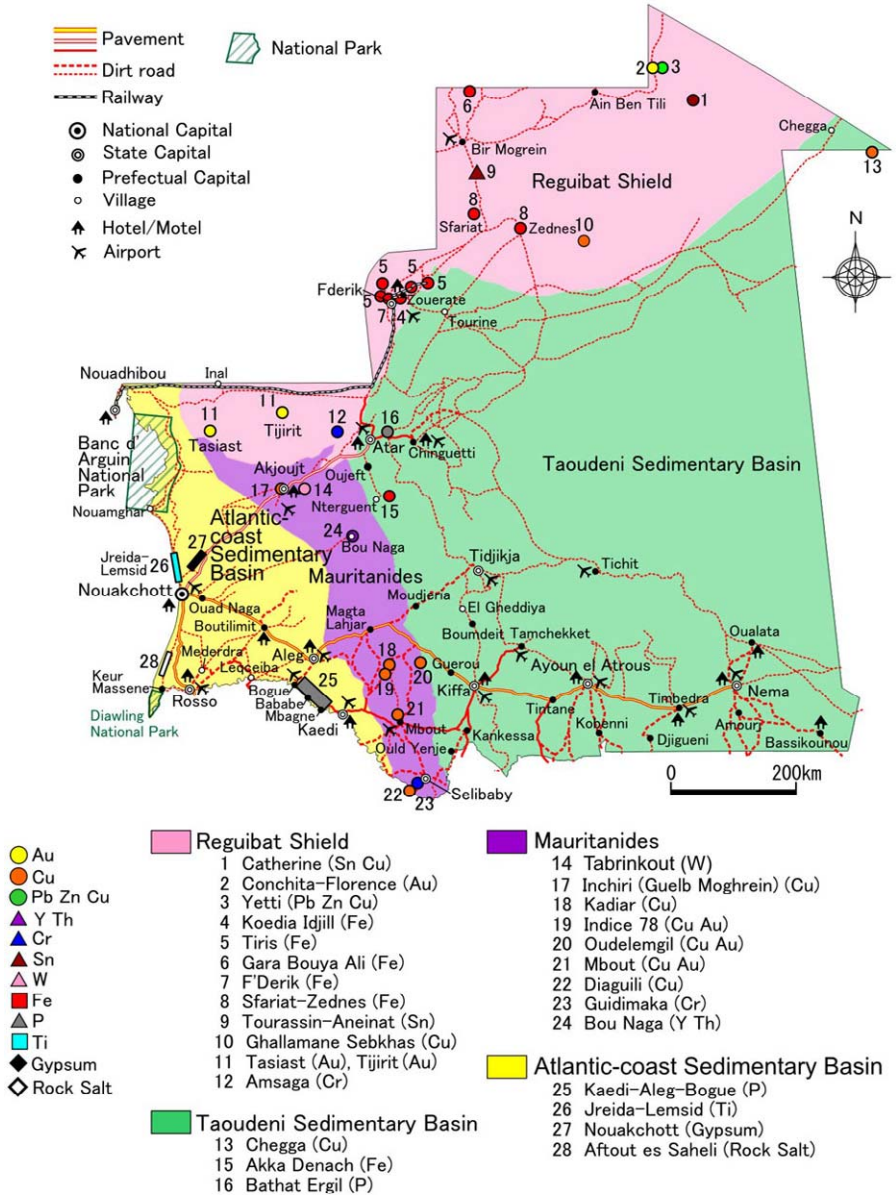


Fig. 4.1.1 Location of Deposits for Supplementary Geological Survey

The 28 deposits were investigated from the point of view of existence and volume of previous data, kind of minerals, accessibility, host rocks, reserves and grade of ore, and type of mineralization (Fig. 4.1.1). The following 13 target areas for geological survey were shortlisted from the 28 deposits:

- Koedia-Idjill (Fe), Tiris (Fe), Sfariat-Zednes(Fe), Tasiast (Fe, Au), Tijirit(Au), Tabrinkout (W), Inchiri (Guelb Moghrein, Cu, Au, Co), Kadir (Cu), Indice 78 (Cu, Au), Oudelemguil (Cu, Au), Diaguili (Cu), Guidimaka (Cr), Jreida-Lemsid (Ti)

