

Chapter 5 Mineral Evaluation

5.1 Remote Sensing Data Analysis

5.1.1 Satellite Imagery Overview

Satellite images, are ideal for mapping vast, remote regions - such as Mauritania with little vegetation (Fig.5.1.1).

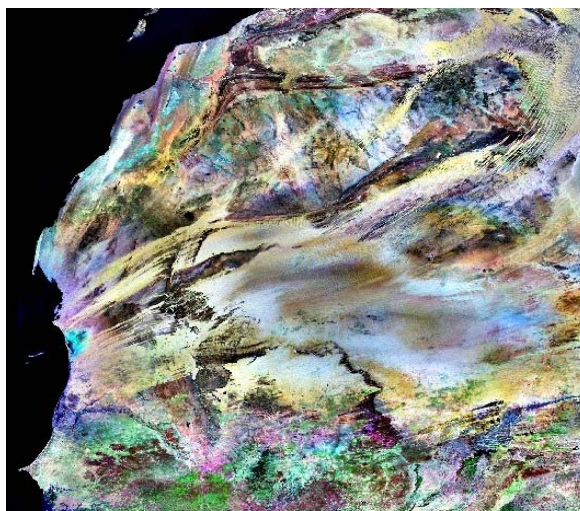


Fig.5.1.1

A mosaic of ca.100 LANDSAT images, covering territory of Mauritania (source: ER Mapper website)

(1) Geological mapping

Geological mapping using remote sensing has two main forms: structural and lithological. There are two aspects of structural mapping: simple lineaments (faults, trends, veins) and complex features (folds, domes, basins) (Fig.5.1.2).



Fig.5.1.2

Draft LANDSAT lineament map of the M'Bout region, Mauritania (Source: British Geological Survey)

With multi-spectral imagery we can go further and faster, utilizing the distinct spectral responses of different rocks and minerals.

(2) LANDSAT and ASTER Images

LANDSAT images, each covering ca. 170km x 170km, have been a key element of geological remote sensing since 1973. In addition to viewing the Earth in the visible spectrum, they also detect in the infra-red (Appendix 13): this facilitates the mapping of regional lithologies, structures and land cover types.

As well as having twice as many spectral bands as LANDSAT (Appendix 14), ASTER can also view the Earth's surface in more detail and produces a Digital Elevation Model for each

60km x 60km scene.

An example of ASTER’s better performance for mineral mapping, relative to LANDSAT TM, is given in Fig.5.1.2: with ASTER data we can not only identify zones of hydrothermal alteration, but can also automatically map the main mineral types (Table 5.1.1).

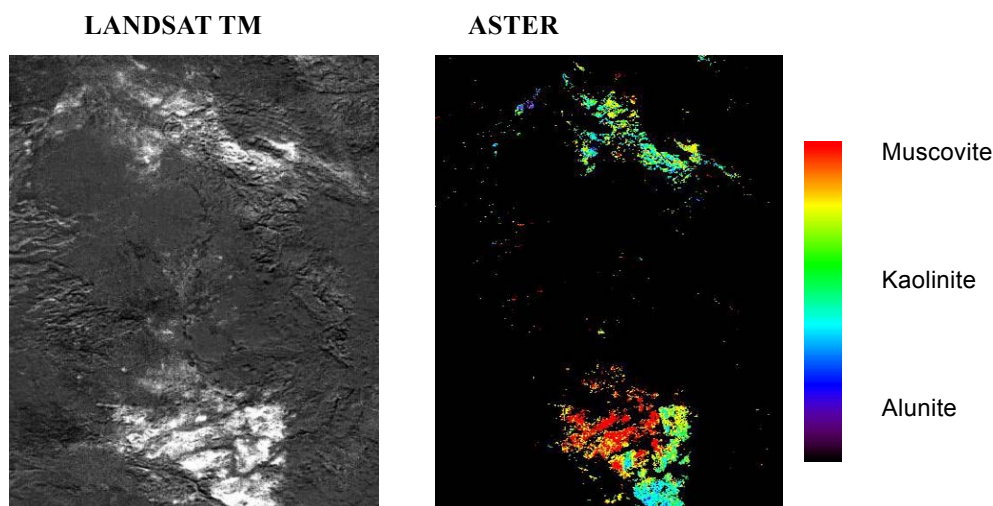


Fig.5.1.3 Comparison between LANDSAT and ASTER to map hydrothermal alteration.

Alunite is an indicator mineral for gold deposits (source: Infoterra plc).

Table 5.1.1 Summary of minerals detectable using ASTER (source: USGS)

ASTER SPECTRAL REGION/ SPATIAL RESOLUTION	BAND CENTER, MICROMETERS	COMPOSITIONAL INFORMATION
VNIR / 15 m	B1 - 0.56 B2 - 0.66 B3 - 0.81	FERRIC AND FERROUS IRON AND REE ABSORPTION
SWIR / 30 m	B4 - 1.65 B5 - 2.17 B6 - 2.21 B7 - 2.26 B8 - 2.33 B9 - 2.40	- AL-O-H IN CLAYS, MICAS, SULFATE MINERALS - CO ₃ IN CARBONATES - Mg-O-H IN AMPHIBOLES, MICAS - H-O-H IN EVAPORITES, CLAYS
TIR / 90 m	B10 - 8.30 B11 - 8.65 B12 - 9.10 B13 - 10.00 B14 - 11.30	- SILICATE MINERALS, ESPECIALLY SHIFT TO SHORTER WAVELENGTHS - SULFATE MINERALS - CARBONATE MINERALS

(3) ASTER-Based Exploration Strategy

The spectral detection bands of ASTER, in the Short Wave Infrared (SWIR) and Thermal Infrared (TIR) provide a means of improving the effectiveness of mineral prospecting. Key indicator minerals for various types of mineral exploration can be identified directly from the processed ASTER imagery (Table 5.1.1). This saves lots of time, in the initial fieldwork stages of exploration and the geochemical analysis of collected samples, allowing targets for drilling to be selected relatively quickly. What has been called “the ASTER advantage” is summarized in Appendix 15.

One further benefit of using ASTER data is that its DEM can have an ASTER-derived mineral map overlay and be viewed in 3-D, or even as a ‘virtual reality’ fly-over. This can assist geologists in visualizing the nature of a given deposit, but it is also a useful display tool for

attracting prospective investors. An example, from Death Valley, California, is given in Appendix 16. Characteristic of satellite images are summarized as follows;

- LANDSAT TM and ETM imagery have been useful for regional geological mapping.
- Imagery from the new ASTER satellite provides a means of mapping mineral families associated with various types of ore deposit.
- ASTER-generated mineral maps produce significant savings in time and costs, relative to conventional prospecting.
- The ASTER DEM allows the production of 3-D views and “flyovers”, aiding mineral deposit modelers and helping to attract investors.

5.1.2 Mineral Exploration/Development Targeting

LANDSAT ETM images have been used by this study in Mauritania to examine known areas of mineralization.

Fig.5.1.4 shows an example from the M’Bout-Kadiar region of the southern Mauritanides mineralization zone. The same image processing routines that were useful for lithological mapping of M’Bout-Kadiar were then applied to other prospective regions, allowing inter-region comparisons (Fig.5.1.5).

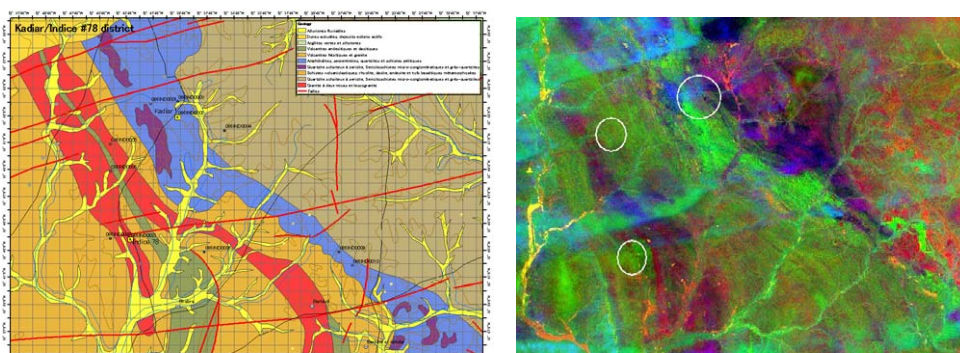
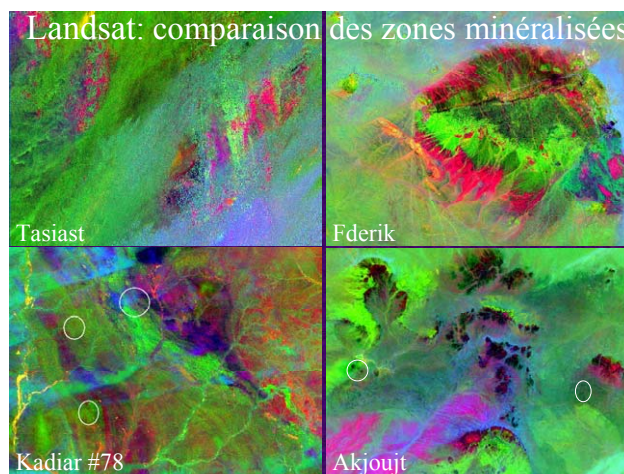


Fig.5.1.4 Geological map (left) and processed LANDSAT image (right), Kadiar region.

Fig.5.1.5 Comparison of mineralized regions, using the same LANDSAT processing (RGB 5/7 4/5 3/1)



(1) Technical method of Remote sensing analysis

Remote sensing analysis is conducted by using mineral spectrum characteristic

(Appendix 17). This analysis is divided to pre-processing, analysis and output.

1) Pre-processing

Pre-processing occupies about 50-60% of the whole processes by the thing which hits the stage of preparation until it goes into the analysis from the acquisition of satellite data.

a. Data search and acquisition

b. Acquisition of the topographical and geological maps and the GIS data

c. Color enhancement and geometric correction

After satellite data are indicated on the display, a histogram is changed, and color enhancement means the method made a clear image. Geometric correction is the technique that each pixel transfer into the same coordinate so that or it can do overlay processing about satellite data, geological map data and GIS data.

d. The adjustment and re-sampling the data size of the satellite data

One pixel of the satellite data copes with the resolution of the sensor. In case of ASTER, the resolution is divided into three of VNIR15m, SWIR30m and TIR90m. On the other hand, in case of LANDSAT the resolution is divided into three of visible-infrared 30m, thermal infrared 60m and monochrome visible 15m. Actually, in case of ASTER, by taking re-sampling all the bands with in 15m of the minimum resolution, each band composition of VNIR, SWIR and TIR became possible. As for the case of LANDSAT as well, it is the same.

e. Extract of target area and image composition

Extract of the target area which cover the study area followed each data of the satellite data that it has been corrected, topographical map and geologic map. Using three bands in each extracted data it has made false color image or a HIS (hue, intensity and saturation) color emphasis image as basic image of the study. Topographic map and geological map of the same area were output, and it used for the analysis. Fig.5.1.6 shows false color image which the band 3,2,1 of ASTER and HIS color-enhanced image in Akjoujt.

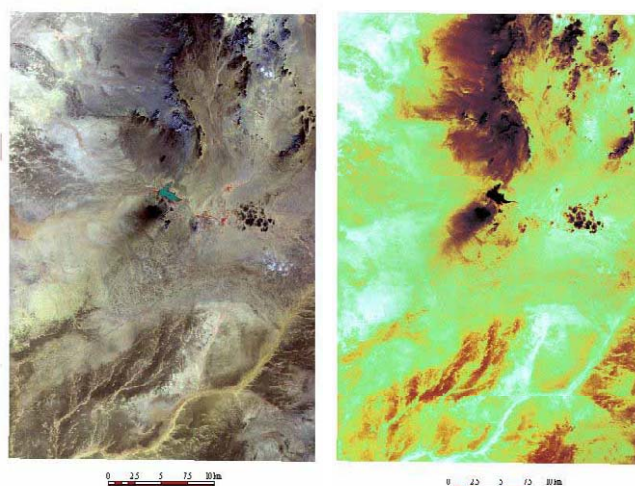


Fig.5.1.6 False Color Image and HIS Color Enhanced Image in Akjoujt

2) Image analysis

Image analysis classified to image interpretation and image processing.

a. Image interpretation

Image interpretation is technique that interpret geological structure using false color image, HIS saturation enhance image, geological map and so on.

Image interpretation is placed the point for classification of litho-logy and the extraction of lineament. Fig.5.1.7 is the case of lineament extraction in Tijirit.

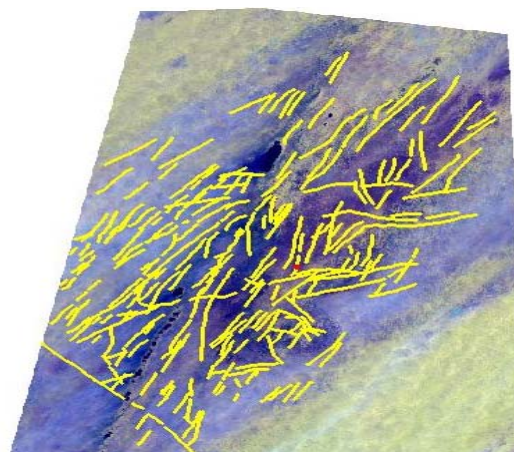


Fig.5.1.7 Lineament extraction in Tijirit

b. Image processing

Image processing is to do various operation and a statistical work by using the various analytic functions of software for remote sensing analysis. There is single band level slice, band ratio processing, and so on in the main image analysis for the mineral. It is judged which technique is the most suitable in the study area from geomorphology, geology, litho logy, spectral characteristic of mineral, and so on, and some trials should be necessary (Appendix 18).

(2) Remote sensing & exploration targeting – summary of progress

Visits have been made to a number of key mineralization sites (Akjoujt, M’Bout and Kadiar regions) in order to assess the effectiveness of satellite remote sensing. LANDSAT ETM was very useful for regional-scale, general geological mapping, but is of limited use for site-specific mineral mapping. ASTER imagery was found to be much more effective than LANDSAT for identifying many mineral types associated with epithermal and mesothermal alteration zones, as well as zones of silicification and meta-carbonate rock of high economic potential. ASTER also provides a means of using night-time thermal imagery to detect mineralization zones buried under desert sand and alluvium. The JICA-donated portable spectrometer (POSAM) was used to determine the spectral signatures of samples from the field sites: this will be a useful tool to use in conjunction with the ASTER multi-spectral satellite imagery.

(3) Remote sensing & mineral targeting - recommendations

A “ground-truth” survey should be carried out at each site, involving the recognition of key lithological and structural feature for ASTER images, as well as the collection of samples for spectrometer analysis using POSAM. Night-time ASTER thermal imagery should be obtained for each site, as the mineralization zones are often buried under recent sediments. Ground-truth data, spectral signatures and thermal imaging from the mineralization sites will greatly improve the effectiveness of ASTER-based mineral mapping and will assist mineral deposit modelling. Regional airborne geophysics data (gravity / magnetics / radiometrics) are needed as much of the Mauritanides mineralization zone is buried under Cenozoic sands and alluvium.

Sites considered of secondary importance should be examined using ASTER imagery, as there will be a better chance of detecting mineralization after the known sites have been examined.

The selection of sites for additional ASTER surveys can be assisted by using GIS to examine multiple exploration datasets (geochemical, geophysical, plus borehole data).

(4) Targeting of mineral resources

Exploration targets are concretized by optimization analysis through images reading, image analysis and information of geography, geology and rock quality etc. Precision of remote sensing analysis is improved by data accumulation indicating geological characteristics of ore deposit-types. For example, characteristics of alteration gained by ground-truth and POSAM measurement are effective for remote sensing analysis (Fig. 5.1.8).

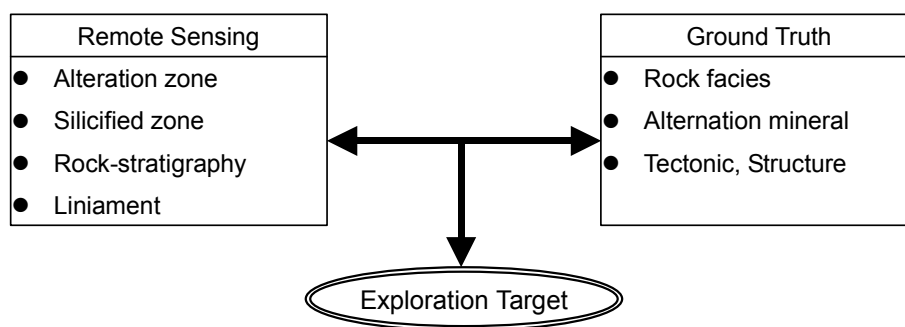


Fig. 5.1.8 Remote Sensing Analysis and Exploration Targets

5.2 Geological Provinces and Characteristics of Mineral Deposits

Each geological province is different in ore deposit type due to geological structure and development history of the geological province. The deposit size is often restrained by the ore deposits type which characterizes each geological province. Therefore, it is an important target for exploration, and also a basis of potential evaluation.

5.2.1 Characteristics of Ore Deposits in each Geological Province

(1) Reguibat Shield

The east section hosts gold, copper, tin, lead and zinc occurrences, such as Conchita-Florence gold manifestation (Gold bearing quartz vein in migmatites), Catherine copper-tin manifestation (Greisen) and Yetti lead and zinc manifestation (Hydrothermal sulfide vein along fractures). In the central part, iron deposits and manifestations are mainly distributed and exploited, such as Koedia-Idjill iron deposits, Tiris iron deposit and Gara Bouya Ali, etc. In the west, gold deposit and chromium manifestations occur, such as iron, gold, rare earth and nickel deposits in the Tasiast and chromium occurrence in the Amsaga. In the Reguibat Shield, a kimberlite was discovered in 1998, and existence of diamond was confirmed (17 kimberlites).

(2) Taoudeni Basin

Copper and phosphate manifestations are discovered in the Taoudeni basin, such as Chegga copper occurrence (Copper dissemination in ferruginous sandstone), Akka Danach (Hematite concentrate in sandy schist), Bathat Ergil (Phosphate minerals in ferruginous sandstone), etc.

(3) Mauritanides Chain

In Mauritanides composed of green stone, there are lots of manifestations of gold, copper,

chromium and rear earth, such as Guelb Moghrein deposit (gold-copper disseminated deposit replaced carbonate rocks in volcano-sedimentary rocks), Kadir copper occurrence (copper dissemination in magnesium rich ferrous carbonate rocks), Guidimaka (massive chromite deposit in serpentinite), Bou Naga (Thorium and lithium deposit in alkaline intrusives), etc.

(4) Atlantic Coast Sedimentary Basin

Deposits of gypsum, rock salts, phosphate and ilmenite are distributed in the Atlantic Coast Sedimentary Basin, such as Kaedi-Aleg-Boghe phosphate deposit, ilmenite deposits along Atlantic coast, Gypsum to the north of Nouakchott, rock salt deposits in Quaternary at Afrou Sahara, etc.

Table 5.2.1 Geologic Province and Mineralization

Geologic province		Rocks	Mineralization
Reguibat Shield	East	<ul style="list-style-type: none"> ● Granite ● Migmatite 	<ul style="list-style-type: none"> ● Greisen (Cu, Sn) ● Gold bearing quartz vein ● Lead and zinc vein
	Central	<ul style="list-style-type: none"> ● Ferruginous quartzite, leptynite ● Itabirite 	<ul style="list-style-type: none"> ● Banded iron formation (BIF)
	West	<ul style="list-style-type: none"> ● Basic schist, ferruginous quartzite ● Granite ● Amphibolite, serpentinite 	<ul style="list-style-type: none"> ● Gold deposit associated with BIF ● Pegmatite (Li, Be) ● Chromite deposits (banded, disseminated)
Mauritanides		<ul style="list-style-type: none"> ● Basic schist, carbonates ● Serpentinite ● Alkaline granitic rock 	<ul style="list-style-type: none"> ● Gold copper disseminated deposit ● Copper disseminated deposit ● Massive chromite deposit ● Thorium and Lithium deposit associated with alkaline intrusives
Taoudeni Basin		<ul style="list-style-type: none"> ● sandstone ● Sandy-muddy schist ● Ferruginous sandstone 	<ul style="list-style-type: none"> ● Copper dissemination in sandstone ● Hematite concentrate in schist ● Phosphate minerals
Atlantic Coast Sedimentary Basin		<ul style="list-style-type: none"> ● Dolostone, limestone ● Coastal sand 	<ul style="list-style-type: none"> ● Phosphate deposit ● Titanium placer deposit

5.2.2 Target Deposits for Development

The Guelb Moghrein and Tasiast deposits are listed as target deposits of non-ferrous metal for development in Mauritania. These two deposits are concrete examples for resources evaluation Mauritania. After detailed geological survey, the two mines have accumulated data for geology and mineralization which will be effective materials for the next exploration.

(1) Guelb Moghrein Deposit

Guelb Moghrein deposit is located in 250km to the northeast of Nouakchott and about 5km west to the Akjoujt. The deposit is copper-gold, which replaced originally existing carbonates. It had been developed and operated as a copper and gold mine since 1955, call under the name of Akjoujt. However, the mine terminated operations in 1978, In 1997, feasibility study was performed by joining an Australian mining company. It is reported that total measured and indicated ore reserves of 23.6 million tons with an average content of 1.88% Cu and 1.41g/t Au have been calculated. In the second half of 2004, MCM (Canada) attained the right and started its action for re-development. First Quantum will begin an operation producing 12,000 t/y copper

within 2006. Around the mine site, there are many mineralized zones in the wide area which has high potential of same type ore deposits.

(2) Tasiast Deposit

Tasiast deposit, located in 300km north of Nouakchott, is a hydrothermal gold deposit. The Amsaga formation of Archean forms a basement around the deposit. The deposit may be a hydrothermal gold deposit, where gold precipitated along bedding and fractures in sedimentary banded iron formation (BIF). In April 2004, Tasiast Gold Corporation (Canada) announced the completion of the bankable feasibility study for its 100% owned Tasiast gold project. The study reports that proven and probable ore reserves amount to 9.0 million tons with 886,000 ounces of gold (approximately 28.5 ton) and average grade of 3.06 g/t Au. They already started mine development with a plan to begin producing an annual average of 120,000 ounces of gold per year in late 2006. Around the mine site, there are many mineralized zones

5.3 Evaluation Methods of Mineral Resources

5.3.1 Present Status of Evaluation of Mineral Resources

At present, Mauritania government has no mineral resources evaluation standard and there is no law or regulations related to this topic. Current economical evaluation of mineral resources to be exploited has been performed by parties (exploration or mining) license holders, who carry out explorations and development in the area, and by consultant companies of Western countries. OMRG and DMG have no technique on ore reserve calculation method, which is base of mineral resource evaluation, because full-scale exploration in Mauritania is only starting. National iron company SINM, however, uses a technology of ore reserve calculation in its operations. If amount of the mineral resources were not realistic in the guideline and goal of investment promotion, it gives a negative influence to exploration activities. The gold resource amount in Tasiast is about 30t and the copper amount about 45 t and the gold amount 32 t in Akjoujt. If the geological condition of an ore deposit is same as above ore deposits, its expected amount can be calculated. To OMRG, “resource evaluation” means estimating the probable amount of reserves (Fig. 5.3.1). And then precision of expected amount is improved according to progress of geological surveys. For example, it is possible to find the Guelb Moghrein deposit type 5 – 6 mineralized zones in 50km by 20km (about 100km²) from the past survey and this study. They are supposed to contain equivalent metals, copper of 300t and gold of 200t as expected amount. In the Tasiast-Tijirit areas, there is potentiality to find 30 blocks (1 block: 30km by 40km) which contain total gold of 300t to 900t.

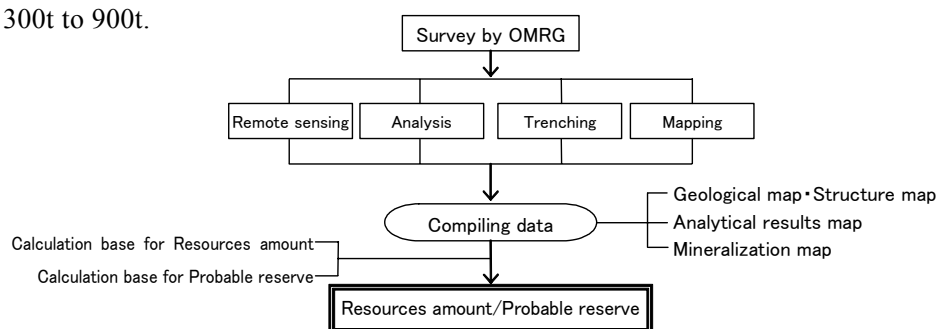


Fig. 5.3.1 Resources Evaluation by OMRG

5.3.2 SNIM Iron Mine

Department of mine and research of National Company SNIM, which have produced iron ore before, have conducted core drilling works to increase minable ore reserves around working sites of TO14 of Tazadit sector, El Rhein and M'Haoudat. SNIM has its own analysis center and engineering geologists. They recalculate ore reserves considering the workable sites changing due to mining (Table 4.2.1).

It is necessary for Mauritanian geologists to share the ore reserve calculation skill. It is needed to improve the skill to calculate each ore deposit for evaluation of mineral resources in Mauritania in the future.

Chapter 6 Development Strategy

6.1 Development Strategy Policy

The development strategy should be harmonized with the Poverty Reduction Strategic Paper with a term of 15 years, so will start in March, 2006 when this study will end in 2020. Its target is nonferrous metal, which enhances foreign currency.

Table 6.1.1 Development of Basic Policy

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

The ore deposits models made by the supplementary field surveys and remote sensing analysis should play an important role for promotion of exploration/development. The plan should be related with PRISM of the World Bank.

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

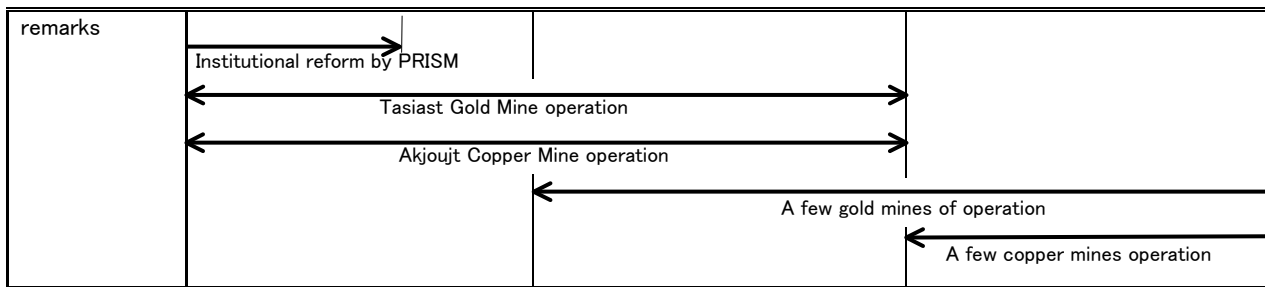
6.2 Development Strategic Plan

Based on the conditions of the investment base, the investment environment, mining activities and mineral potential in Mauritania, a strategic plan to promote exploration and development in that country was drawn up according to the development strategic policy.

Table 6.2.1 Strategic Development Plan

	1 st Stage 2006 - 2010	2 nd Stage 2010 - 2015	3 rd Stage 2015 - 2020
Goals	<ul style="list-style-type: none"> • Improve exploration and development of gold. • Understand potential of base metal resources 	<ul style="list-style-type: none"> • Promote exploration and development of base metals • Understand potential of rare metal resources 	<ul style="list-style-type: none"> • Strengthen exploration and development of base metals • Promote exploration and development of rare metals
Target		<ul style="list-style-type: none"> • 25% of GDP by 2015 (including 15% of ferrous mining) 	
Exploration targets	<ul style="list-style-type: none"> • Promote OMRG surveys of gold and copper • Extensive areas survey system • Construction of a deposit model 	<ul style="list-style-type: none"> • Promote OMRG surveys of copper, rare metals • Development of a resource evaluation ledger 	<ul style="list-style-type: none"> • Promote OMRG surveys of rare metals • Undertake structural boring
Introduction of foreign investment (Promotion of investment)	<ul style="list-style-type: none"> • Publish the seasonal magazines • Establish investment promotion office- • Hold investment seminars • Formulate policy for promoting 	<ul style="list-style-type: none"> • Prolongation of depreciation period • Government guaranty for development • Leading policy for development of underground mines 	<ul style="list-style-type: none"> • Expand the Investment Promotion Office (to Agency) • Introduction of foreign investment on underground mines

	introduction of foreign capital		
Human resource cultivation	<ul style="list-style-type: none"> • Experts invitation system • Overseas training system • English language instruction system • Establishment of mining faculty in the Technical Education Center 	<ul style="list-style-type: none"> • Establishment of Mining Technical Instruction Center • Establishment of mining faculty in the university • Education of resources economics 	<ul style="list-style-type: none"> • Independent management of Mining Technical Instruction Center • Education of quality control
Infrastructure	<ul style="list-style-type: none"> • Water resources development in the mineral promising areas • Infrastructure construction plan 	<ul style="list-style-type: none"> • Formulate a construction plan of the port (or wharf) for mineral resources. • Systemize the water resources use • Establish the support of infrastructure (road, water, electricity) 	<ul style="list-style-type: none"> • Railway construction • Road construction
Environmental Protection	<ul style="list-style-type: none"> • Legal framework for environmental management • Mining environmental management plan (Baseline survey) 	<ul style="list-style-type: none"> • Establishment of monitoring center 	<ul style="list-style-type: none"> • Establish environmental standards • Formulate guidelines for mine safety and environment
Compilation and disclosure of information	<ul style="list-style-type: none"> • Collect and compile mining environment information • Expand the mineral resources database • Improve the archives • Add the ASTER images • Accumulate the GIS data • Information disclosure system • Expand the website • Create 1:100,000 geological maps 	<ul style="list-style-type: none"> • Utilize the database • Create 1:100,000 geological maps • Construct an environment website • Disclose the company financial data 	<ul style="list-style-type: none"> • Develop the 3D data • Information sharing system between ministries • Evaluation of resources amount
Organization Of Mining Sector	<ul style="list-style-type: none"> • Periodical roundtable meetings between Government and companies • Establish an organization to formulate policies 	<ul style="list-style-type: none"> • Restructure the government mining organization • Establish a mining association • Establish a mining council 	<ul style="list-style-type: none"> • Establish a research organization • Establish an academic society for mineral resources
Nurturing domestic companies	<ul style="list-style-type: none"> • Joint acceptance of projects of the international organization with foreign investors • Formulate a plan for growth of domestic companies • Investigate the privatization of SNIM 	<ul style="list-style-type: none"> • partnership with the foreign investors • rental system of exploration equipment • supporting system for development by domestic companies • training and instruction to the domestic companies • privatization of SNIM 	<ul style="list-style-type: none"> • rental system of development machines • interest provision system • rental system of environmental tools and equipment
Institutional reform of OMRG	<ul style="list-style-type: none"> • Construct the LAN system and connect with MMI's LAN • Provide one computer per main person • Formulate medium and long term plans • Improve the survey equipment and machines 	<ul style="list-style-type: none"> • Restructure the organization • Maintenance of boring machines • Presentation of papers on the survey results • Privatize the repair sector • Establish an analytical center 	<ul style="list-style-type: none"> • Expand and strengthen the analyses center • Nourish researchers
Mining policy	<ul style="list-style-type: none"> • Formulate the 2nd Stage policy. 	<ul style="list-style-type: none"> • Formulate the 3rd Stage policy. 	<ul style="list-style-type: none"> • Revise drastically the mining policy.



6.2.1 Methodology for Realization

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

Table 6.2.2 Methodology and Targets for Realization

Methodology	Targets for Realization
National treasury	<ul style="list-style-type: none"> To be possible technically and personally Government basic works like policies, organization reform, medium-long term plans
Donor countries	<ul style="list-style-type: none"> To comply with supporting policies of donor countries. To build bilateral co-operational relationships with donor countries. To dispatch experts, and receive technical cooperation and loans
International organizations	<ul style="list-style-type: none"> To comply with supporting policies of the international organization. To dispatch experts, receive technical cooperation and loans, and hold seminars
Private funds	<ul style="list-style-type: none"> To support the private organizations, semi-private agencies and NGO. To provide instruction, training, overseas education, and establish organizations

In the 1st Stage, US\$ 25 million will be needed, US\$ 50 million will be needed in the 2nd Stage and US\$ 100 million in the 3rd stage are needed. (And see individual costs for promotion measures in 6.10) Costs in the 1st Stage and 2nd Stage are almost the same with the present PRISM.

6.2.2 Scheduling of the Strategic Development Plan

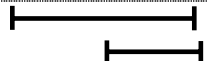


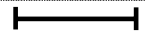
It would be desirable that the strategic development plan is implemented according to a schedule (see Table 6.2.3) based on the current status of exploration and development and the investment climate in Mauritania. It will be necessary to send requests to donor countries and international organizations 2 to 3 years in advance.

Table 6.2.3 Scheduling of the Strategic Development Plan

Item	Promotion Measure	1 st Stage	2 nd Stage	3 rd Stage
		2006 – 2010	2010 – 2015	2015 – 2020
Exploration targets	• Promote OMRG surveys of gold and copper	----- -----		
	• Extensive areas survey system	----- -----		
	• Construction of a deposit models	----- -----		

	<ul style="list-style-type: none"> • Promote OMRG surveys of copper, rare metals • Development of a resource evaluation ledger • Promote OMRG surveys of rare metals • Undertake structural boring 			
Introduction of foreign investment (Promotion of investment)	<ul style="list-style-type: none"> • Publish seasonal magazines • Release information. • Establish investment promotion office. • Hold investment seminars • Formulate policy for promoting introduction of foreign capital. 			
	<ul style="list-style-type: none"> • Extensive areas joint-venture exploration • Prolongation of depreciation period • Government guaranty for development • Leading policy for development of underground mines 			
	<ul style="list-style-type: none"> • Expand the Investment Promotion Office (to Agency) • Introduction of foreign investment on underground mines 			
	<ul style="list-style-type: none"> • Experts invitation system • Overseas training system • English language instruction system • Establishment of mining faculty in the Technical Education Center • Establish Mining Technical Instruction Center • Establish mining faculty in the university • Education of resources economics • Independent management of Mining Technical Instruction Center • Education of quality control 			
	<ul style="list-style-type: none"> • Water resources development in the mineral promising areas • Infrastructure construction plan • Formulate a construction plan of the port (or wharf) for mineral resources. • Systemize the water resources use • Establish the supporting system for infrastructure (road, water, electricity) • Construction of the port for exclusive use of mineral resources • Railway construction • Road construction 			
	<ul style="list-style-type: none"> • Legal framework for environmental management • Mining environment management plan (Baseline survey) • Establish a monitoring center • Establish environmental standards • Formulate guidelines for mine safety and environment 			
	<ul style="list-style-type: none"> • Collect and compile mining environment information • Expand the mineral resources database 			

Compilation and disclosure of information	<ul style="list-style-type: none"> • Improve the archives • Add the ASTER images • Accumulate the GIS data • Information disclosure system • Expand the website • Create 1:100,000 geological maps 				
	<ul style="list-style-type: none"> • Compile data for infrastructure, water resources and land use • Utilize the database • Construct an environment website • Disclose the company financial data 				
	<ul style="list-style-type: none"> • Develop the 3D data • Information sharing system between ministries • Evaluation of resources amount 				
Organization Of Mining Sector	<ul style="list-style-type: none"> • Periodical roundtable meetings between Government and companies • Establish an organization to formulate policies 				
	<ul style="list-style-type: none"> • Restructure the government mining organization • Establish a mining association • Establish a mining council 				
	<ul style="list-style-type: none"> • Establish an information center • Establish a research organization • Establish an academic society for mineral resources 				
Nurturing domestic companies	<ul style="list-style-type: none"> • Joint acceptance of projects of the international organization with foreign investors • Formulate a plan for nurturing domestic companies • Investigate the privatization of SNIM 				
	<ul style="list-style-type: none"> • Partnership with the foreign investors • Rental system of exploration equipment • Supporting system for development by domestic companies • Training and instruction to the domestic companies • Privatization of SNIM 				
	<ul style="list-style-type: none"> • Rental system of development machines • Interest provision system • Rental system of environmental tools and equipment 				
Institutional reform of OMRG	<ul style="list-style-type: none"> • Construct the LAN system and connect with MMI LAN • Provide one computer per main person • Formulate medium and long term plans • Improve the survey equipment and machines 				
	<ul style="list-style-type: none"> • Restructure the organization • Maintenance of boring machines • Presentation of papers on the survey results • Privatize the repair sector • Establish an analytical center 				

	<ul style="list-style-type: none"> • Expand and strengthen the analyses center • Nourish researchers 			
Mining policy	• Formulate the 2 nd Stage policy.			
	• Formulate the 3 rd Stage policy.			
	• Revise drastically the mining policy.			