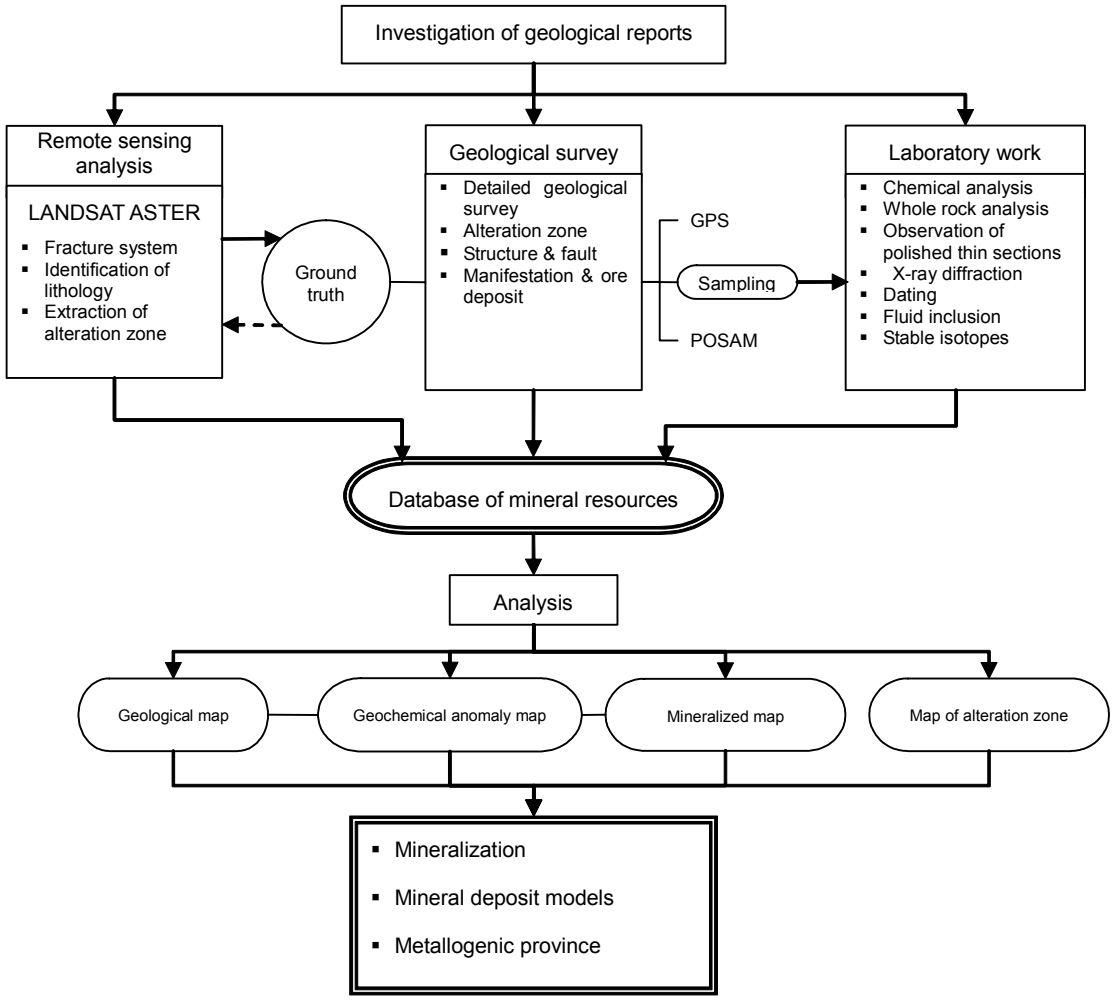


Fig. 4.1.2 Method and Position of Supplementary Geological Survey

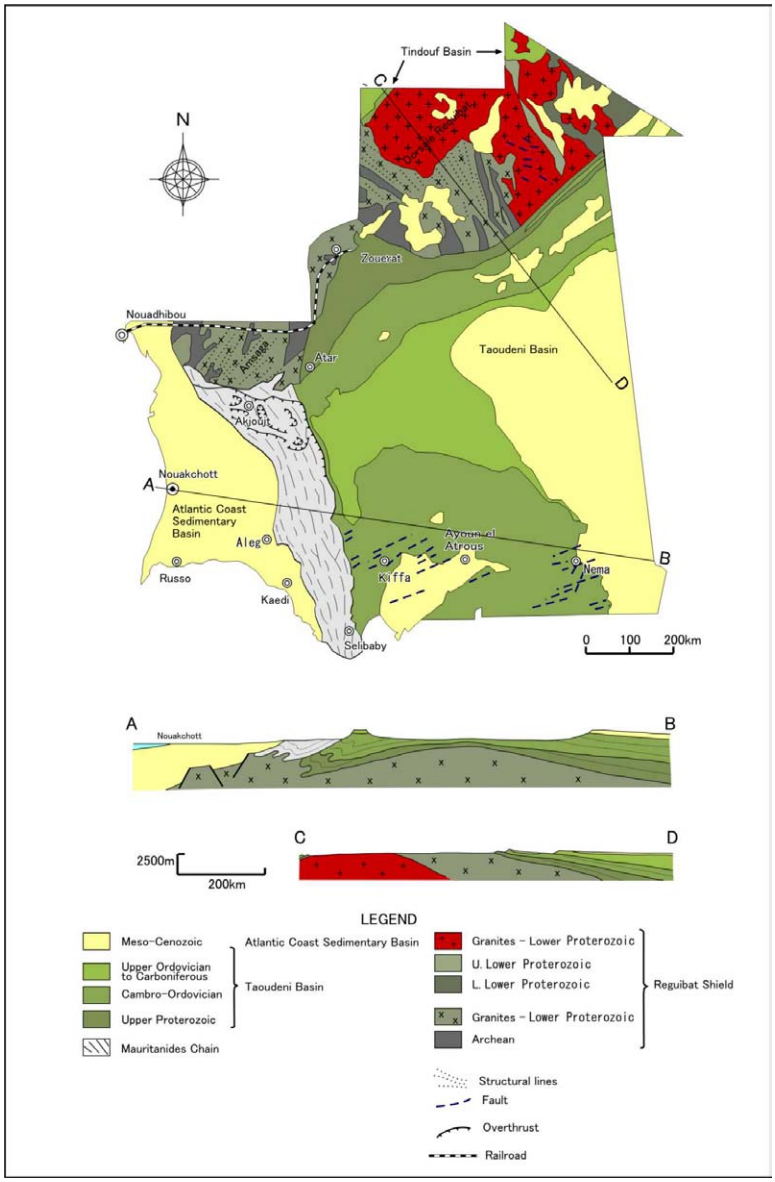
The geological survey was done using GPS and simplified surveying as the need arose with the results to be used for geological mapping. In the mineralized zone, relationship between the host rock and mineralization, and occurrence of alteration minerals and ore minerals were noted. Ground truth was implemented on the results of various remote sensing analyses. Also, The laboratory work of the collected rock samples and ore samples was done such as chemical analysis, whole rock

analysis, microscopic observation of polished thin sections, X-ray diffraction analysis, dating, stable isotope and fluid inclusion (homogenization temperature and salinity) (Fig.4.1.2).