6.3 Importance of Mining and Mining Policies

6.3.1 Position of Mining Industry

Mining industry plays an important role in the economy of Mauritania, from the viewpoint of the GDP, exportation, hard currency and employment. Promotion of nonferrous metal mining supports the diversification of Mauritanian mining industry and leads to strengthening the economic base of the country, activating the local development and improving the infrastructure. The contribution of the mining industry to the Mauritanian economy is significant, representing 14% of GDP and 50% of the total value of exports. However, as the current Mauritanian metal mining industry consists only of only the iron ore mining, the promotion of non-ferrous metals exploration and exploitation is the logical way to build on the present monoculture of iron ore mining and encourage further economic growth.

6.3.2 Mining Policies

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

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

Regarding 1), promising areas identified by this study are effective for implementing this policy, and OMRG survey strategy should be formulated and implemented based upon this policy. Regarding 2) , it is preferable for the Investment Promotion Office to be the driving force for implementing this policy, however, organic development based on this study will have to be done to promote this policy.

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

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

Foreign investors have already advanced gold exploration. The gold potential is comparatively higher, and it might not appear that the infrastructure, in particular the road and port, is

a hindrance factor for the gold exploration/development, because the gold can be produced as dore at the mine site. At the 1st stage, it is also necessary to grasp the potentiality for the base metal resources.

- Translation of information on the gold deposits into English and its presentation
 - To compile the survey data.
 - To raise the precision of the ore deposit models.
 - To appeal them in seminars and magazines.
- Supporting the infrastructure system in gold potential areas
 - To develop water resources in the potential areas.
 - To prepare a supporting system for infrastructure (in development).
- Reduction or exemption system of royalty for a limited period
 - To limit applicants by the investment capitals for development.
 - To reinvest exempted money in Mauritania.
- Geological surveys for base metal resources by OMRG
 - To make geological ore deposit maps.
 - To prepare survey equipment.
- Translation of information on base metal resources into English and its presentation
 - To compile the survey data.
 - To raise the precision of the ore deposit models.
- Expansion of database for mineral resources
 - To store the survey data and develop the archive.
 - To expand the ASTER images.
- Staff training
 - To instruct English.
 - To establish an Instruction Center for Mining Technology.

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

- Promotion measures for introduction of foreign investment
 - The government guarantee for the investment
 - Simplification of the investment procedures
- Disclosure of information
 - Disclosure and renewal of information by the web site
 - Periodical investment seminars
- Establishment of Investment Promotion Office, training personnel and functionalizing
 - Transmission of mining information (publication of magazines)
- Construction plan for infrastructure

(3) Establishment of environmental management system

- Establishing the legal framework for environment management
 - To review the Mining Law and Environment Law (ex: to clarify the environmental issues covered in the Mining Law.)
 - To formulate detailed regulations for mining-related environment.
- Establishing Monitoring Center
- Preparing a plan to manage mining environment (Baseline survey).
 - To understand background of rock, soil and water as environmental management.

6.4 Improvement of Investment Base

6.4.1 Mining Administration and Function

It must make its organization more functional and propose the following items such as the reform for practical and functional organization, based on reviewing completion percentage of the strategic development plan every stage, evaluating the status of exploration and development, introduction of the foreign investment, etc.;

- To expand the organization in case development/production is promoted.
 - “Service of Mines” in DMG will consist of “Division of Development & Production”, “Division of Safety” and “Division of Technologies”. SM will be mainly in charge of the supervision of mining activities.
 - Staff training, improvement of tools and facilities and systemizing.
- To expand DMG as General Direction of Mining Policies.
 - The organization to make policies and plans for a long term.
 - Overall control of mining.
- Restructuring and independence of OMRG
 - To restructure the organization to be independent.
 - To privatize the repairing divisions.
 - To systemize the work using IT. To utilize the database.
 - To maintain exploration equipment and machines.
 - To make a medium and long-term program.

Systematization by IT involves the construction of a LAN system and the procurement of 1 computer per person. As IT comes into greater use, it will be necessary to add performance and organic power that can formulate a mid- to long-term plan which uses the database. The repair cost for OMRG machines are not small although there are not so many machines. It would be desirable that the OMRG repair section to enhance the functional organization and emphasize survey work. Exploration will depend on improving the survey capability of OMRG, and on whether or not OMRG can provide the attractive data and information for

the foreign companies. To establish Mineral Information Center.

- An organization in MMI or a part of DMG
- To collect and compile mining information (geology/ore deposits, tendency of exploration and development, tendency of technical development, policies, legal/tax institution, environment etc.) as well as present it to relative organizations.
- To clarify the role of information analysis section in case of its establishment at the Investment Promotion Office.

This center is planned to be established in the 3rd Stage, but collecting the oversea mining information itself can be linked with promotion of investment, reviewing policies, introduction of survey methodology. Therefore it would be desirable to collect information in each organization from the 1st Stage. Mining Association

It is necessary to keep balance between the government and private companies for healthy growth of mining industry. Mining Association is an organization guiding private companies to promote mining activities.

- To be an organizer of private companies.
- To be established by the NGO funds, etc.
- To consolidate the information of private mining activities.
- Roundtable meetings between mining companies and the Government
The opinions of foreign companies are very important to improve the investment climate.
 - Examination of mining policy
 - Analysis and revision of factors hindering exploration and development
 - Formulation of measures to promote mining
- Organization to evaluate and examine the mining policies and institution
A specific organization is necessary to evaluate the effects of the mining policies and institution and correct them in their implementation. It will consist of mining companies, NGOs, universities, international organizations and etc. It will examine objectively the policies and institutions made by the government. It is desirable at first to prepare above-mentioned roundtable meetings consisting of foreign companies, government agencies and international organizations.
 - Periodical round-table meetings (once per each three months).
 - Establishment of a mining committee from the second stage.
 - Correcting and improving the mining policies and institutions.

6.4.2 Policies for Poverty Reduction and National Budget for Mining

Poverty Reduction Strategy Paper (PRSP) gives importance to the mining field, but the

weight of mining is comparatively lower in the program in PRSP and the national budget in 2001 to 2004. The important task in the poverty reduction policies is the economical development in the communities with many poor people, and mining can play an important role here.

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

6.4.3 Financial Market

Construction of the financial market is a national economical policy, which has influenced the economical growth in Mauritania. Its industrial structure consists of the primary industry, mining, fishery and agriculture; thus, the company activities will not proceed without advancement of the industrial restructuring. Investment fund for domestic companies and operation fund for foreign companies resulting from the promotion of exploration/development will be necessary to be collected at the Mauritanian financial market.

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

It is also noted that a long-term loan system and subsidy system for interest payment would be indispensable for the local companies to obtain capital if exploration and development by local investors are promoted in the future.

6.5 Improvement of Investment Climate

6.5.1 Promotion System

It is absolutely necessary for the mining promotion to make several systems for advancement of exploration/development activities. The systematization would improve exploration efficiency and enhance the profitability of OMRG and the foreign companies.

- The exploration system
 - Survey system in extensive areas
 - To systemize the extensive areas surveys by OMRG.
 - To carry out the base metal survey in the first stage and the rare metal survey in the second stage by the national budget.
 - Joint-venture extensive areas exploration system
 - Joint-venture exploration between OMRG and foreign companies
 - To keep the OMRG exploration right and give OMRG engineers' services. Foreign companies cover the exploration costs.
 - OMRG transfers the exploration right to foreign companies after the exploration.
 - Interest provision system

In case exploration works are independently carried out by domestic companies, the government provides them the interest for commercial bank loans during the exploration period.

- Disclosure of information

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

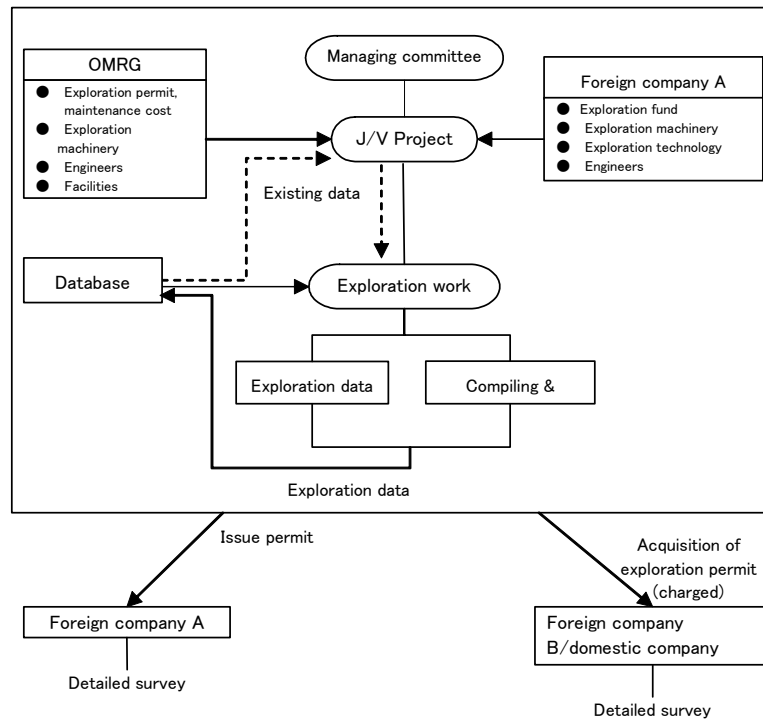


Fig.6.5.1 Schematic Diagram for Joint Venture Extensive Areas Exploration System

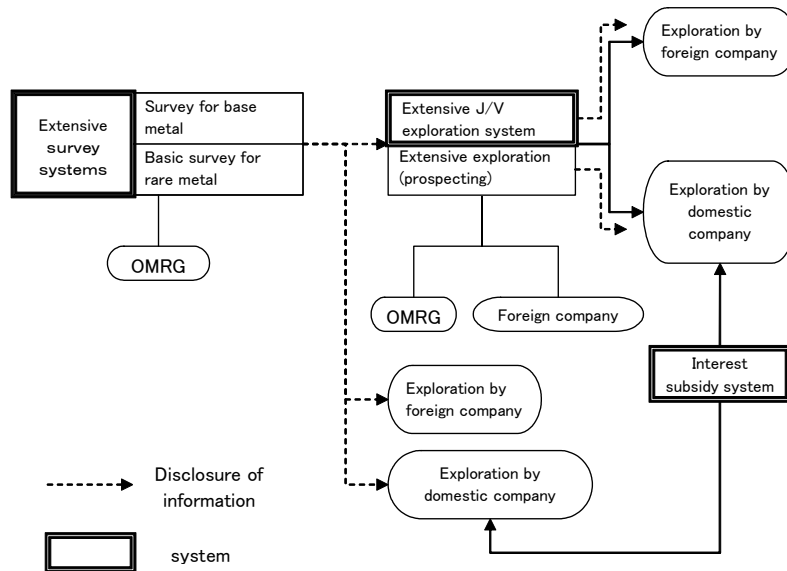


Fig.6.5.2 Location of Exploration System

- Infrastructure support system

If the government's roles and responsibilities such as cost burden for subsidies, ancillary maintenance, etc., are not clarified, it will be difficult to promote development, so it is necessary provide specifics at least 2nd Stage if not earlier.

Table 6.5.1 Tasks for Supporting System for Infrastructure

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

- Development system
 - The government guarantee system
 - To guarantee the development right period except for the political power shift or change (same in the exploration right).
 - To guarantee property (including capital) in superior force (political change or war).
 - To guarantee the pocket value (including deposit money) under the economical policy (currency policy) or deviated exchanging rate.
 - Special measure for depreciation
 - To shorten or prolong the depreciation period regarding machines and facilities.
 - Machines and facilities appointed by the mining organizations or property resulted from development works.
- Environmental measures and protection measures
 - The subsidy system for environmental technologies, tools and facilities
It is very difficult for domestic companies to prepare everything due to their financial shortage. This system should be located as one of promotion measures for domestic companies.
 - Recommendation for environmental measures
Local companies need instruction and recommendation on environmental protection and measures due to lack of mining experience.
 - Presentation of environmental information
 - Presentation by the web site for environmental protection utilizing the environmental management database (SIGE)
 - Disclosure of environmental survey data (exhibition)
 - Baseline survey

Table 6.5.2 Summary of Extensive Baseline Survey

Item	Summary
Target areas	<ul style="list-style-type: none"> Mineral potential resource areas. Mining districts (There are already activities in progress.)
Target objectives	<ul style="list-style-type: none"> Rock, soil, water quality, water level (ground water), fauna, flora, air
Method	<ul style="list-style-type: none"> Grid sampling (one sample/1 to 5km) for rock and soil. Well and river analysis for water quality. Processing of ASTER image data Chemical analysis of samples
Compiling	<ul style="list-style-type: none"> Database of chemically analyzed values and observational
Analysis	<ul style="list-style-type: none"> Selection and analysis of anomalous zones Hydraulic structure
Result	<ul style="list-style-type: none"> Baseline map Analysis

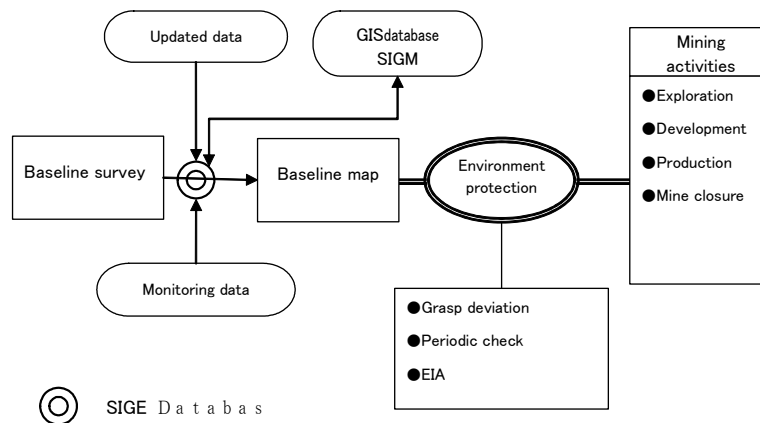


Fig. 6.5.3 Location of Baseline Survey

6.5.2 Infrastructure

Infrastructure development is important for promoting exploration and development; it is necessary to develop roads, water and power supply systems, and so forth.

- Dedicated wharves for mineral resources

If there is no port that can ship several hundred thousand tons of concentrates for export, then it will be impossible to promote exploration for medium to large base metal mines. There would have to be either exclusive port facilities for mineral resources, or a new wharf constructed. At the very least, the plan would have to be formulated at the 2nd Stage.
- Water resource development in areas with promising mineral resources

A water supply is essential at the exploration and development stages. Under the present conditions, water has to be transported 100 to 300km at the exploration stage, which hinders the promotion of exploration.

- Formulation of an infrastructure construction plan

A mid-term plan for infrastructure construction would be very effective for the formulation of a development plan, because it is linked to acceleration of exploration activities.

6.5.3 Environmental Management

The system of environmental management should be built according to proceeding of exploration/development, implementing the following items for practical function. Regarding the legal framework for environmental management, it should be improved as soon as possible. What are needed first are guidelines and detailed regulations for EA (Environmental Assessment) and EIA (Environmental Impact Assessment). Tasiast and Akjoujt are at the development phase and thus require these immediately.

- To establish the monitoring system.

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

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

- To establish Monitoring Center.

Monitoring Center will compile and analyze the data, conduct the satellite image analysis, input data at each monitoring point in the SIGE of PRISM and utilize the linkage system of SIGM of PRISM.

- Disclosure of environmental information by the website

Monitoring data and baseline data compiled in SIGE or information related to environment should be disclosed by the website (website for environmental protection.)

- Collection of mining environment information

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

- The environmental management system of the government and its function

- To link the government organizations related to environment with SIGE.
- Utilization of the environmental protection web site by the government organizations .

- To install the intranet between relative ministries and organizations.
- To establish Mining Environmental Protection Committee.

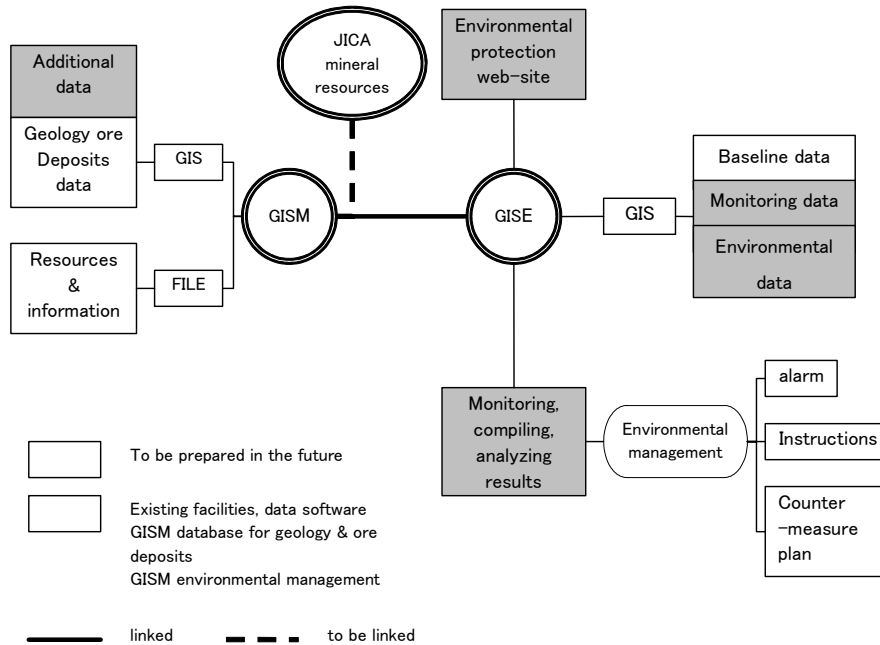


Fig. 6.5.4 Location of Environmental Management Database

- To nurture environmental experts.
 - To invite experts to have their direct instruction.
 - Training system in foreign countries
 - To introduce environmental projects prepared by international organizations or donor countries.
- Establishment of legal frame including environmental management regulations
 The legal framework related to environmental management needs to be established through systematic review. Furthermore, the development of environmental regulations can in no way be said to be satisfactory. It is necessary to make regulations for practical environmental management, in the legal system, harmonizing with the Mining Code and laws related to environment.
- Environmental standards
 Mauritania has no environmental standards in place. It is better to establish standards earlier.
- To hold seminars and workshops for environmental management.
 It is gainful for acquisition of knowledge, technologies and information of environmental management to open international workshops in Mauritania. At the same time, it will be an

opportunity to raise an interest towards the environmental management.

- To establish Laboratory Center.
Analyzing capacity in OMRG should be expanded as well as the staff - trained in order to establish a laboratory center, able to do full analysis of rocks, soils and water.
- Mine closure funds and reserve
Specific environmental works should necessarily be conducted when a mine closes. Thus, some mines need to continue monitoring mine pollutions after closing. The reserve and fund is a system to pool the money for mine closure while it still manages normally the operation. It is a very important system from the viewpoint of permanent management of mining environment.
- Instruction to local companies
- Formulating a plan for environmental management
Making a long-term plan or master plan for mining environmental management in harmony with poverty reduction strategic paper (PRSP) and this development strategic plan, as well as implementing the administration for mining environmental management with medium and long-term view, will lead to sustainable development of mineral resources.
- Mine safety and environmental guidelines
In Mauritania, there are no mine safety and environmental guidelines. At the 3rd Stage, which envisions full-scale mine operation, it will be possible to establish guidelines to match the conditions in the country.

6.5.4 Information Disclosure and its Methods

Disclosure of information on mineral resources is indispensable for the promotion of exploration/development, and the disclosure by the web site is the first step of such disclosure for investors. The second step is to disclose the detailed exploration information on ore deposits, etc.

- The web site
 - To link the web site of OMRG constructed under this study with the web site of MMI and SNIM.
 - To link the environmental protection web site with the mining-related web sites, searching system.
- Translation of information into English.
 - Literal information on the web site, document, reports, etc., various figures such as geological maps, input data in the database
- Installation of facilities for disclosure of information on mineral resources
 - Systematic compilation of information on mineral resources and searching system

- Installation of facilities for public disclosure (in Investment Promotion Office, etc.)
- Information disclosure system

It is necessary to disclose the information on data stored in the GIS database and the newly attained materials as much as possible to promote the overseas investments through the OMRG web site. Therefore, it is needed to formulate rules and regulations for disclosing and providing information.
- Disclosure of business finances data of companies

It is a key for a joint venture between foreign and domestic companies conducting exploration and development activities, as well as for the growth of the financial market to keep the transparency of business finances and companies activities.

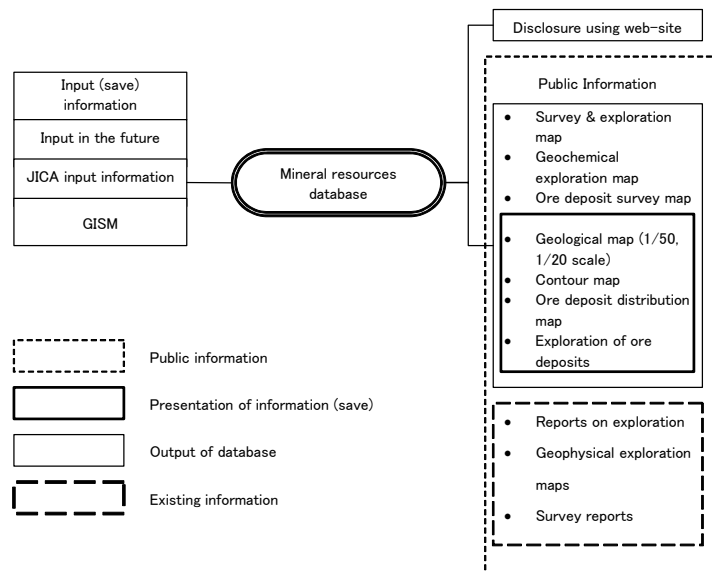


Fig.6.5.5 Mineral Resources Database and Exhibition of Information

6.5.5 Maintenance and Management of Mineral Resources Database

Maintenance and management of mineral resources database is to master the function and availability of GIS for data addition and its full utilization. It will be related with the maintenance and management of the database to output the information requested by investors.

- To expand the database (Mineral Resources Database).

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

Usability of the database shall be increased by customizing retrieval tool.

- To utilize GIS.
 - There are many utilization of GIS, for instance, in the studies of geological ore deposits by OMRG, selection of mineral potential areas, elaboration of survey plans and compilation, analysis of survey data and so on.
- To make the detailed geological maps with scale of 1/100,000.

Additional ASTER data with high spatial resolution should be procured for the more detailed geological maps are needed, for example with scale of 1/ 100,000, in order to study whether or not to invest in exploration.

 - To select target (promising) areas for the detailed geological maps from the existing geological maps of 1/200,000 scale.
 - To request making the maps from the international organizations and donor countries.
- To employ staff.
 - To employ experts in charge of database in OMRG. (IT engineers who speak English.)
 - To request the dispatch of experts from donor countries (for long period).
 - To employ workers for data input

6.5.6 Utilization of Mineral Resources Database

Data for various sectors like the infrastructure, water resources, meteorological phenomena, flora etc. should be added to the database for its wider use.

With the exception of the mining industry, there is almost no use of remote sensing technology in Mauritania. In the field of mineral resources, the efficient use and continuous accumulation of mineral resource data including remote sensing data, are indispensable for the promotion of exploration and development. Adding data such as SIGM/SIGE and OMRG survey data, developing archive, using global elevation data, adding ASTER imagery, acquiring and storing data on infrastructure, water resources, vegetation, land use, climate and so on, will be linked with application to other fields (such as agriculture, land use, infrastructure planning, water resource development, desertification monitoring, etc.).

- Support for the creation of an infrastructure development plan

Infrastructure development is multi-faceted. The creation of an infrastructure development plan requires various types of data, for example, on mineral resources, water resources, climate, land-use, agriculture, vegetation, topography, desert areas, rivers and streams, existing infrastructure, and environment. In addition, the infrastructure development plan itself should be connected to the promotion of investment in exploration and development of mineral resources.

- To use for the Poverty Reduction Strategic Paper (PRSP) and the local development.
Land conditions (climate, hydrology, topography, soil, state of water resources, etc.) are derived as theme maps from satellite and GIS data. The identification of areas suitable for farming and livestock raising through land classification can contribute to agricultural development. Satellite data are effective for monitoring (seasonal and annual changes) in grassland for livestock farming and water resources.
- To protect from the desertification.
It is possible to ascertain the state of desertification by satellite data. Desertification has many factors, but it is possible to find out the clue for solution of desertification through understanding annual and seasonal changes.
- To use for water resources development, water pipeline construction and water supply.
The development of water resources in Mauritania should be given top priority since it is instrumental for the development of communities, mineral resources, mining, agriculture, and other areas in the country.
- To formulate an industrialization plan.
Satellite data have been used for monitoring the changing conditions in the cities each year and to promote an appropriate type of urban development. In the formulation of urban development plans, detailed topographic maps based on aerial photos are useful but expensive, so it might be possible to use satellite data in their place.

6.5.7 Support to Investment Promotion Office

- To make brochures for investment promotion, publish investment guidebooks and prepare CD-ROM.
 - To make brochures for introduction of the Mauritanian situation, investment climate, mining policies, mineral potentialities and ore deposits.
 - To publish investment guidebooks.
 To publish magazines for introduction of the Mauritanian mining.
- To make videos/DVDs for investment promotion.
- To install a PC for three-dimensional display of ore deposits.
- To prepare a section for investment information analysis.
- To prepare an investment promotion section for local companies

This unit is planned within the PRISM sector framework program. In support of the Investment Promotion Office this study has considered its needs and likely operational format. The future design, role and function of the Investment Promotion Office is shown in the Appendix in the Draft Final Report which is a result of cooperative work with PRISM.

Table 6.5.3 Role and Function of Investment Promotion Office

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

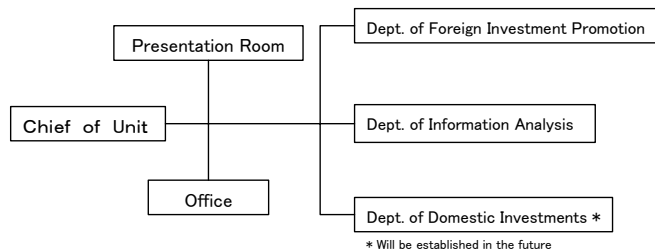
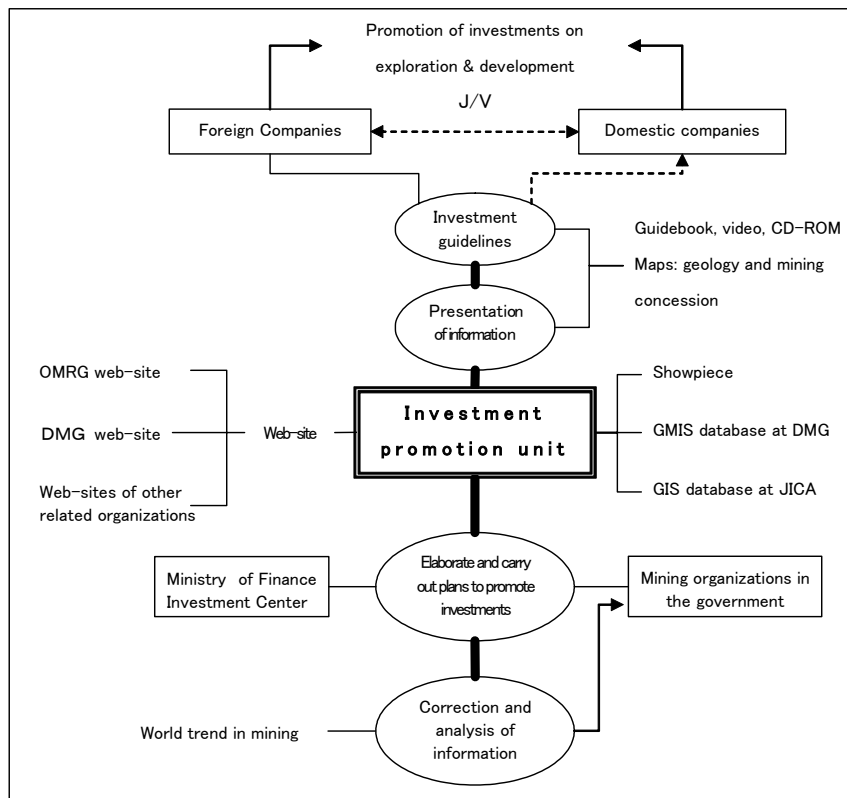


Fig. 6.5.6 Promotion of Exploration/Development by Investment Promotion Office

6.6 Introduction of Foreign Investment and Growth of Domestic Companies

6.6.1 Introduction of Foreign Investment

Improvement of the investment climate for introduction of foreign investment is described in 7.4.1, indicating the current situation for the investment and relative tasks.

- To make an incentive in the exploration/development system for attracting foreign investors.
 - In case a foreign company has a joint venture with a domestic company, it can prolong the exploration right period up to more than two years at the exploration stage. The foreign company can reduce the royalty at the development/production stage.
 - In case a foreign company constructs a road by its own fund at the development stage, it can reduce the royalty for five years after beginning of production.
 - To fix the rate of interest and exchanging rate to the mining activities fund for a foreign company within a limited period in Mauritanian commercial banks.
- To present digitalized information on ore deposits.
- To make a construction plan for infrastructure, compile and present the information on infrastructure.

6.6.2 Nurturing Domestic Companies

If the dependence on foreign companies continues in future, the capital accumulation accompanied by mining activities will be impossible in Mauritania. The profit will go out of the country, and foreign companies will escape from mining activities according to the deviation of metal price. It might seriously influence the employment rate. From the view-point of economical growth of Mauritania, it is important for domestic companies to carry out exploration/development works independently at the second and third stages of the development strategic plan.

- Proposal for nurturing domestic companies
 - To nurture domestic companies, it would be preferable to provide financial support for exploration and development, but it would be difficult under the present financial conditions in Mauritania to establish a system for finance and subsidies. At the 1st Stage, it is necessary to formulate a proposal for nurturing domestic companies and investigate the feasibility of financing and subsidizing them.
- To accept project orders of international organizations jointly with foreign companies.
 - Accepting the project orders of international organizations jointly with foreign companies is related to acquisition of the necessary technologies and knowledge.
- Partnerships with foreign investors
 - If domestic companies can grow up at the 1st Stage, linkages with foreign companies could be considered. They also can lead to the introduction of technologies and knowledge as well as staff training by OJT.

- Rental system for exploration/development machines

This is a measure for promoting in the 2nd and 3rd Stage. Based on the rental system, the government mining organizations can lease exploration and development machines to domestic companies that are poor in capital.

6.6.3 Privatization of SNIM

Today, mining companies are doing well and SNIM's management is being improved, so now is the time to investigate concrete ways of reforming management.

- Investigation of SNIM privatization

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

Table 6.6.1 Separation Plan for Privatization of SNIM

Targets	Separation for Privatization
Mines	<ul style="list-style-type: none"> ● Privatize facilities for Production ● Include the infrastructure related to production
Stockyards and shipping facilities	<ul style="list-style-type: none"> ● Privatize the facilities in Nouadibou ● Privatize the long-distance facilities from the mine site
Railway	<ul style="list-style-type: none"> ● National railway company (partial private investors) ● Include maintenance sectors
Port	<ul style="list-style-type: none"> ● National port company ● capital & management by government but operation by private company
Water and electricity	<ul style="list-style-type: none"> ● National or public management ● Supply for production facilities in Zouerate is managed by the mine.
Subsidiary companies	<ul style="list-style-type: none"> ● Perfect privatization ● Each company is privatized by the foreign and national companies.

- Privatization of SNIM

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

6.7 Human Resource Cultivation

Training engineers related to mining is fundamental for promotion of exploration and development, so it should be a priority matter in the development strategic plan. Employing foreign engineers is expensive and it might be disincentive for mining development. On the contrary, Mauritania might loose opportunities of employment.

- Training system

- To establish a training system like training for top officials, training and invitation of experts.

- Establishment of a university faculty of mining engineering
(Science of ore deposits, exploration engineering, mining engineering, beneficiation engineering, mining environment engineering)
- The overseas study program (master level)
There should be experts who can give advice to private companies, provide information about the geological deposits of a region, etc. The needs of private companies could be met through study abroad programs that could train specialists at the master level. This would also lead to a qualitative improvement of OMRG.
- To establish a faculty of mining in Technical High Education Center
A faculty of mining is established in this center. Target fields for training are considered in topography, boring, geological drawing and mapping etc.
- Experts invitation system
This is a system in which the knowledge and technical base will be enhanced by the direct instructions of the world experts.
 - Specific knowledge and technologies in each special field
(Mineral evaluation, environmental economy, mineral resources economy, feasibility study, engineering, exploration technologies, mining technologies and processing technologies)
 - Mining financing, mining accounting and mining management
 - Mining tendency
- To establish an Instruction Center for Mining Technologies.
This is a place for staff training to feed workers in the exploration, development and production within the global mining activities by instruction of practical technologies. It will be built by international organizations or donor countries and it is desirable to become a Technical Development Center in future, including neighboring countries.

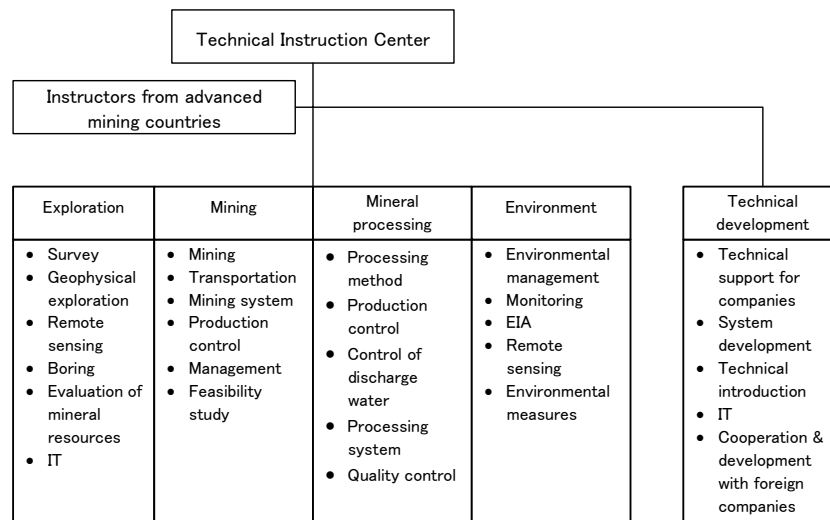


Fig.6.7.1 Organization of Technical Instruction Center

- English-language instruction system

English-language education is emphasized, but there are very poor opportunities for English instruction to the engineers who need understanding English. English language should be instructed in the above-mentioned vocational technical educational center.

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

- Overseas training system

At present, Mauritania needs practical technology and knowledge, and so establishment of overseas training system for engineers and government top officers who need understanding the mining technology and know-how of mining business.

6.8 Promising Areas of Mineral Resources

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

OMRG should continue strengthening the survey capacity and surveying the objective areas of ore deposit models or potential areas applicable to ore deposit models in order to increase the data necessary for promotion of exploration and development.

- To review the ore deposit models

Exploration targets will be further clarified by the ore deposit models specified by data augmentation from the field data to be obtained by OMRG in the future.

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

- To continue the geological survey.

OMRG should continue the survey in the target areas for the models in the supplementary field survey by means of methods and technologies acquired by OJT in this study to

expand data from linear to plane.

- To survey the altered zones.

OMRG should survey the altered zones, using the tools provided by this study (portable spectral radiometer for mineral identification: POSAM). It is necessary to improve the analysis accuracy in the altered zones by comparison of remote sensing images.

- Geochemical exploration

Sampling should be done to increase the amount of geochemically analyzed data in the supplementary field survey. Increasing the data amount would facilitate finding solution for the metal condensed areas and mechanism through compilation and analysis of the data obtained as a result of the geological survey and altered zone survey.

- Geophysical exploration

OMRG has neither the geophysical exploration equipment nor geophysical engineers. First of all, electrical, electromagnetic, magnetic and gravity survey equipment should be procured and at the same time, engineers should be trained. First of all, it is important for geophysical engineers to have good training to carry out their surveys by themselves.

- Trenching

Trenching survey should be carried out in the anomaly zones revealed by the geochemical survey and altered zones survey should be conducted to condense the data and analyze the anomaly zones.

- Structural boring

Deep underground data is needed to specify the target and reduce the exploration risk. If the structural boring were carried out, OMRG would attain the three dimensional data which might be useful for foreign companies. Therefore, it is necessary to improve the accuracy of the background for the geology and ore deposits as soon as possible by implementation of the structural boring.