4.2 Description of Geologic Provinces

4.2.1 General Geology in Mauritania

Mauritania comprises five geologic provinces. These are composed of Reguibat Shield, Taoudeni Basin, Tindouf Basin, Mauritanides Chain and Coastal Sedimentary Basin (Fig.4.2.1). The Reguibat Shield consists of Archean and Lower Proterozoic groups and granites. The Taoudeni Basin and the Tindouf Basin are constituted by Upper Proterozoic and Palaeozoic sedimentary rocks. The Mauritanides Chain was formed by the orogeny during the Late Proterozoic to Palaeozoic era. The Atlantic Coastal Sedimentary Basin is composed of Cenozoic sedimentary rocks. The following description of geology and mineral deposits are mainly quoted from the Mineral Plan by BRGM (1975).



(After BRGM, 1975)

Fig.4.2.1 Geological Map of Mauritania

(1) Reguibat Shield

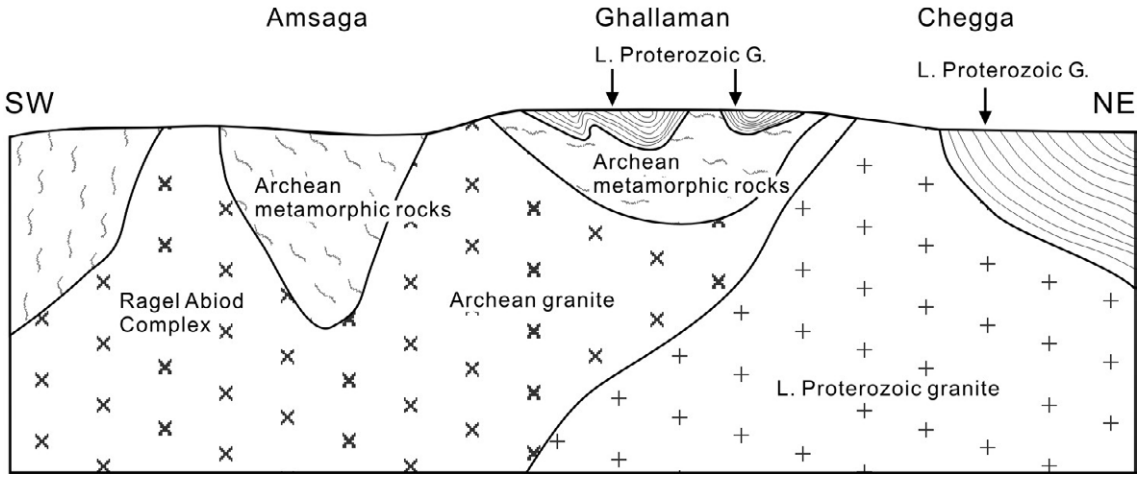
The Reguibat Shield covers the north of Mauritania. It is composed of the Archean and Lower Proterozoic metamorphic rocks and granites, which forms the northwestern margin of the West Africa craton (Cahen et al., 1984; Fig.4.2.2).

The Archean consists of metamorphic and granitic rocks. The metamorphic rocks are constituted by ferruginous quartzites, mica schist, gneiss (including leptynite), and amphibolites. These formations are often migmatised. As intrusive rocks on small scale, some massifs of basic rocks ranging from anorthosite to gabbros and ultrabasic rock such as serpentinites were known.

The Lower Proterozoic consists of sedimentary, volcanic rocks and granites, and is layered in unconformable strata. Sedimentary volcanic rocks are constituted by lower Aguelt Nebkha series on top and upper Imourene series below. The Aguelt Nebkha series are composed of the sandstones and schists at the bottom, and the rhyolitic tuff and flow and meta-andesite at the top. The Imourene series consist of sandstones and conglomerates, and are laid in unconformable layers on the Aguelt Nebkha series. Granites of the Lower Proterozoic crop out at the east of the Reguibat shield. They are constituted by alkaline granites, syenites and gabbros (BRGM, 1975).

The Archean in the southwest of the Reguibat Shield is called Amsaga basement, which is divided by Ragel Abiod complex and Saouda series. The Ragel Abiod complex is composed of migmatites and granites. The Saouda series consist of the lower formation composed of charnockites, amphibolites and anorthosites, the middle formation – composed of gneisses and granulites, and the upper formation – composed of amphibolites and ferruginous quartzites (BRGM, 1975).

The Archean formation represent a N-S striking in the Chegga region at the east, a NW-SE striking in the Ghallaman region in the centre and NNW-SSE striking in the Amsaga region at the southwest of the shield.



(Based on data of BRGM, 1975)

Fig.4.2.2 Illustrated stratigraphic relation of the Reguibat Shield

(2) Taoudeni Basin

The Taoudeni Basin is a large-scale basin, which occupies 2/3 of West Africa craton. The basin is located to the southeast of the Reguibat Shield. Its western part constitutes more than half of Mauritania. The basin is composed of Upper Proterozoic formations, Cambrian to Ordovician formations, and Silurian to Carboniferous sedimentary rocks. Its eastern part is covered with Mesozoic to Cenozoic sediments.

The Upper Proterozoic formation is characterized by the coastal platform sedimentary rocks, composed of sandstones, mudstones and limestones and also including continental sedimentary rocks.

The Upper Proterozoic formation is 600m to 1400 m thick in the Hank region and 1,400m thick in the Adar regions. The thickness increases to the central part of the basin.