- To evaluate the mineral resources.

Evaluation of the resources potentiality should be carried out using the results of the above mentioned surveys. Potential ore reserve and grade should be calculated to be presented to the investors.

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

- Presentation of papers

New information would be attained by a series of works reviewing the ore deposit models.

It would also connect with exploration/development, attracting the interests of the foreign companies by presenting the new information as research papers.

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

- To make a model for each area.

It is necessary to make models based on the data gained from this study and the future survey. In particular, it might be a large-scale task at the second stage to make models for rare metal resources.

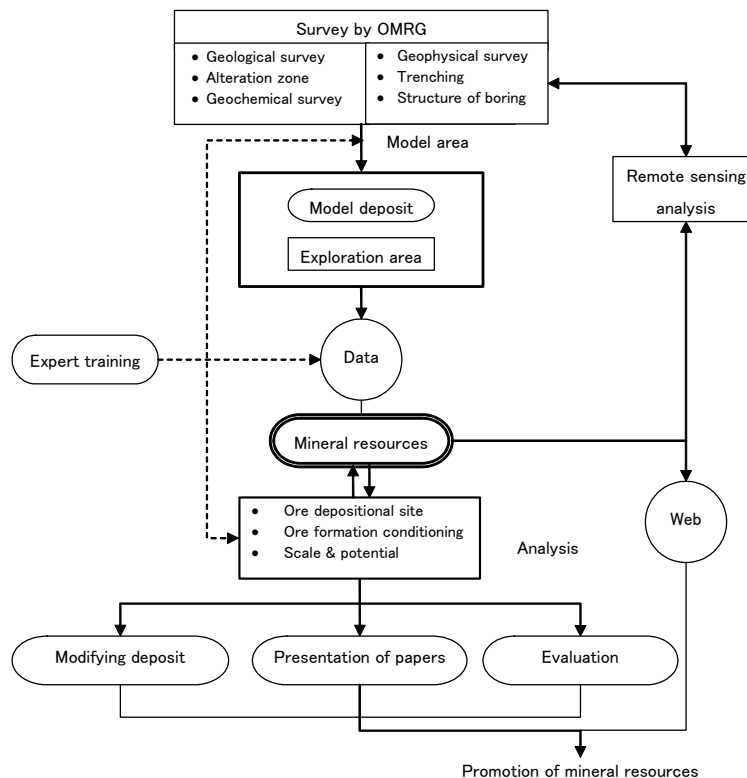


Fig.6.8.1 Survey in Model Areas and Promotion of Expansion

- To verify and utilize the models.

It might be possible to verify the models in the reviewing process.

- Remote sensing

The Fe-condensed areas and altered zones could be estimated by remote sensing analysis using ASTER images. It would be effective to select the basic survey areas for OMRG and

attract foreign companies.

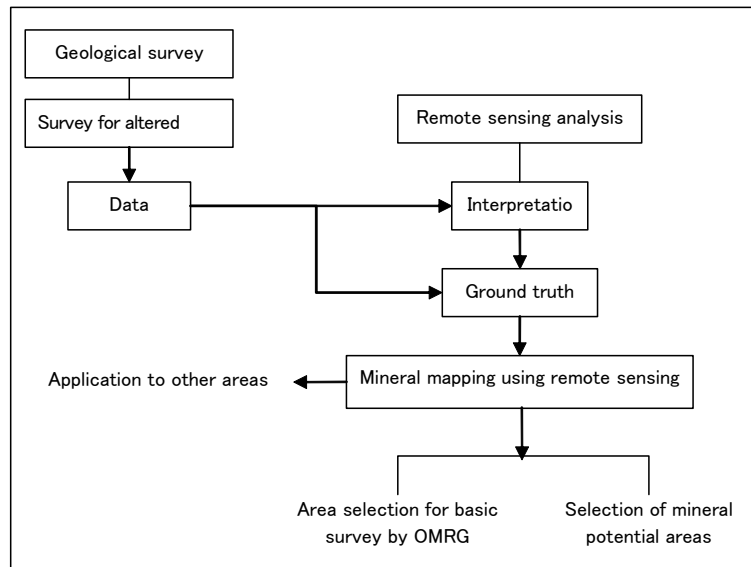


Fig.6.8.2 Mineral Mapping by remote sensing

Utilization of the remote sensing skill and GIS in OMRG should be specialized in detailed researches and studies related to mineral resources, so the computer skill is indispensable.

- One PC per one man (within 5 years)

It is necessary for all main engineers to have their own PCs for engagement in digitalizing and analyzing the geological data through remote sensing, GIS and web site.

- LAN in OMRG (within 5 years)

It is necessary to construct LAN for daily use of the mails and internet by connection of each PC and PD.

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

It is necessary to select and train 2-3 engineers who engage in remote sensing for technical improvement of remote sensing and GIS.

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

- Field spectrometry
- For remote sensing image analysis, it might be necessary to find specific phenomena and condensed zones of minerals in Mauritania as the basic document for the field survey. Field spectrometry will be done by remote sensing mineral mapping and surveys in the above mentioned model areas.
- To display the model areas in three dimensions (3D).
3D express deepens recognition of the geology and ore deposits, and enables concretization of the geological targets. Above-mentioned structural boring is vital for 3D express.
- To procure exploration machines and equipment for OMRG.

Even if OMRG is a national organization for geological survey, it is troubled by a lack of machines and equipment vitally needed for its work. Therefore, it is necessary to procure the machines and equipment for the survey in order to perform its function.

- Survey machines and equipment
X ray diffraction analyzer, physical exploration (IP, electromagnetic, gravity, magnetic etc.), analyzer, and boring machine
- Vehicles
Vehicles for survey and transportation

The promotion of exploration requires that OMRG undergo systemic reformation in order for it to fulfill its role as a survey institute.

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

6.8.2 Exploration Strategy

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

(1) Survey Strategy by OMRG

a. Guidelines

1) Gold deposit

Rock enclosing BIF related to gold mineralization is greenstone. Sericite is confirmed in the vicinity of gold deposit.

2) Copper deposit

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

3) Chromium deposit

This deposit is a podiform type chromite deposit in the serpentine. Aeromagnetic survey is an effective method for chromium ore, and PGM exist as platinum group elements and their sulfides in the chromite ore.

b. Survey strategy

1) Gold deposit

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

2) Copper deposit

- Greenstone belts are extracted by the regional geological survey, and positive aeromagnetic anomalies are confirmed.
- Oxidation zone is extracted by rationing of the ASTER image.
- Reconnaissance survey is done around the above-described aeromagnetic anomalies and oxidation zone.
- When mineralization and hydrothermal alteration are recognized, same methods are adopted as the gold deposit.

3) Chromite deposit

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

(2) Exploration strategy

It is desirable that first priority metal for exploration is the Tasiast and Tijirit areas for gold, next target is copper with gold in the Akjoujt area, and at the third stage, the Selibaby and Amsaga areas are selected where the chromite deposit exist with platinum group minerals.

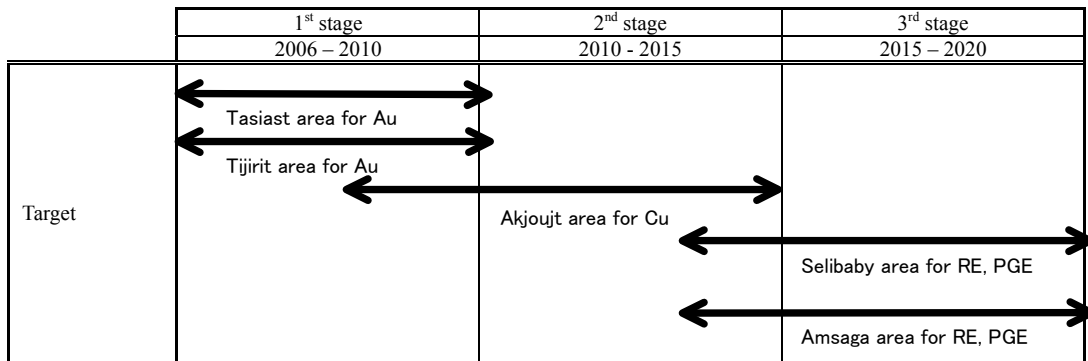


Fig. 6.8.3 Draft of exploration schedule in the promising area

6.9 Action Programs

This development strategic plan consists of three stages (fifteen years), as follows; 1) exploration/development of gold, 2) exploration/development of base metals and 3) exploration/development of rare metals. This is the range of steps necessary for mining development and promotion, taking into consideration the current status of Mauritania. Realization of the action programs requires a lot of funds and support from the international organizations and donor countries. However, promotion of exploration/development will not be achieved, if the Mauritanian government does not increase rate of the national budget allocated to mining sectors and does not implement the action programs by its own funds. The action programs should be specific and clarify the possibility of realization, projected effectiveness, source of funds, implementing body and evaluation method. It is necessary to establish a committee (tentative name: the development strategic committee) in the mining organization of the government in order to suggest, budget, implement, manage and evaluate the action programs.

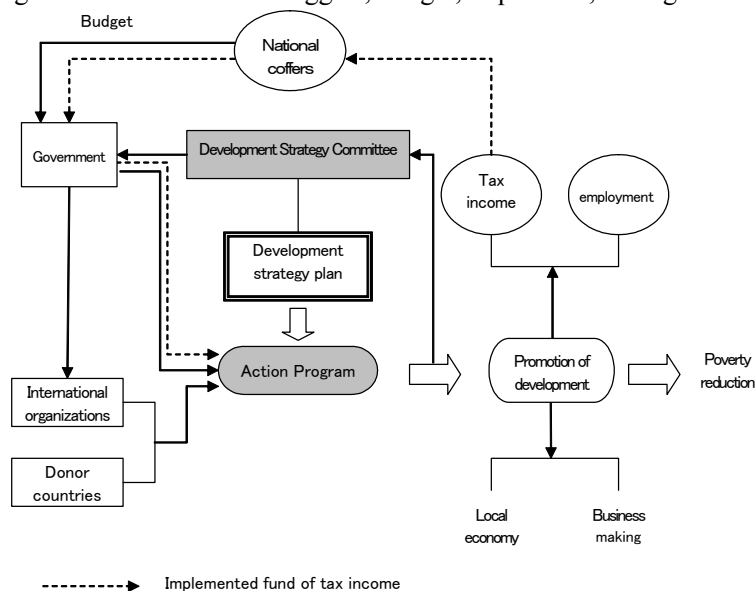


Fig.6.9.1 Location of Action programs

6.9.1 Action Programs at First Stage

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

Table 6.9.1 Action Programs at 1st Stage

Programs		Contents
Expert invitation system		<ul style="list-style-type: none"> ● Resources evaluation, physical exploration, remote sensing technology ● Investment promotion, resources economics
Studying abroad system		<ul style="list-style-type: none"> ● “Training system for mining related technology” by development of the current studying abroad system in the Ministry of Education (one year training for exploration, mining, beneficiation, data processing and other technologies)
Investment seminars		<ul style="list-style-type: none"> ● Opening the investment seminars in AMA (Mining Association in London) etc.
OMRG’s surveys		<ul style="list-style-type: none"> ● Promotion of the surveys in Tijirit and Inchiri. ● Formulation of the extensive survey system
Extensive survey system		<ul style="list-style-type: none"> ● Quantitative and successive surveys in extensive areas by OMRG
Seasonal magazines		<ul style="list-style-type: none"> ● 1st and 2nd volumes are published in this study. ● Volumes after 3rd are published by OMRG (before establishment of the IPO).
Additional supplement by ASTER images		<ul style="list-style-type: none"> ● Preparing ASTER images for survey areas
Development of the archives		<ul style="list-style-type: none"> ● Storing OMRG data and reports into the database
Accumulation of GIS data		<ul style="list-style-type: none"> ● Storing continuously geological data, etc.
Expansion of the website information		<ul style="list-style-type: none"> ● Renovating the OMRG website content and linking with MMI
System Reform in OMRG	One PC per one man	<ul style="list-style-type: none"> ● IT innovation of OMRG
	Construction of LAN system	<ul style="list-style-type: none"> ● Sharing information and improving deskwork efficiency
	Preparation of survey equipment	<ul style="list-style-type: none"> ● Preparing geophysical equipment and boring machines, etc.
Training of mining technology		<ul style="list-style-type: none"> ● Topography, boring, geology (mapping and digital drawing), geophysical exploration
English language education		<ul style="list-style-type: none"> ● Instruction of basic and mining English
Water resources development in the promising mineral areas		<ul style="list-style-type: none"> ● Promotion of maps for hydrology and ground water potential ● Utilization plan of Water resources in mining areas
Mining environment management		<ul style="list-style-type: none"> ● Baseline survey, master planning of environment management ● Establishing legal framework for environment ● Preparation of mining environmental information
Infrastructure planning		<ul style="list-style-type: none"> ● Formulating the outline of infrastructure plan from the viewpoint of mining promotion

The following Fig. 6.9.2 shows an action schedule for the 1st Stage, especially for information development and systemic reformation related to OMRG.

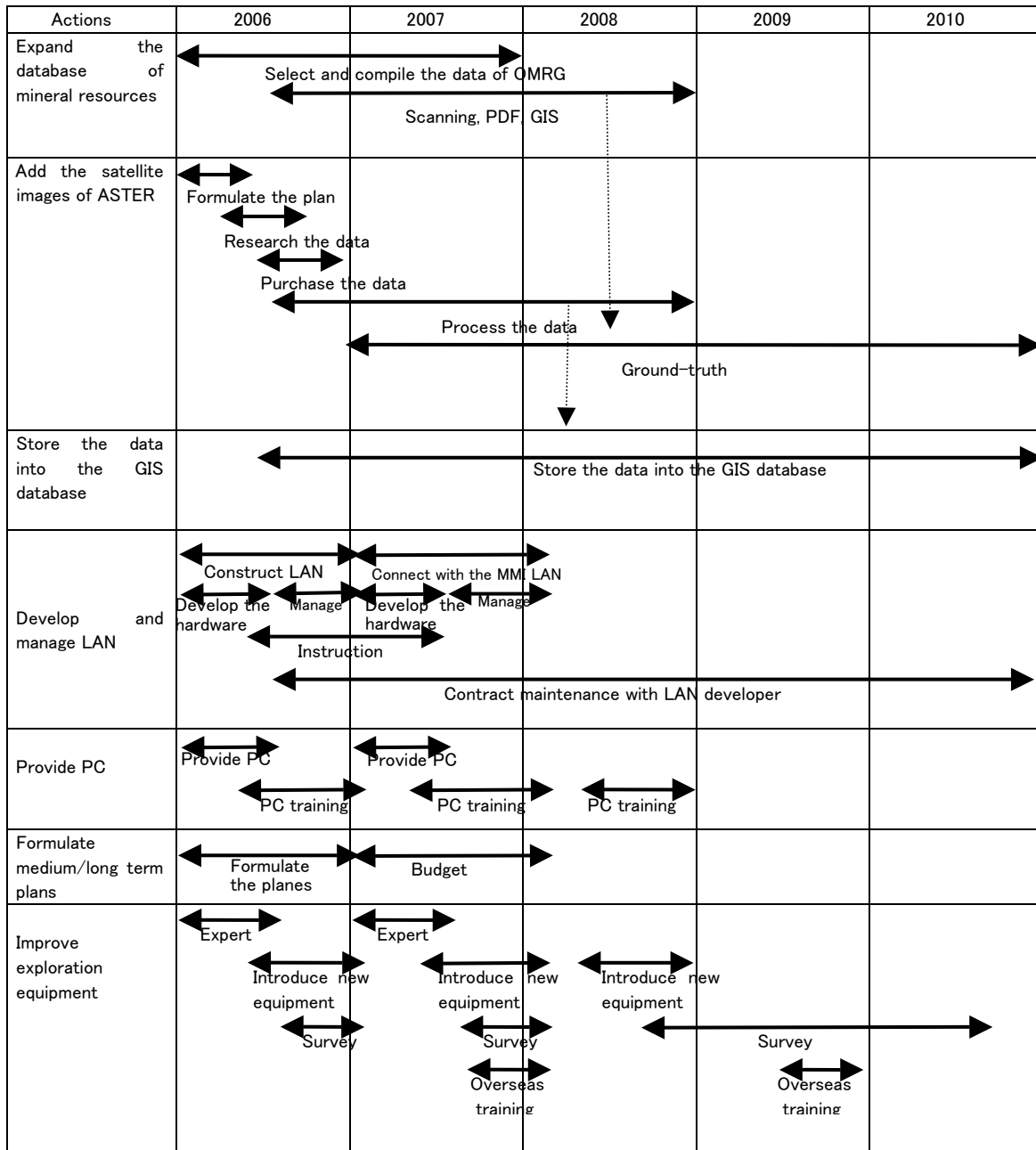


Fig.6.9.2 Action Schedule for Information Innovation and System Reform of OMRG at the 1st Stage

6.10 Main Promotion Programs

6.10.1 Promotion of Exploration

(1) Promotion of Gold Surveys by OMRG

1) Purposes:

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

2) Current situation:

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

3) Overview of survey promotion

a. Period: 5 years

b. Survey promotion items:

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

c. Target areas for surveys (see Appendix)

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

d. Costs

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

It is noted that each cost does not include expenditure for trenching and boring. However, boring is indispensable for full scale survey as a tool.

It is noted that main issues are machines for surveys, training personnel, budgeting the surveys, etc.

(2) Survey System in the Extensive Areas

1) Purposes;

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

2) Current state;

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

3) Overview of the system;

a. Roles;

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

b. Survey targets;

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

c. Contents of the survey;

Table 6.10.1 Survey Content

		Reconnaissance	Regional survey
Target		Unexplored areas	Explored areas
Method	Field	<ul style="list-style-type: none"> • Geological surveys (root map) • Geochemical survey (Spot sampling) • Rock and ore survey (sampling) 	<ul style="list-style-type: none"> • Geological survey (1:10,000 or 1:50,000) • Survey area : 50km by 50km per survey area • Geochemical survey • Outcrop survey (including sampling) • Geophysical survey (preliminary survey) • Structural boring
	Lab	<ul style="list-style-type: none"> • Remote sensing analysis • Ground truth • Analysis of geological and geochemical data 	<ul style="list-style-type: none"> • Remote sensing analysis (quantitative) • Ground truth verification • Geological structure analysis • Geological and geochemical analysis
Tangible results		<ul style="list-style-type: none"> • Geological root maps • Selection of promising areas • Maps of outcrops 	<ul style="list-style-type: none"> • Geological maps • Geological maps of potential deposits areas • Maps of outcrops • Anomaly map • Geological deposit map • Ore deposit models • Analysis of mineralization
Period		6 months	2 years per area

d. Costs;

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

e. Mining concession;

- Reconnaissance is carried out for selecting areas for wide area survey and so does not need application of mining concession.
- Special mining concession (survey rights) is needed for wide area survey during the survey period. The special mining concession can be maintained until exploration rights are obtained by private sector.
- If private sector has a mining concession in the area for wide area surveys, overlapping areas become the targets for the JV Wide Area Survey System.

f. Provision of tangible results (including data);

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

g. Obligations of parties acquiring exploration rights;

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

h. Schedule: Preparations and Commencement in 2006

It is noted that main issues are budgeting, acquiring technology, converting tangible results and data into English, lack of machinery, etc. And machinery and equipment must be brought in from elsewhere to implement this system.