The Cambrian to Ordovician formations, composed of conglomerates, mudstones, sandstones, siltstones, cover the Upper Proterozoic unconformably. They are up to 1,000 m thick. The Silurian-Carboniferous systems are constituted by sandstones, mudstones and limestones.

The Palaeozoic succession was caused by a weak tectonic movement, and has a flat structure with a few faults, revealing a simple structure. However, there are some ENE-WSW directed faults in the southern region, with accompanying dolerite intrusions of Permian-Triassic age (BRGM, 1975).

(3) Tindouf Basin

Some parts of the Tindouf Basin intercept small sectors near the northeastern borders of the West Sahara or Algeria. The Basin covers the Reguibat Shield, and consists of dolomite of the Upper Proterozoic and sandstone, shale and limestone of the Ordovician-Devonian (BRGM, 1975).

(4) Mauritanides Chain

The Mauritanides Chain, the so-called "Greenstone Belt", characterized by folds and thrust faults formed by Palaeozoic Hercynian orogeny, is located at the western margin of the West Africa craton. It stretches for more than 2,500km, from Senegal through Mauritania to Morocco. It shows a NNW- SSE strike directed to Mauritania and reaches 150km in width. It is constituted by sedimentary rocks, igneous and metamorphic rocks of the Precambrian to Palaeozoic era (BRGM, 1975).

In the Inchiri region in the north, the Mauritanides is the site of major overthrusts with the Reguibat Shield.

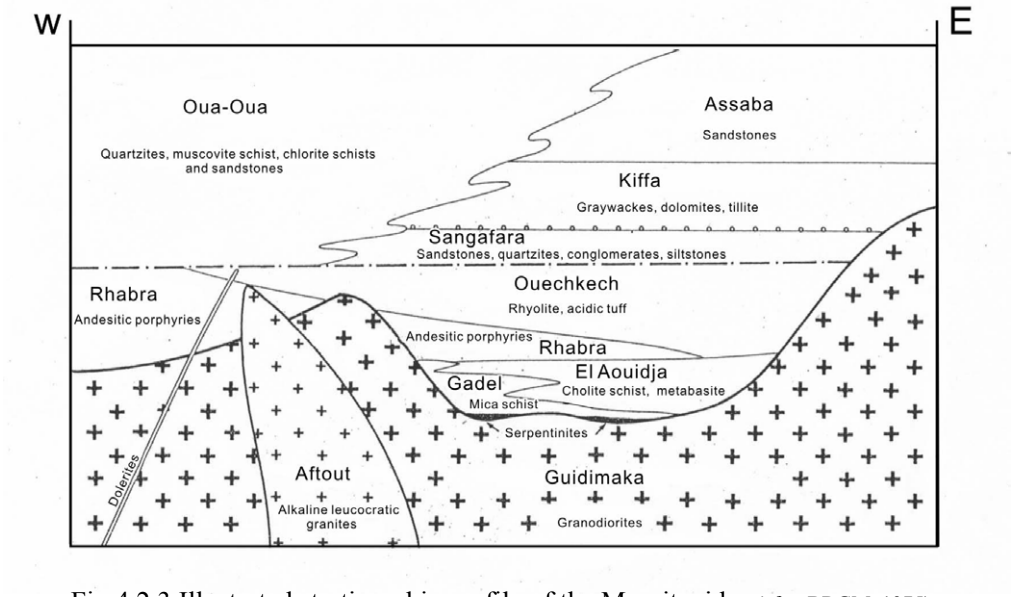


Fig.4.2.3 Illustrated stratigraphic profile of the Mauritanides (after BRGM, 1975)

The Mauritanides is divided into three units from east to west: the external zone, the axial zone and the hinterland. In the external zone, the sedimentary formations of the Sangafara and Kiffa

series crop out and are formed in the following way: The Sangafara series are constituted by sandstones, quartzites, conglomerates and siltstones and correspond to the Precambrian group; while the Kiffa series include tillites, greywackes and dolomites and correspond to Cambrian-Ordovician system (BRGM, 1975; Fig.4.2.3).

The axial zone is characterized by volcano-sedimentary complex and plutonic rocks. The volcano-sedimentary complex is divided into four groups; the Gadel group – composed of mica-schists, siliceous carbonates, serpentinites and amphibolites; the El Aouidja group – including chlorite schists, metabasites, the Ouechkech group – represented by rhyolites, acidic tuffs and conglomerates, and the Rhabra group - comprised of andesitic porphyries and, pyroclastic breccias. The plutonic rocks are comprised of the Guidimaka granodiorite and the Aftout granite. The Guidimaka granodiorite is accompanied with biotite-muscovite granites. The plutonic rocks could be of the Lower Proterozoic age, while the volcano-sedimentary rocks on the axial zone are older (BRGM, 1975).

The hinterland hosts the Oua-Oua group. It is constituted by quartzites, muscovite schists, chlorite schists and sandstone.

The Mauritanides is affected by folds overturned to the east (to the Taoudeni Basin) due to metamorphism of the later period of the Upper Proterozoic and the Hercynian orogeny, with a few recumbent folds by overthrust.

(5) Atlantic Coast Sedimentary Basin

The Atlantic Coast Sedimentary Basin is located in the west of the Mauritanides. It is constituted by the Lower Cretaceous to Quaternary sediments and sedimentary rocks, the oldest deposits gradually petering out towards the east.

The Paleocene series consist of calcareous argillaceous stone with a few layers of sandstone and corresponds to a 100m thick regression.