6.10.2 Introduction of Foreign Investment (Promotion of Investment)

(1) Publication of Seasonal Journals

1) Purpose;

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

2) Current status;

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

3) Overview;

- a. Name of the magazine: Mauritanian Mining
- b. Publication: 3 times per year (once per 4 months)
- c. Publisher: DMG, MMI / OMRG

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

- d. Circulation: 1,000 copies

e. Distribution entry:

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

- f. Size of the magazine: A4
- g. Volume: 12 pages
- h. Languages : English/French
- i. Content:

- Introduction to mineral resources in Mauritania
- Mining activities in Mauritania (exploration, development, production)
- Activities of the government agencies
- Information on mining concession, legal amendment, etc.
- News and topics related to mining

It is noted that main issues are publishing periodicals, budgeting, etc. However, OMRG will

be able to publish the magazine with general funds, and they will be able to handle this on their own, which will improve their abilities.

(2) Investment Promotion Office

1) Purpose;

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

2) Current status;

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

3) Contents

a. Staff;

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

b. Training method for the staff;

- Overseas training: in the magazine publishers related to mining, mining or exploration companies
- A mining expert: visiting the gold and copper mines
- Assistants: the English language and business skill training

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

- 2005 June: design of the Unit, June-Dec.: preparation for the Unit, Oct.-Dec. staff training
- 2006 Jan. test start

d. Contents of the test period and the training;

- Contents of the test period;
 - ◆ Collect and compile the mining information.(mainly by the internet and books)
 - ◆ Compile the information on the current Mauritanian mining activities.
 - ◆ Publish “Mauritanian Mining” magazine.
 - ◆ Communication with the mining organizations (MMI, OMRG) and companies

- ◆ Held a Investment Seminar.
- ◆ Build the website.
- Contents of the training;
 - ◆ Instruction by invited mining experts (3 months)
 - ◆ English language training (continuation)
 - ◆ Training by OJT.
- e. A schedule after opening the Unit;
 - The 1st phase: 2006 Jan. to 2008 July (about 2 years);
 - ◆ Establish the organization and function of the Unit.
 - The 2nd phase: 2008 Aug. to 2010 July (about 2 years);
 - ◆ Detailed organization (Department of Investment Promotion in Foreign Currency, Information Analysis and Investment Promotion of Domestic Investors)
 - The 3rd phase: after 2010 Aug;
 - ◆ Integrate the Investment Promotion Office into MEAD.

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

(3) Investment Seminars

1) Purposes;

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

2) Current situation;

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

3) Overview of investment seminar;

- a. Period: 5 years (in the First Stage)
- b. Organizer: Investment Promotion Office (-cum- secretariat), MMI (DGG and OMRG), MEAD

and MFA

c. Number of seminars per host city;

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

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

One time in Toronto

One time in Nouakchott

d. Contents;

Table 6.10.2 Content of Investment Seminars

	In London, Tokyo and Toronto	In Nouakchott
Objectives	Junior companies, banks, trading companies, mining companies and government organizations	African mining companies from South Africa, Morocco, etc, and domestic companies
Period	One or two days	One day
Contents	(1) Presentation <ul style="list-style-type: none"> • Mauritanian mineral resources and ore-deposit models • Current mining activities • Investment procedure (2) Individual consulting <ul style="list-style-type: none"> • Up to 10 companies • Government organization • Mining association 	(1) Presentation <ul style="list-style-type: none"> • Mauritanian mineral resources and ore-deposit models • Current successful examples • Investment procedure (2) Individual consulting <ul style="list-style-type: none"> • Instruction to domestic companies • Requesting support of domestic financial companies • Up to ten African companies
Cost items	Meeting costs, arrangement costs, traveling expenses (for Mauritanian attendants)	Meeting costs

e. Cost;

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

It is noted that the AMA seminar is held in March 1, 2006 and also the Mauritanian mineral resources seminar is held in March 7, 2007 during the PDAC International Convention.

6.10.3 Human Resource Cultivation

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

1) Purposes;

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

2) Current situation;

- The vocational-technical education center was built in 1982 by the Ministry of Education, which operates the center with government funding.
- The center has trained technicians in the fields of electrical engineering, mechanics, maintenance, construction and automobile engineering who have subsequently been sent to SNIM, government organizations and private companies as high level engineers.
- There are few engineers in the mining sector, so it is necessary to train engineers in this field to promote the growth of the mining industry.

3) Overview of mining sector training courses;

- a. Training Period: 2 years per course
- b. Names of courses: Mining geology, Mining, Mineral Dressing and Analyzing and Boring
- c. Estimated number of graduates: Total 50 engineers (10 engineers per course) in the first stage (2006 to 2010)
- d. Contents of each training course;

Table 6.10.3 Content of Curriculum in the Mining Faculty

	Mine Geology	Mining and Boring	Mineral Dressing and Analysis
Main subjects	<ul style="list-style-type: none"> •resource geology •exploration methods •exploration equipment •geological drawing and mapping •topography 	<ul style="list-style-type: none"> •mining and boring methods •mining plan and management •mining and boring machines systems •mine economy •topography 	<ul style="list-style-type: none"> •mineral dressing theory •basic analyzing theory •mineral dressing machines •production management
Training materials	<ul style="list-style-type: none"> •survey equipment •exploration equipment •computers 	<ul style="list-style-type: none"> •drilling machines •boring machines and related machines •survey equipment •computers 	<ul style="list-style-type: none"> • small mineral dressing facilities • analyzer (atomic absorption) •computers

- e. Instructors: Engineers from SNIM, OMRG and private companies (including foreign engineers in Mauritania), and foreign engineers dispatched from donor countries or international organizations.
- f. Initial cost: US\$ 1-2 million, excluding annual operating costs
- g. Projected date of commencement: Sometime during 2006

It is noted that main issues are procuring funding to obtain materials and facilities, instructors, budgeting operating expenses, etc.

(2) English-language Instruction System

1) Purposes;

- To facilitate the accumulation of mine-related information from English-language sources

- To facilitate communication with English-speaking investors

2) Current situation;

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

3) Overview;

- Instruction period: 2 years (2 one-year terms), but it may be prolonged according to its result.
- Instruction items: Basic English, technical English, English conversation, business English
- Target students: Employees of government mining organizations (OMRG, DMG, SIGM, etc)
Domestic mining companies: 15 students/year
- Content of instruction;

Table 6.10.4 Content of English Instruction

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

- Instructors: English-speaking Mauritians or foreigners residing in Mauritania who are experienced in teaching English and specialists in mining fields (geology, deposits, profiling techniques, dressing, resources), are appropriate as instructors.
For example, US Embassy economists are appropriate for business English.
- Cost: US \$25,000 per year (for operating)
- Starting date: within 2006

6.10.4 Construction of Infrastructure

(1) Development of Water Resources in Mineral Promising Areas

(Basic Development Plan for Promoting the Mining Industry)

1) Purposes;

- To clarify hydrogeology and locations of water resources in mineral potential areas.

- To develop water resources to promote mineral exploration and mine development, and to remove disincentives that can disrupt the water supply

2) Current state;

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

3) Overview;

- Period: 3-4 years
- Target areas: 4 areas with mineral potential (Tijirit, Akjoujt, Atar, Amsaga)
- Contents;

Table 6.10.5 Content of Water Resource Development Project

	1st year	2 nd year	3rd year
Hydrogeology	<ul style="list-style-type: none"> • Geological survey in 4 areas • Analysis of existing materials (geology, water resources) • Physical survey (preliminary) <ul style="list-style-type: none"> • Characterization of mineralized zones (extent of mineralization) • Analysis of water systems, geological data • Survey of nearby wells 	<ul style="list-style-type: none"> • Analysis of hydrogeology and structure • Surveys of nearby wells • Detailed survey of test drilling sites (physical probes, geological surveys) 	<ul style="list-style-type: none"> • Hydrological structure model <ul style="list-style-type: none"> • Quantification of water resources • Water quality analysis <ul style="list-style-type: none"> • Compilation of water resource data from the Internet • Map of mineral and water resources
Water resources	<ul style="list-style-type: none"> • GIS database (preparation to compile water resource maps) 	<ul style="list-style-type: none"> • Analysis of reservoir characteristics • Rough estimation of proven water resources • Water resource map 	<ul style="list-style-type: none"> • Comprehensive analysis of water resources
Development	<ul style="list-style-type: none"> • Selection of test drilling sites • Formulation of test drilling plan • Environmental survey 	<ul style="list-style-type: none"> • Test drilling (6 boreholes) at water potential sites • Analysis of drilling results • Environmental assessment 	<ul style="list-style-type: none"> • Test drilling (4 boreholes) at water potential sites • Analysis of drilling results • Development design (plan) • Water resources use system for mining • Operation and management

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

e. Schedule: Preparations in 2006; commencement in 2007

6.10.5 Environment Management

(1) Establishment of a Legal Framework including Appropriate Regulations

1) Purposes;

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

2) Current situation;

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

3) Overview;

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

- Category 1 (e.g., exploration activities with minor environmental impact such as small-scale geological surveys, geochemical exploration, geophysical exploration, etc.) → Report exploration activities to MMI
- Category 2 (e.g., boring in up to 20 locations, exploration area of up to 10ha, tunnel excavation of up to 50m, whichever is applicable) → Exploration plan and environmental protection plan are submitted to MMI for approval.
- Category 3 (e.g., exploration activities that exceed the above conditions) → An environmental assessment (EA) is submitted to MMI for approval. Note: While EA is not as detailed as an environmental impact assessment (EIA), it does estimate the potential for negative impacts on the natural, living, and social environments of target regions and contains measures for alleviating these impacts. The EA is publicly released, and affected parties can submit comments within 25 days. The EA is examined for up to 15 days after this period.

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

estimation methods, impact alleviation methods, monitoring methods, etc.)

- c. At the operation stage, precise regulations must be established for such things as environmental monitoring (measuring sites, measurement items, measuring frequency), annual mining environment reports (types of environmental activities at each mine), mine closure plan (measures required at time of mine closure, calculation of associated costs), and MMI environmental monitoring (compatibility with the mine inspectorate decree)
- d. At the mine closure stage, it is necessary to faithfully abide by the closure plan; however, there must be measures in place in case the closure plan cannot be executed, regulations must be made for MMI management of closed mines, and so on.

(2) Mining Environment Management Plan (Baseline Survey)

1) Purposes;

- To prepare natural background data that will allow objective judgments to be made of EIAs for new mine development
- To release information to private mining companies that are considering mining activities in promising areas
- To create baseline maps for promising areas to facilitate environmental management
- An environmental protection plan and concrete action plan are formulated with a long-term outlook in conjunction with mining sector promotion.

2) Current situation;

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

3) Overview;

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

a. Creation of baseline maps;

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

state) which are then used to create baseline maps.

b. Groundwater surveys and hydrological analyses;

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

c. Expansion of the database;

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

d. Guidelines for environmental considerations and technical development;

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

e. Formulation of a master plan for environmental protection;

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

6.10.6 Compilation and Disclosure of Information

(1) Expanding the Mineral Resources Database

1) Purpose;

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

2) Current status;

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

each other. Integrating the databases and hardware system would promote the organic use of these data.

3) Overview;

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

(2) Additional Procurement of ASTER Imagery Data

1) Purpose;

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

2) Current situation;

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

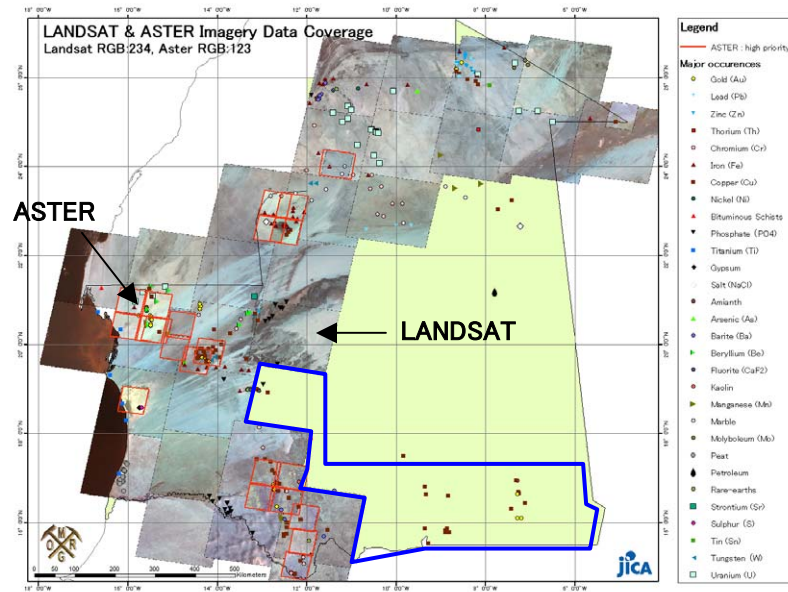


Fig. 6.10.1 ASTER and LANDSAT Data introduced by This Study and Main Mineral Potential Areas

3) Overview;

- a. Target areas: The areas covered by LANDSAT data in Fig.8.10.3 (one scene: 180km×180km) and the southern area surrounded by a blue line.
- b. Cost: US\$300,000 in total (including data cost of US\$50,000)
- c. Period: 5 years, starting in 2006.
- d. Technical transfer: processing data for images.

(3) Expansion of the website

1) Purposes;

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

2) Current situation;

- The website is being constructed by this study. The OMRG’s website has been officially opened to provide information about Mauritania’s mineral resources to users inside and outside the country.
- The JICA team is transferring technology for website-structure and its renovation to OMRG.

- The JICA team has discussed and exchanged opinions on the website content with OMRG and MMI.
 - The mineral resources database is being built.
 - The BGS website provides an introduction to MMI and PRISM, and is making partial information available to the public. MMI has received a new web address, installed a web server on site and established a web construction committee for developing its own web site to transmit information, but this project has been put on hold due to a restructuring of the ministry.
- 3) Content of expansion;
- a. Period: An organization for expansion of the website will be prepared in the first stage (5 years).
 - b. Expansion tasks:
 - To fix responsible persons as partial work of OMRG.
 - To reflect opinions of the investors who access “Contact us” from the site map.
 - To collect the latest information on relevant agencies, activities of foreign investors, revised laws, etc and disclose it in the website.
 - To disclose both the data stored in the database and the data which OMRG will obtain in future surveys.
 - To make a new website.
 - c. Expenses: OMRG will budget this as ordinary expenses for the website maintenance (US\$500/year), labor and translating French into English. In addition, it is estimated that a total of \$US150,000 will be needed to pay the expert, development and maintenance costs associated with integrating the MMI and OMRG web sites.

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

1) Purpose;

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

2) Current situation;

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

Table 6.10.6 Achievement State of 1:200,000 Geological Maps by PRISM

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

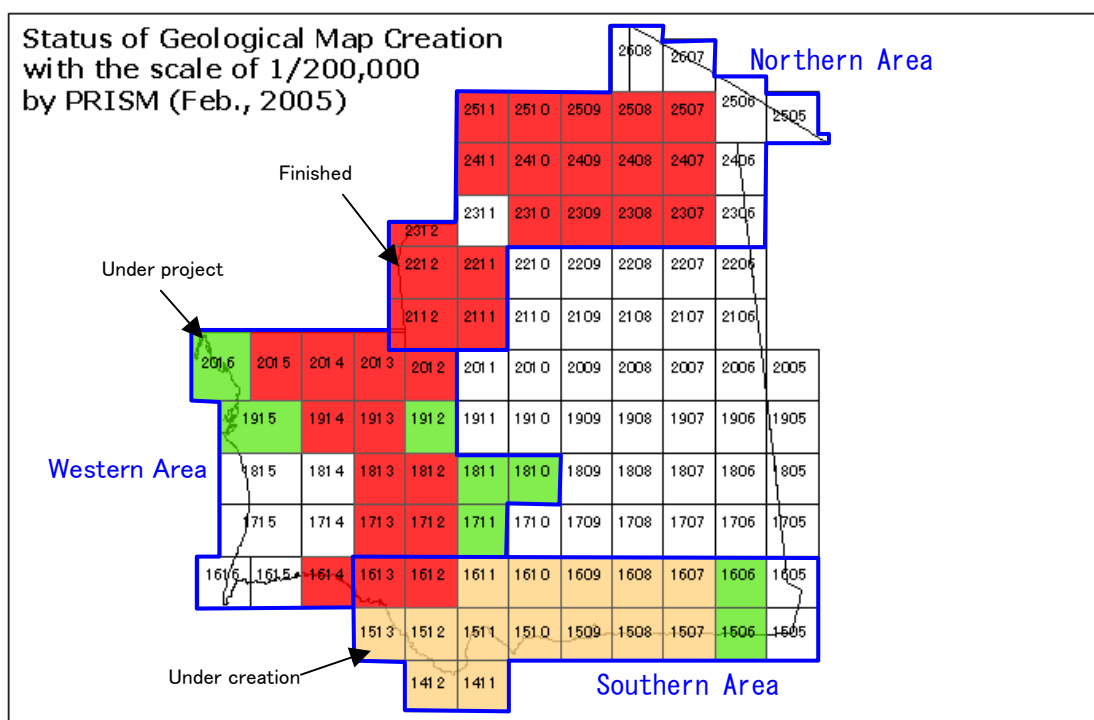


Fig.6.10.2 State of Achievement of 1:200,000 Geological Maps (as of 2005 Feb.)

3) Overview;

a. Creation order;

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

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

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

6.10.7 Organization of the Mining Sector

(1) Regular Roundtable Meetings between Government and Mining Companies

1) Purpose;

- Presently, there are 5 to 10 foreign companies engaged in exploration and development. To give them a chance to meet regularly and directly exchange opinions with Mauritanian government representatives (Technical Committee members), “Roundtable Meeting for Promoting the Mining Industry” are held periodically.
- Meetings are held between the government and the mining industry to discuss ways of improving the investment climate and to promote future exploration and development.

2) Present status;

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

3) Overview;

a. Responsible organization: MMI

b. Time and place of meetings:

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

c. Members:

Minister (Chairman), Technical Committee

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

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

d. Topics:

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

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

e. Secretariat:

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

records the meetings.

It is noted that the first Roundtable Meeting was held in November 17, 2005 in Nouakchott with participants from the World Bank, PRISM, etc.

6.10.8 Institutional Reform of OMRG

(1) Constructing the LAN System and linking with MMI

1) Purposes;

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

2) Current situation;

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

3) Overview of the LAN system

a. Period: 1st, 2006-07

b. Items:

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

- Provide instruction in IT techniques
- c. Targeted persons: All technicians and office workers
- d. Costs
- OMRG general budget
 - Support from donor countries and international organizations
 - Machines and equipment: US\$44,000
 - Maintenance: US\$3,600

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

Table 6.10.7 Overhead costs of the OMRG system

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

The machines and equipment are being applied for the World Bank's 2005 Poverty Reduction Project for Mauritania.

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

It is noted that building a LAN for OMRG/MMI will be completed by the antenna (see Fig. 6.10.3). The total cost is expected to be about US\$70,000 (\$30,000 for the internal system, \$20,000 for maintenance (5 years), and \$20,000 for training).

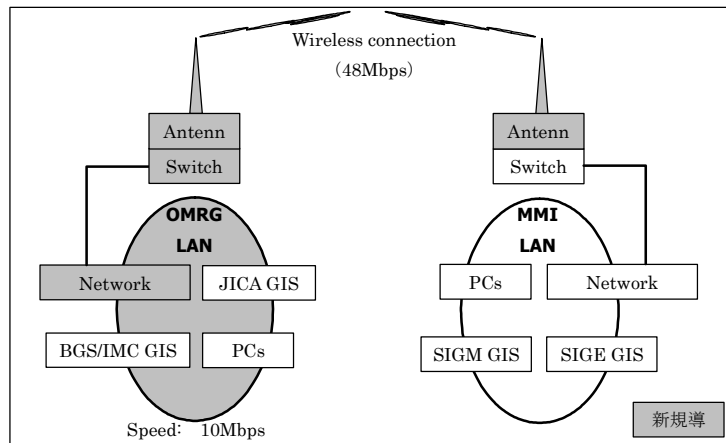


Fig. 6.10.3 Conception of the OMRG Network

(2) Preparing Survey Equipment

1) Purpose

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

2) Current status

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

3) Overview of development

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

b. Targeted equipment:

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

Table 6.10.8 Equipment needed by OMRG

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

c. Costs:

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

It is noted that the introduction of equipment for geo-physical exploration, which is one of issues, will require technical instruction from geo-physical experts. This will entail learning about all technical aspects, such as handling the equipment, acquiring data, and conducting analyses.

Chapter 7 Recommendations

7.1 Positioning and Role of Mining Industry

7.1.1 Mining Industrial Structure

The globalization of the world's mining structure is leading to the formation of an oligopoly of financially strong companies. Amidst a structure that is heading toward a single market, there is increasingly fierce competition to develop large-scale deposits.

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

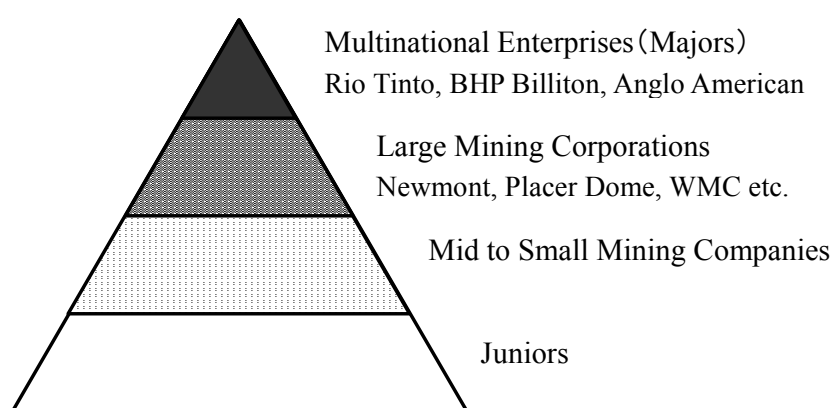


Fig.7.1.1 Structure of Mining Companies in the World

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

7.1.2 Role in National Development Plan

In the Poverty Reduction Strategic Paper (PRSP) prepared in 2000, mining was clearly identified as a future driver of economic growth.

Thus mining plays an important part in generating other economic activity in thinly populated areas which, in Mauritania, are the home of subsistence and nomadic farmers. It is also logical that mining should be included within the national strategy as communicated by the PRSP to help make the strategic development plan relevant and effective. In-addition, mining plays a large role for promoting economic activities in the areas with the large population of poor people. It is necessary to diversify the range of mineral types exploited by the host country, to increase

infrastructural development to foster the growth of new business sectors, etc.

Diversification of mineral development should be carried out in three stages. Currently, gypsum and phosphate are being excavated or are under development study. However, for industrial materials it is necessary to conduct resource potential surveys, select main targets, build a cooperation framework including OMRG and domestic mining companies and research marketing in neighboring countries. The development of Tasiast requires transportation, mechanical repairs and material sales. This is an opportunity to make downstream businesses and increase employment. Government and mining-related agencies should consult each other about the growth of domestic companies.

7.1.3 Strengthening the Ability to Formulate Mining Policy

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

Table 7.1.1 Policy Formulation Capability

Required capability	Tasks involved
Policy formulation	<ul style="list-style-type: none"> • Policy formulation for each stage • Procedure for approving and implementing policy
Establishing systems	<ul style="list-style-type: none"> • Establish a system to promote exploration and development • Procedure for approving and implementing system
Formulation of mid-to long-term plans	<ul style="list-style-type: none"> • Formulate 3–5-year and 10-year plans for promoting exploration and development • Review and revise plans after implementation
Evaluation of policy system	<ul style="list-style-type: none"> • Annual evaluation of implementation policy and system • Revision of system and policy after seeing evaluation results
Plan for implementing action program	<ul style="list-style-type: none"> • Establish plan for implementation based on survey action program • Evaluation after plan implementation, revision of plans

7.2 Development Promotion

7.2.1 Promotion Measures

Exploration and development strategies of other mining countries provide no suitable references because of the unique conditions in Mauritania. But, it is worthwhile to identify the promotion policies of other countries and incorporate them into Mauritanian development strategy. The following are some examples of exploration and development policies at the present stage.

- Establishment of Investment Promotion Center (Tanzania)
- Tax exemption when 80% of production is exported (Mali)
- Two-year mining zone tax exemption for small & medium-size companies (Mali)
- Reducing income tax for exploration investment (Canada)

- Possibility of negotiating income tax, customs tax, fixed rates for foreign exchange with regard to 20-year investment (Chile)
- Survey subsidies given to prospectors at the survey stage (Canada)
- Infrastructure subsidies (Australia)
- Exploration subsidies----subsidy of 30-50% of exploration expenses (Japan)
- Three-step domestic exploration system (Japan)
Extensive area survey (using government funding)---- detailed survey (company pays 1/3, remainder paid by national and local governments)---- company exploration (using company funding)
- Funding for overseas rare metal exploration---- low-interest, exemption of principal or protraction of paying (Japan)

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

7.2.2 Strategies of the Majors

As financing becomes more liberalized, majors like Rio Tinto, BHP Billiton and Anglo American are aiming for global expansion of activity areas by globalizing investment areas. The management strategy of majors is resource development (iron, coal, copper, aluminum, etc.) that can be done as a large-scale, mass-production operation, and they are avoiding ores that have small production scales or are highly vulnerable to market fluctuations. Rather than "vertical development", from upstream to downstream as it were, projects are being developed so that mineral concentrates can be produced from various types of ores. In addition, majors have easy access to markets for their products and they are targeting areas that do not involve a lot of transporting costs (Table 7.2.1).

Table 7.2.1 Strategies of Majors at Each Stage

Stage	Strategies
Exploration	<ul style="list-style-type: none"> ● Low-cost minerals with large-scale, long-term production life ● Nothing at grass routes level, possible in VP with juniors. ● Close to production areas (smelter, etc.), market, etc.
Development	<ul style="list-style-type: none"> ● Infrastructure is being developed. ● Operating mines are already nearby. There is potential in the surrounding area. ● Promising areas are acquired.
Investment	<ul style="list-style-type: none"> ● Small initial investment ● Maximum NPV can be calculated. ● Mines (companies) that can create synergy are acquired.

Under the present conditions of the above majors' strategies, it may be difficult for majors to come to Mauritania to excavate gold and other non-ferrous metals. As a first step, we need to assume advancements by juniors.

7.2.3 Joint Ventures with Juniors

The main business of “junior” companies in Canada, Australia, etc., is exploration and they support the mining industry in both countries. In Canada they are listed in the stock markets of Vancouver, Toronto and Montreal, and in Australia they are listed in stock markets like Perth and Sydney. In both countries, there are about 400-500 junior companies listed in stock exchanges, with many more that are not listed. While junior companies can be involved in everything from initial prospecting to detailed exploration and feasibility studies, there are many cases where they disclose their results at the initial prospecting stage and sell them to mining companies. The strategy of junior exploration companies is to handle the stage with the largest risk to increase the value of the project. Mauritania exploration activities are nearly all at the “grass root” stage, making them particularly attractive for junior exploration companies. The prepared information by PRISM and this study is considered to be aimed at attracting juniors. OMRG’s survey data should be accumulated, arranged, and translated into English for transmission to juniors. While still rare, some junior companies are conducting preliminary surveys in Mauritania. To promote greater involvement of juniors, both OMRG and the private sector must develop strengths that will enable them to become partners with juniors; geologists with fluent English skills are particularly needed.

7.2.4 Presentation of the Geological and Mineral Resources Data and Disclosure of Information

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

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

The website will also provide information about data and services available from other government organizations apart from the mining sector. Information services for the government organizations except mining sectors as well as disclosure of computerized information (various figures with scales) to investors should be advanced using the geological infrastructure.

7.2.5 Improvement of Infrastructure and Implementation of Construction Plans

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

Table 7.2.2 Infrastructure - Current Status and Tasks

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

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

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

Right now, there is no long-term plan to improve the infrastructure in Mauritania. The time from site exploration to mine development is measurable in years (for large deposits up to seven years) and it is essential to have a clear long-term plan for infrastructure readily available for investing exploration companies. This plan needs to show year by year how the infrastructure will be developed and needs to be updated each year to show the progress achieved.

The important tasks concerning infrastructure are as follows:

- To prepare, agree and publish the Infrastructure Development Plan.
- To prepare, agree and publish a plan for the development of water resources in areas of mineral potential. Priorities to be flexible according to need.
- To outline a construction plan for a port facility to ship concentrates. (To make a construction plan for a port facility to ship large amounts of concentrate.)
- To clarify the national responsibility for infrastructure construction costs in the

development areas, make and implement a national plan to support the infrastructure construction.

7.2.6 Introduction of Technologies and Facilities

There is a lack of technology and facilities in Mauritania and much time and money will be needed to bring these to international standards. A detailed action plan that stays in step with the advancing pace of exploration and development is needed for the introduction of these new technologies and facilities. The Mauritanian government should finance this and The World Bank, which has already focused on improvements to institutions and building a mining sector management system, should also be invited to help build a base for the introduction of these technologies.

Table 7.2.3 Technologies and Facilities Tasks for Nonferrous Metal Mining

Items	Current Situation	Tasks
Geological Infrastructure	<ul style="list-style-type: none"> ● Being upgraded by PRISM and JICA. ● Includes some technology transfer. ● Introduces basic hardware and software. 	<ul style="list-style-type: none"> ● To translate information into English. ● To train many more engineers. ● To improve hardware & software facilities
Survey	<ul style="list-style-type: none"> ● OMRG has a few technologies. ● There is some geochemical and geophysical survey capability. 	<ul style="list-style-type: none"> ● To train experts in the interpretation of mineral deposit geology & mineralogy. ● To develop geophysical engineers in exploration techniques. ● To train students in foreign countries. ● To introduce specialized tools and analyzing equipment.
Exploration	<ul style="list-style-type: none"> ● Depends on foreign companies. ● Exploration is confined to few minerals. ● No experience of total exploration. 	<ul style="list-style-type: none"> ● To introduce more foreign companies. ● To introduce technologies for collation of exploration data and ore reserve calculations. ● To find a way to introduce the technologies & facilities (geophysical exploration, drilling, mineral testing etc.)
Development, Environment, Mining, Processing	<ul style="list-style-type: none"> ● Lack of basic technologies and know-how. ● Use of old technology because of inexperience. ● Depends on foreign companies. 	<ul style="list-style-type: none"> ● Need to obtain technologies from foreign companies. ● Need to introduce new tools and facilities. ● Need to introduce new technology know-how
Resources Evaluation, Feasibility Study	<ul style="list-style-type: none"> ● Lack of basic technologies and know-how. ● Depends on foreign companies. ● No training in place 	<ul style="list-style-type: none"> ● Need to obtain the technologies from foreign companies. ● Need to train specialists in foreign countries. ● Need to introduce new technology know-how

7.2.7 Personnel Training

Training is also an important issue if the promotion of exploration and development is to be successful. Currently training in Mauritania is largely unstructured and is implemented as ‘On the Job Training’ (OJT). As a priority, the following categories of staff need training:

- Staff with detailed experience of the global mining industry.
- Experts on the basic geological units in Mauritania.

- Experts on the ore deposit types
- Geophysical engineers with practical exploration experience.
- Experts on the evaluation of mineral resources, the environment, information technology etc.
- Staff with international business skills

7.2.8 Continuing Surveys and Promoting Exploration after the Supplementary Geological Survey

It is extremely important for OMRG to use the present survey as a reference to conduct continuing surveys, add survey data to the database, and disclose the results on its website to appeal to the investors (Fig. 7.2.1).

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

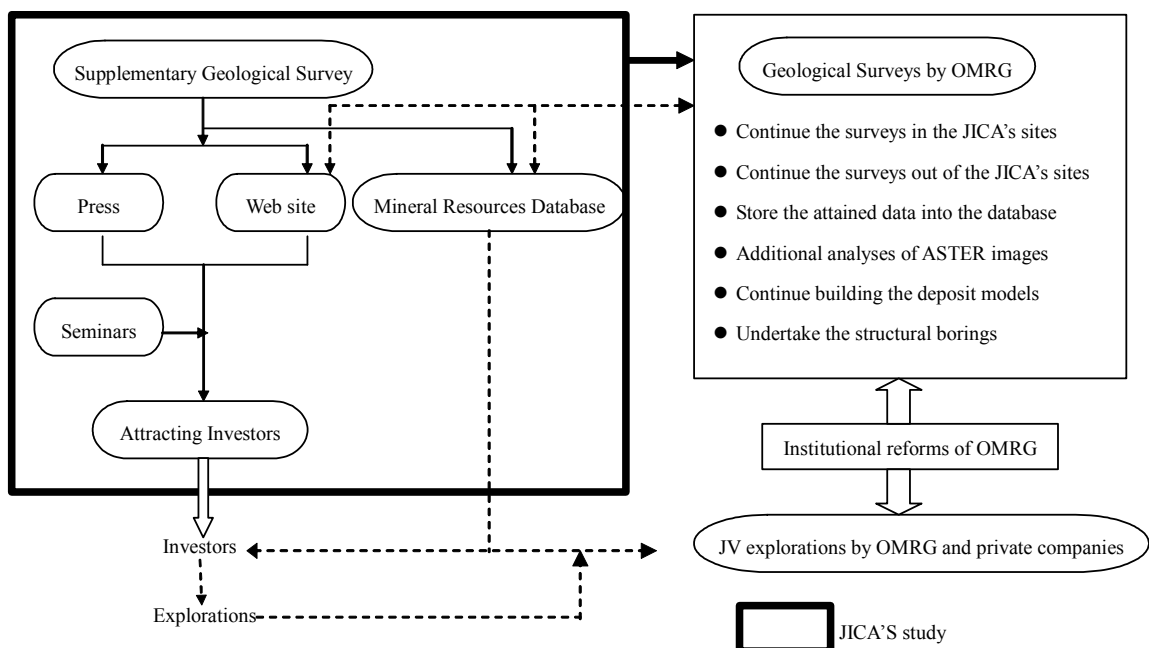


Fig. 7.2.1 Promotion of Exploration attained from Surveys Continued by OMRG

7.3 Conditions for Foreign Investment in Exploration and Development

7.3.1 Investment Conditions for Foreign Capital

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

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

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

Foreign investors are selecting target countries for exploration and development, so Mauritania must compete with many competitors, including neighboring countries, to attract foreign investment. To encourage exploration and development by foreign investment, the investment climate must be improved in order to prevent 1) to 6) above from becoming disincentives.