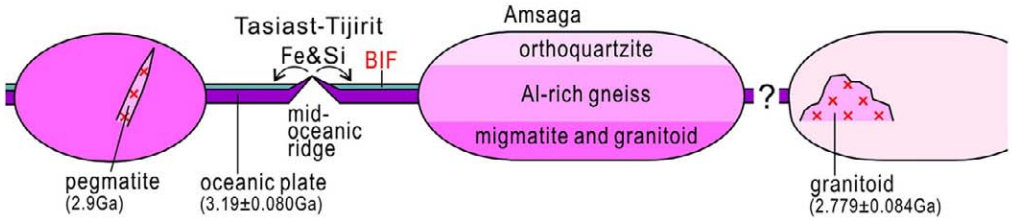
The middle to upper series are composed of argillaceous sandstone containing glauconite, colored in red due to the presence of iron oxides. Beds of siliceous and phosphate layers are also observed.

The Oligocene-Miocene series are composed of argillaceous or argillaoceous-marly sediments. The average facies is an argillaceous sandstone of red color due to the presence of iron oxides.

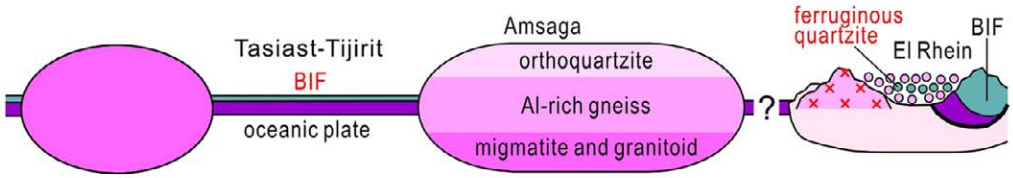
The quaternary is composed of four transgressions; glauconious clayey sandstone (Tafaritian age), sandstone (Aioujian age), clastic calcareous formation (Inchirian age), sand and shells (Nouakchottian age). Coastal dunes develop among each transgression (BRGM, 1975).

From viewpoints of geological structure, supplementary geological survey and literature research, geotectonic history of the north area of Mauritania is presented in Fig.4.2.4.

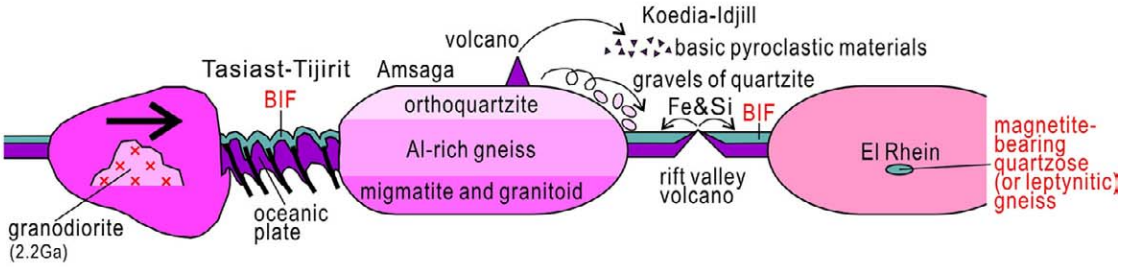
app. 2.8Ga (late Archean)
Deposition of Algoma-type BIF and felsic igneous activities



2.5Ga? (late Archean)
Sedimentation of ferruginous quartzite



app. 2.0Ga (early Proterozoic)
Deposition of Superior-type BIF and metamorphism of the ferruginous quartzite



app. 1.7Ga (middle Proterozoic)
Collisions of continental crusts → Formation of suture zone and Au-mineralization in Tasiast and Tijirit
Obduction of Idjill group over Tiris group

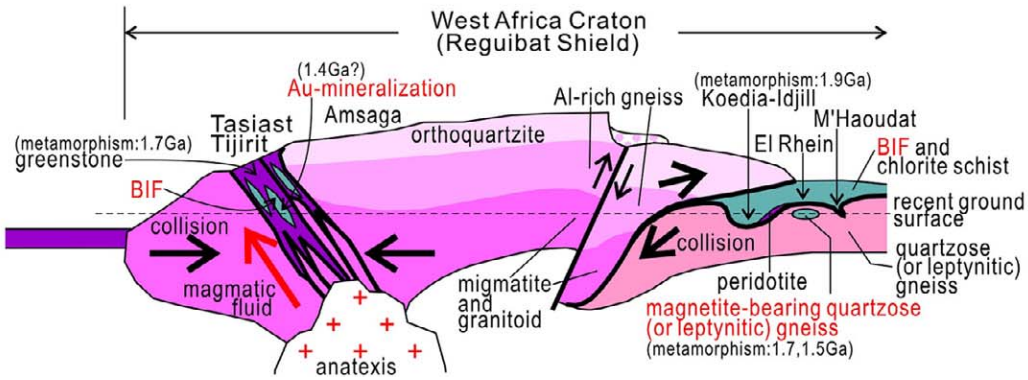


Fig.4.2.4 Geotectonic history of northern Mauritania (1)

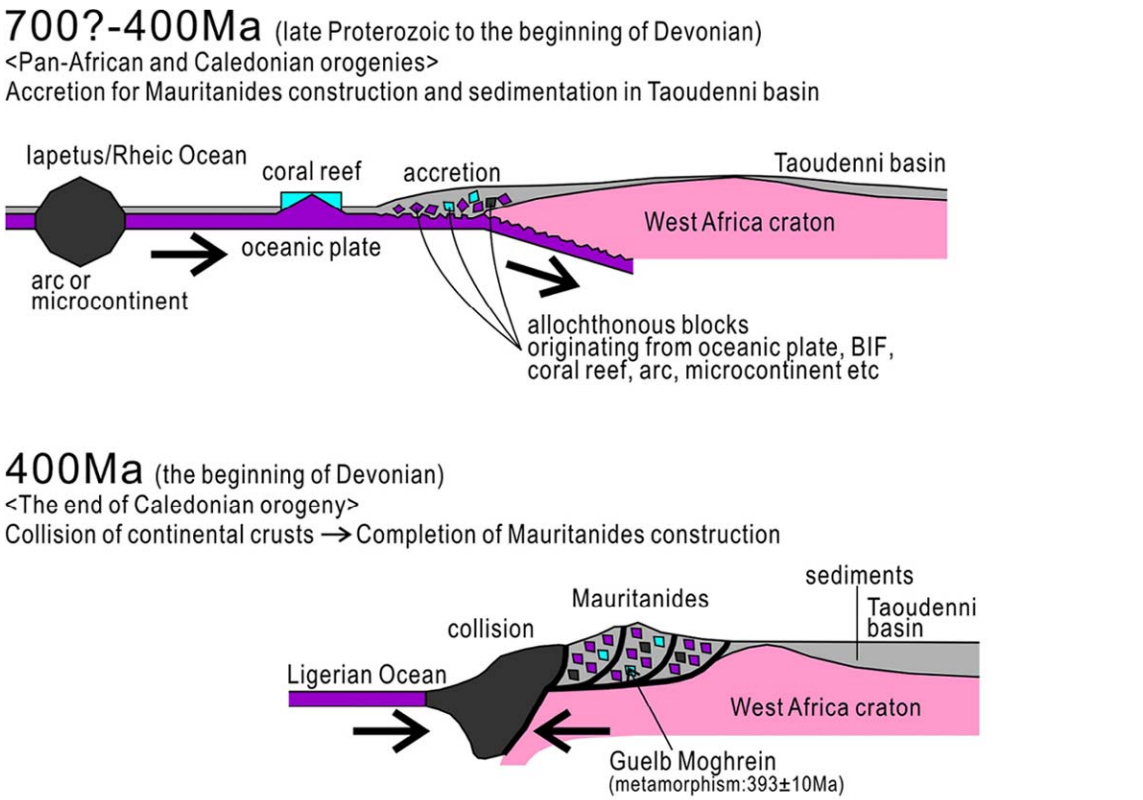


Fig.4.2.4 Geotectonic history in the north area of Mauritania (2)

4.2. 2 Overview of ore deposits

The 13 deposits where the supplementary geological survey has been implemented are as follows (Appendix I-2.1).

(1) Tiris iron formation group and Koedia-Idjill iron formation group

Zouerate area where the Tiris iron formation and Koedia-Idjill banded iron formation (BIF) are distributed, is located in about 700 km northeast of Nouakchott. It takes 12 hours from Nouakchott

to Zouerate by vehicle. The area is located in the central part of the Reguibat shield. These iron formations have been mined since 1955, and produced 19.6 million tons of iron ore in 2003.

The area comprises the Tiris group of the Archean, the Idjill group of the probable Proterozoic and the Quaternary that covers the formers (Fig. 4.2.5, Fig. 4.2.6 and Fig.4.2.7).

The Tiris group is composed of amphibolites and the metamorphic rocks of meta-ferruginous quartzite and leptynite originated from the clastics of the Archean. The iron ore deposit of the Tiris group consists of coarse-grained magnetite orebody in meta-ferruginous quartzite. The ore is mainly composed of coarse-grained magnetite with average grade ranging from 35 to 42% of Fe. The ore grade is low as iron ore, so it is enriched to 65-66 % of Fe by magnetic separation.

The Idjill group thrusts over the Tiris group as nappe. The nappe comprises seven units: El Hadej unit, La Breche unit, L'Achouil unit, Tazadit unit, Zouerate unit, Hamariat unit and M'Haoudat unit (Bronner et al., 1992). The itabirite formation is predominant in the Tazadit unit which is one of the nappes of the Idjill group. The formation is accompanied by schists and nonferrous quartzite (BRGM, 1975). All the iron deposits of the Koedia-Idjill BIF consist of the itabirite formation in the Tazadit unit. The formation thickness ranges from 300 to 2,000 m, while the length reaches 30 km. It comprises siliceous phyllite, siliceous Itabirite (35-45 % Fe) and hematite-bearing itabirite (63-64 % Fe) from the lower layer (BRGM, 1975). The ore body is about 150m thick hematite-bearing Itabirite. It generally reveals banded structure that is several millimeters thick. The high-grade ore is found in the concentrated layer of fine-grained scaly hematite and reveals grade of 67-68 % Fe. These deposits are mined with the largest open pit of Tazadit T01 being 700 m in the major axis, 500 m in the minor axis and 500 m deep.

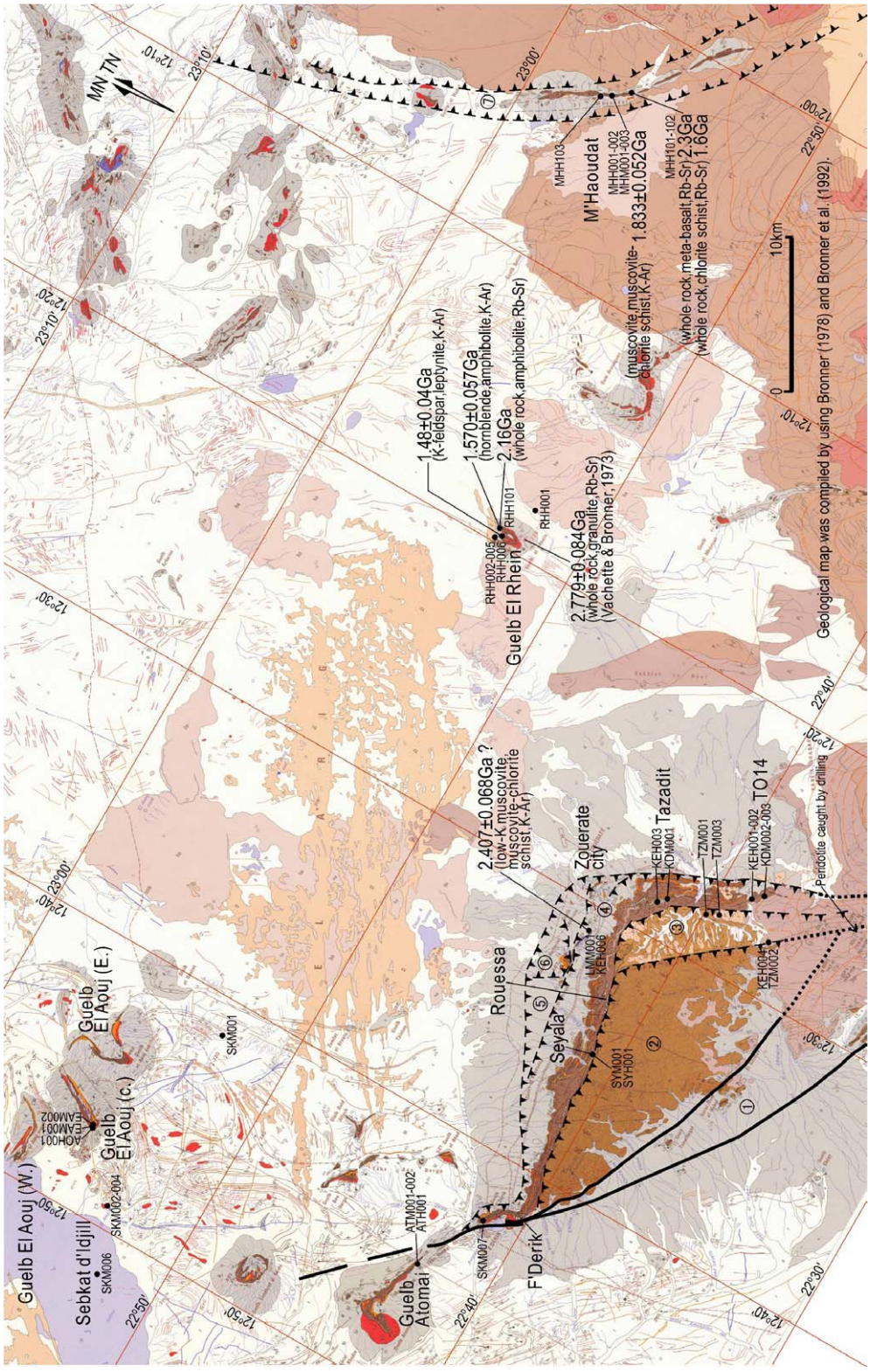
The Tiris iron formation group and Koedia-Idjill banded iron formation group are described later in 4.3.

Operating deposits are as the following: TO14 ore body of the Tazadit deposit, the Seyala deposit and the M'Haoudat deposit of the high-grade Koedia-Idjill BIFs, and El Rhein deposit of the Tiris iron formation. Ore reserves in the above deposit are given in Table 4.2.1.

Table 4.2.1 Ore reserves of iron ore (as of 2002)

Deposit	Reserves (Mt)	Grade (% Fe)	Remarks
Tazadit T014	170	67	hematite ore
M'Haoudat	(not available)	66	hematite ore
El Rhein	342	37	magnetite ore
El Aouj	287	40	magnetite ore
Atomai	616	36	magnetite ore

(Source: SNIM unpublished data)



(compiled by using Bronner, 1974 and Bronner et al., 1992)

Fig. 4.2.5 Geological map of the Zouerate area

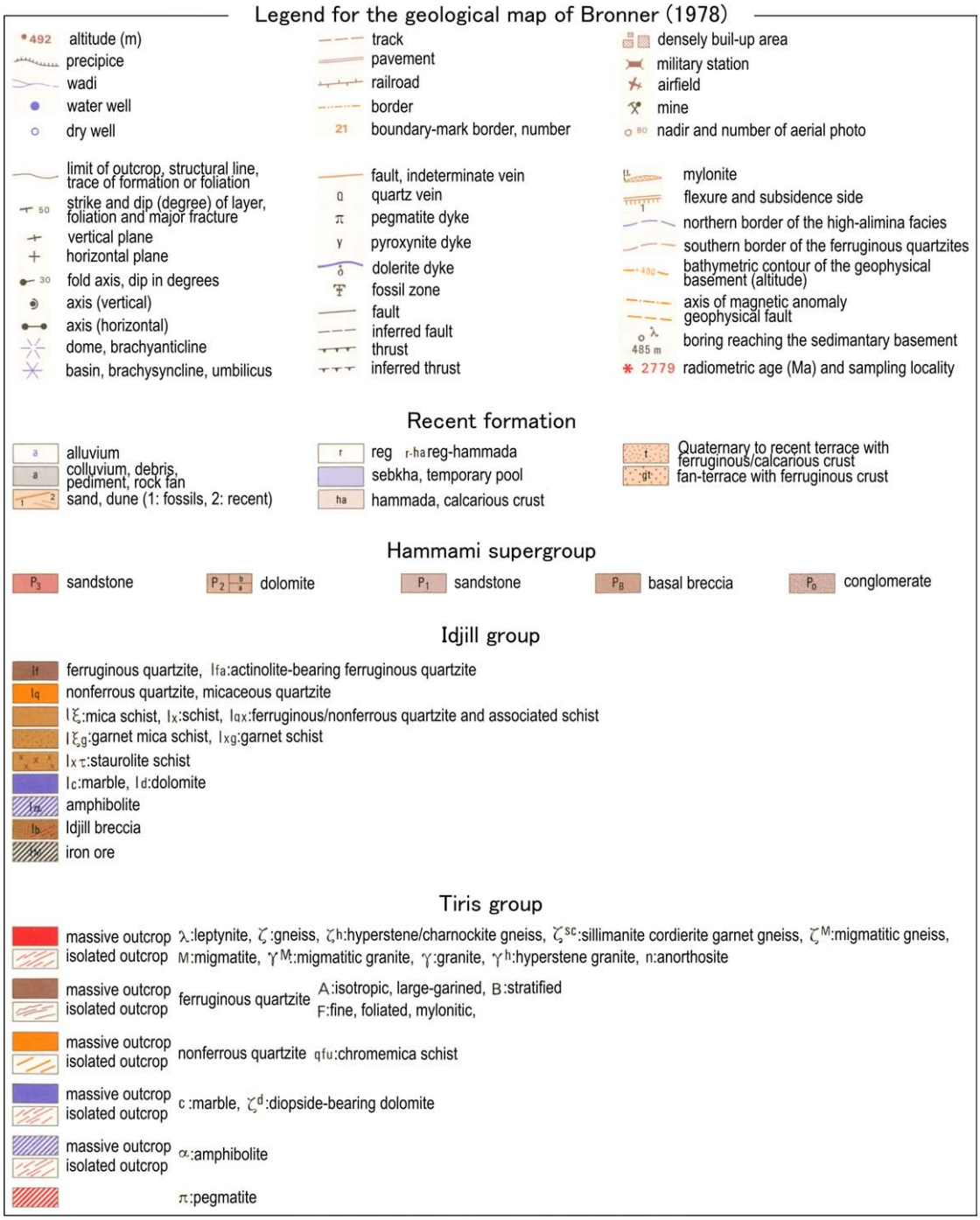
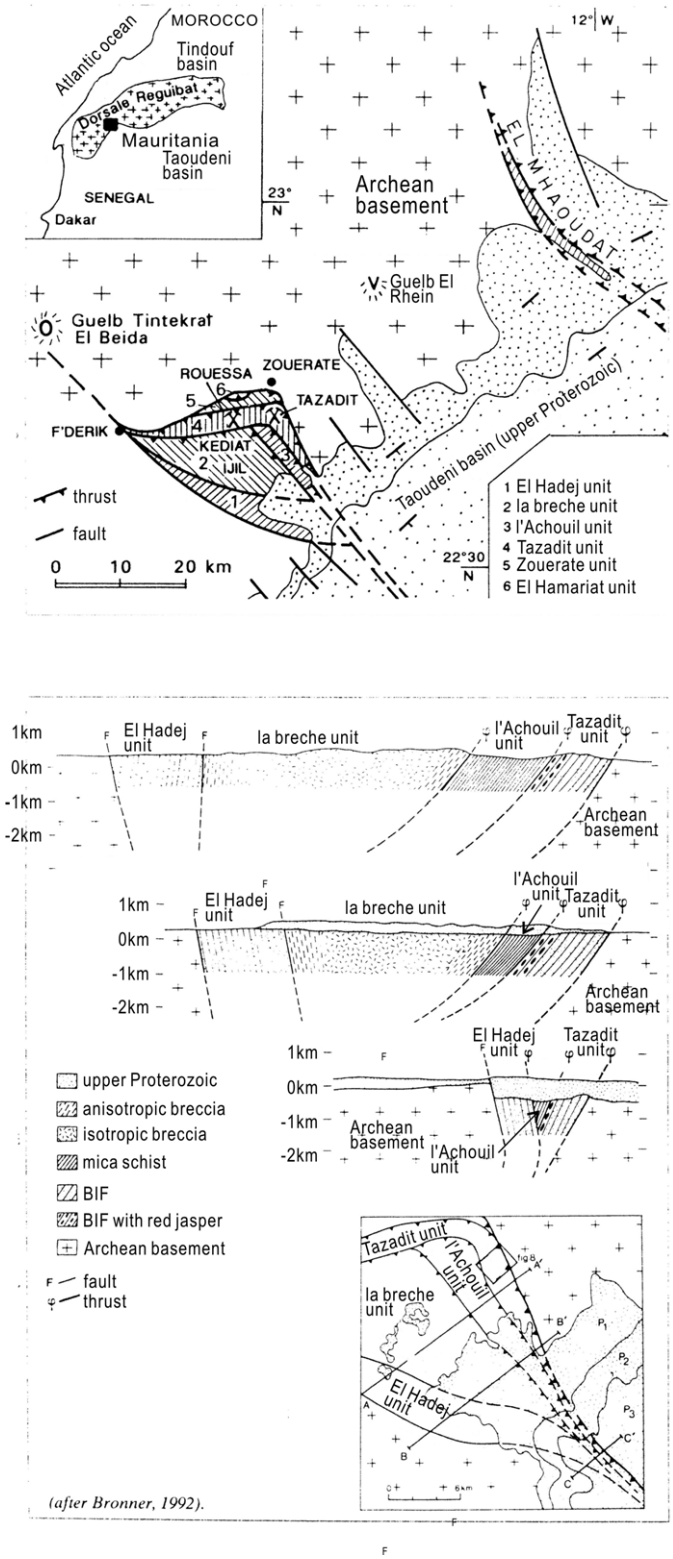


Fig. 4.2.6 Legend of the Geological map of the Zouerate area



(after Bronner et al., 1992)

Fig. 4.2.7 Geological profile of the Zouerate area