7.3.2 Characterization of Mining Investment by Japanese Companies

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

- Avoiding risk, or low risk (country risk, exploration risk, etc.)
- Investment in the form of providing raw materials (concentrates) to their own smelting facilities
- Mining company = smelting/processing company
- Vertical development of the mining industry due to their country’s status as a processor of raw materials
- Investment in development projects through alliances with large trading companies
- Targets are politically and economically stable countries

- Each company has technology for exploration, extraction, dressing, refining and processing.
- Exploration utilizing the Japanese government system

Secondly, it looks as though exploration utilizing such tools as JOGMEG joint-venture resources development base surveys will not occur if large Japanese business firms or mining companies do not make their final decisions which the purpose of their explorations in Mauritania is to import the concentrate or develop the mines. Japanese companies tend to develop a type of consortium for investment in the development stage between majors and Japanese trading companies or mining companies, as shown in Fig. 7.3.1

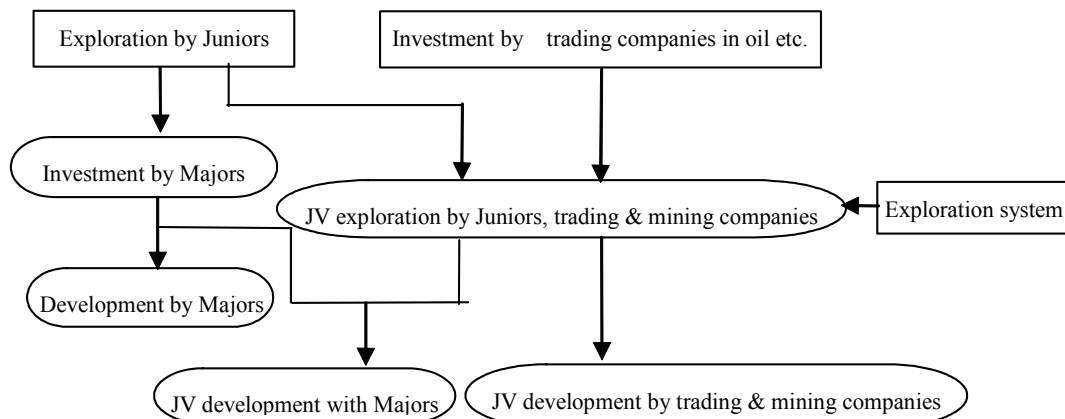


Fig. 7.3.1 Possible Pattern of Japanese Companies' Investment in Mauritania

7.4 Environmental Protection

7.4.1 Environmental Management

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

7.4.2 Environmental Management, Framework for Mining and Technologies (Areas for Exploration and Development)

Baseline survey will be implemented in the same manner in the Mauritanides metamorphosed zone during PRISM 2 project. As activity levels in exploration and development are

likely to increase in future it is very important that the metal content of rocks, soils, water and vegetation be measured and subsequently monitored prior to development. The purpose of this is:

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

Technologies for environmental management include surveying techniques, data measurement technology and analysis technology for evaluating data. The organization and a framework of environmental law applicable to the mining environment is now being established with the support of international organizations. Initially, activities will be focused on geological and mining exploration and drilling and its environmental impact will be great. However, once mine operations start the environmental issues will increase at both the development and operational stages. The mine developers must have the primary responsibility for the protection of the environment from mining pollution. The government must have a strict system to control violations and be capable of administering and policing the system which includes important sanctions for non-compliance. To achieve this, the government must introduce the technologies needed for environmental management.

7.4.3 Extensive Baseline Survey

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

As there is no natural background data in the development area, insufficient basic data might cause some delays in the management of the environmental protection for mining activities. The mining sector in Mauritania must quickly introduce baseline survey technology and plan to budget, plan and implement surveys systematically using the example provided by PRISM.

7.4.4 Strengthening Cooperation between Related Organizations

It is essential to reinforce cooperation and the exchange of information between related organizations, because mining activities can have an environmental impact and create water contamination and dust, affecting agriculture, fishing grounds and the health of local inhabitants. An environmental protection committee should be set up with participation of relevant ministries and

organizations (MDRE, MET, MHE, MPEM, MPH, CNRE and SNIM) as well as NGO. Also it should convene at regularly scheduled intervals. The DMG sends information related to the mining environment to the ministries and agencies, and receives some information about mining activities in return. Information exchange may be facilitated by the construction of an environmental web site, activated by the environmental database (SIGE). The main actions to strengthen the cooperation between government organizations on environmental matters related to mining activities are recommended as follows:

- Establishment of a cross-organizational environmental protection committee for mining.
- Establish a small executive unit to implement the committee policy
- Create an Intranet between the ministries and agencies to share the information.

7.5 Use of Database

7.5.1 Enhancing Development of Mineral Resources

To extend the scale of use of the GIS database, the following actions are needed.

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

Completing these tasks will enable the provision of precise information to investors and strengthen

OMRG's functional capacity (implementation of research and exploration). Also, they may result in the acquisition of additional knowledge about mineral resources and will facilitate the dissemination of exploration knowledge from Mauritania to a wider audience.

7.5.2 Potential Fields for Future Usage and Relevant Approach

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

Table 7.5.1 Potential Application Fields Based on a Mineral Resource Database

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

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

7.5.3 Maintenance and Expansion of Database

In order to maintain and grow the database it is essential to allocate an adequate annual budget to allow for the costs of personnel, consumables, software upgrades, PCs and peripherals renewal and other operational items. Following this project, a system of appropriate training or instruction conducted by experts will be needed to maintain, and innovatively grow the GIS database by monitoring technical trends in hardware and software development.

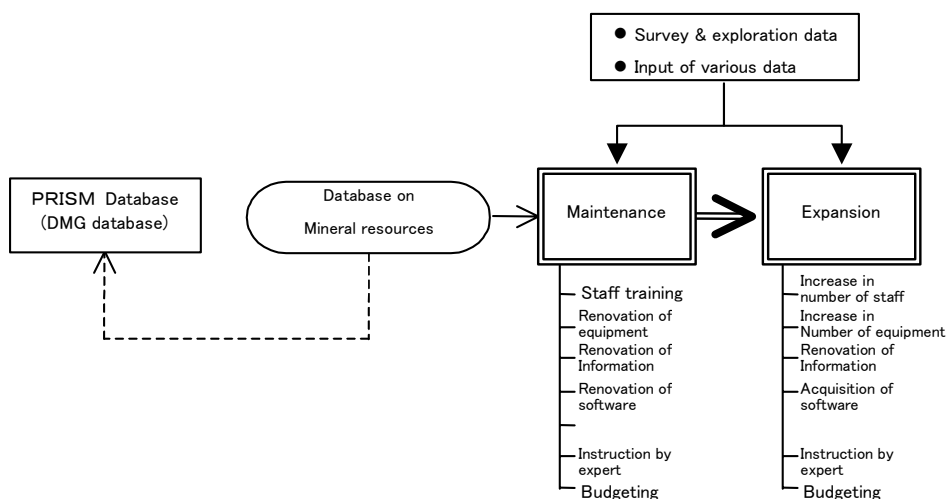


Fig. 7.5.1 General Features for Maintenance and Expansion of Database

7.6 Mineral Resources Promising Areas

7.6.1 Promising Areas

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

Table 7.6.1 Items for Selection of Promising Areas

Geologic province	Target	Point of selection of promising area
1. Reguibat shield	Au mineralization (veins, disseminated) (medium scale, Au amount of about 50 t)	<ul style="list-style-type: none"> • Fracture zone in BIF • Development of hydrothermal alteration
2. Mauritanides	Cu-Au mineralization (Carbonate replacement deposit, massive sulphide deposit) (small scale, Cu amount of about 500 thousand t)	<ul style="list-style-type: none"> • Carbonate rock in mafic schist • Around mafic volcanic rocks
1. Reguibat shield + 2. Mauritanides	Rare metal mineralization (Co, W)	<ul style="list-style-type: none"> • Hydrothermal alteration associated with 1 and 2 mineralization

7.6.2 Promising Deposits and Mineralization

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

The present conceptual thinking concerning potential deposits of gold, copper and rare metal in Mauritania is that:

- Potential gold deposits are vein types and are disseminated deposits related to hydrothermal alteration in BIF.
- Potential copper deposits are carbonate replacement deposits and volcanogenic massive sulfide deposits found in the Mauritanides.
- Potential deposits of rare metals are a concentration of rare metals which are transported by ore-fluid and which precipitate at the stage of gold or copper mineralization. Besides rare metals had originally contained in the Pre-Cambrian group.

7.6.3 Examination of Mineral Deposit Model

Mineral deposit modeling has an important role to play in encouraging exploration and influencing the selection of exploration methods and imaging the target depth for drilling programs. Therefore, improvements in the precision of mineral deposit modeling are necessary. Factors that will improve the precision include a better understanding of igneous activity, dating, metamorphism, geological structure, alteration, mineralization and ore forming circumstances. Regarding gold deposits in BIF, the model of the carbonate replacement copper-gold deposit and improving precision of models will be examined in the future on the basis of comprehensive logic as below. The ore deposits model were built by this study, but it is needed to improve precision of the models with more data attained by OMRG in the future.

- Gold deposit in the Algoma type BIF
Formation of the Algoma type BIF on the ocean floor between continental plates during the Archean era → Collision of continental blocks → BIF and the oceanic plate had penetrate the blocks as a suture zone → Metamorphism and cataclasis → Anatexis around the base of the continental block → Generation of new magma → Ascent of magma → Cooling → Partial solid → Emission of magmatic fluid containing gold and tungsten → Fluid rising along fractures → Flow into BIF → Gold mineralization (As dissemination, quartz vein and alteration formations)
- Carbonate replaced copper-gold deposit
The oceanic plate thrust over the West African shield → Formation of the Mauritanides → Flow of reduced deep groundwater into meta-ferruginous sandstone beneath the separated fault → Outflow of ferric solutions into the deep groundwater → Rising of the deep groundwater → Flow into carbonate rocks of the Mauritanides → Oxidation of the deep groundwater in the carbonate rock during mixture with subsurface groundwater where the oxygen dissolved originated in the atmosphere → Deposition of magnetite → Ascent of neutral magma → Cooling → Partial solid → Emission of magmatic fluid containing

copper and gold → Flow into carbonate rock → Copper and gold mineralization

Table 7.6.2 Examined Factors for Modeling Mineral Deposits in Mauritania

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

7.6.4 Examination of Metallogenic Provinces

At specific stages of the formation of deposits, and in specific metallogenic provinces, many similar types (genesis and kinds of ore) of ore deposits will form because of common geologic circumstances and mineralization and deposition conditions. To designate an area as a metallogenic province, an accumulation of surveyed data is necessary.

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

The supplementary geological survey has identified the two provinces:

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

Table 7.6.3 Factors to Examine in Metallogenic Provinces

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

7.6.5 Potential for Rare Metals in Mauritania and Associated Characteristics

Mauritania has potential for rare metals such as platinum-group metals, nickel, and titanium, and their existence has already been confirmed. Exploration, development, and the market for these metals are complex and are different from gold and base metals. In the present study, mineralization indicators for platinum group metals (PGMs) were confirmed in the Guidimaka ore body. However, it is not indicated quantitatively yet, so it is necessary to grasp expansion of mineralization and possible mineral concentration with preparation of geological maps. Currently, PGMs are being utilized in catalytic converters of vehicles with increase of the global environment awareness and their demand has is increasing. Their supply sources are not general, so it is meaningful to conduct the survey on potential PGM deposits which could link with discoveries of related ore deposits such as nickels, etc. Therefore, Mauritania needs to provide information to foreign investors by clarifying the potential for PMG existence with OMRG surveys, obtaining survey data, and listing these data on its website, so that foreign investors can be used to conduct exploration activities.

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

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

7.7 Mining Alliances with Neighboring Countries

7.7.1 Mining Technical Cooperation with Neighboring Countries

Mauritania's neighbors (Mali, Morocco, Burkina Faso, etc.) also possess resources and, like Mauritania, are promoting their development. These countries all have several issues in common, including nurturing human resources, introducing technology, and development. Both Mali and Mauritania are desert countries, so they face the same issues related to resource development in the desert. It is the same way with infrastructure development.

The following types of alliances are being considered:

- Joint resource surveys and geological surveys in national boundary areas
- Technical development center

- Jointly held training sessions, seminars, etc. (by invitation of foreign experts) to nurture human resources
- Joint geological mineral research (e.g., greenbelt, IOGC)

To stimulate collaboration, the first step that engineers or organizations like the DMG or OMRG in surrounding countries should take is to hold working-level meetings such as the Responsible Personnel Conference in Western Africa or the Mining Seminars in Western Africa to strengthen relationships with each other and exchange opinions.

7.7.2 Cooperation in Environmental Protection with Neighboring Countries

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

- To construct a system for linking the websites.
- To manage regional environmental protection using satellite images.
- To hold seminars for mining environmental management.

7.7.3 Ripple Effect of the Mining Industry

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

Businesses related to mine development and ore production will create employment and nurture local companies in the future. Transporting needs alliance with neighboring countries, and companies engaged in constructing and procuring materials are also expected to expand their business through alliances and cooperation with neighboring countries.

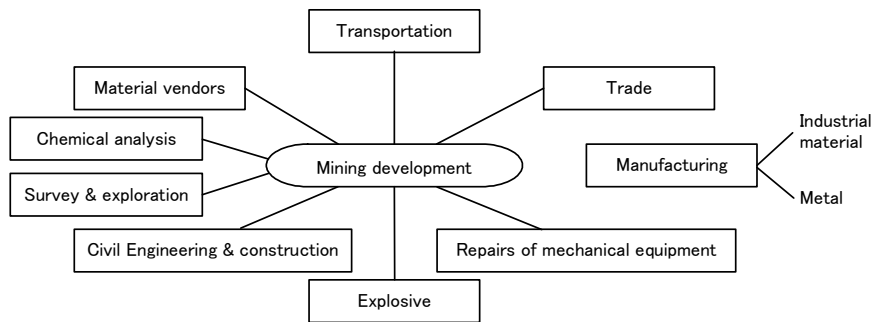


Fig.7.7.1 Ripple Effects in Mining Industry

7.8 Business Skills

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

Most potential investors are from the English-speaking world or can use English to communicate with. English is already used around the world for communications, and it is becoming commonplace for information to be collected and transmitted in English. Therefore, it is vital to collect information in English and access communication in English to “jump-start” the mining industry. An educational base should be built to improve English language skills and make English a semi-official language. The time to start making these preparations for the future is now.

7.8.2 Implementation of Promotion Measures

If the promotion measures in the strategic development plan can not be achieved, the current situation will not change. The promotion measures are still in the conceptual stage, so it is important to investigate each promotion measure, ways of materializing the content, effects, feasibility, existence of donor countries/organizations, etc., and formulate an implementation plan.

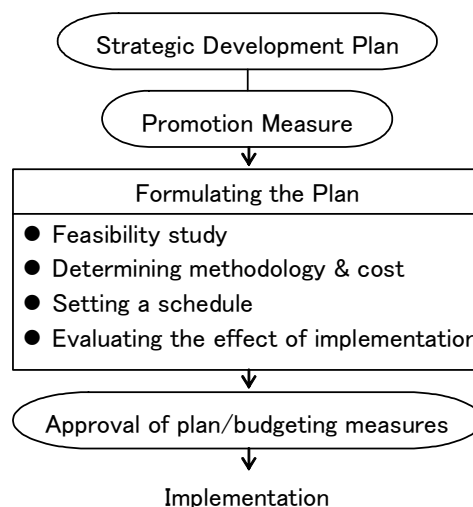


Fig. 7.8.1 Implementation of Promotion Measures

7.8.3 Importance of Planning, Implementing, and Checking

The strategic plan is actually composed of various programs that are promotion measures. It is necessary to establish a system that can allow for routine work to be done, such as formulating an execution plan for each promotion measure (the programs), and formulating and executing concrete plans for achieving goals while checking progress and making revisions. It is also necessary to be aware of the importance of planning, implementing and checking.

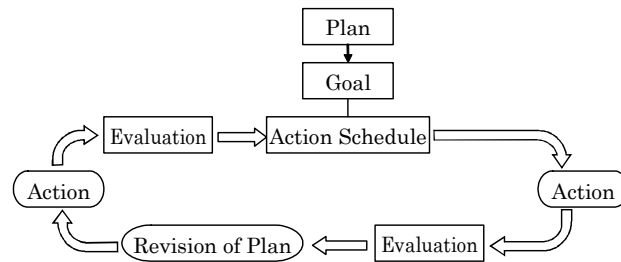


Fig.7.8.2 Implementing and Checking the Plan

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

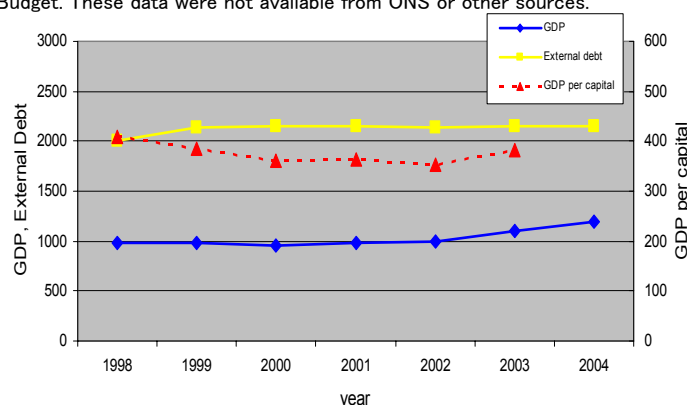
End of Report (Summary)

Appendix

Appendix 1 Macroeconomic Indicators in Mauritania 1998–2004

Indicator	Unit	1998	1999	2000	2001	2002	2003	2004
GDP	US\$ million	980	986	956	988	990	1,106	1191
GDP per capita	US\$	410	384	362	363	352	383	ND
External Debt	US\$ million	2,010	2,138	2,150	2,150	2,138	2,150	2,150
Economic Aid	US\$ million	ND	ND	220	262	ND	ND	ND
Trading Deficit	US\$ million	109	72	153	202	51	190	ND
N.B. *Revenue	MU million	41,060	50,845	56,651	55,436	101,130	77,094	ND
N.B. *Expenses	MU million	35,800	50,643	56,057	62,071	84,536	94,651	ND
Unemployment	%	23	21	28.9	ND	ND	ND	ND

ND: * N.B. is National Budget. These data were not available from ONS or other sources.

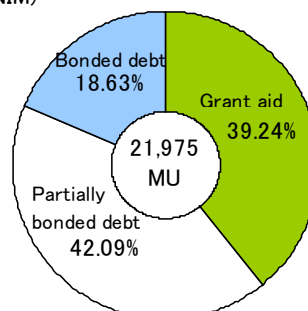
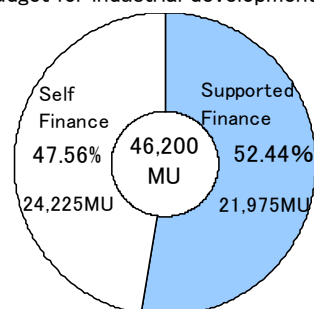


Mauritanian Main Economic Indices

Appendix 2 Composition of National Budget

Sector	Budget (Million MU)	Composition (%)		Budget Details (million MU)	
		2002	2003	Self Finance	Supported Finance
Agricultural Development	6,551.82	15.15	14.18	1,932.45	4,619.37
Industrial Development	4,367.74 (688.00)	9.14	9.45	1,667.75 (88.00)	2,699.99 (600.00)
Land Development	10,747.86	20.59	23.26	7,196.85	3,551.00
Manpower	13,383.58	30.85	28.97	5,503.58	7,880.00
Institutional Reform	2,191.00	4.07	4.74	1,316.00	875.00
Multi-sector projects	6,358.00	13.84	13.76	4,358.00	2,000.00
SNIM	2,600.00	6.36	5.63	0	2,600.00
Total	46,200.00	100.00	100.00	21,974.64	24,225.36

NB) (): Investment budget for industrial development (excluding SNIM)

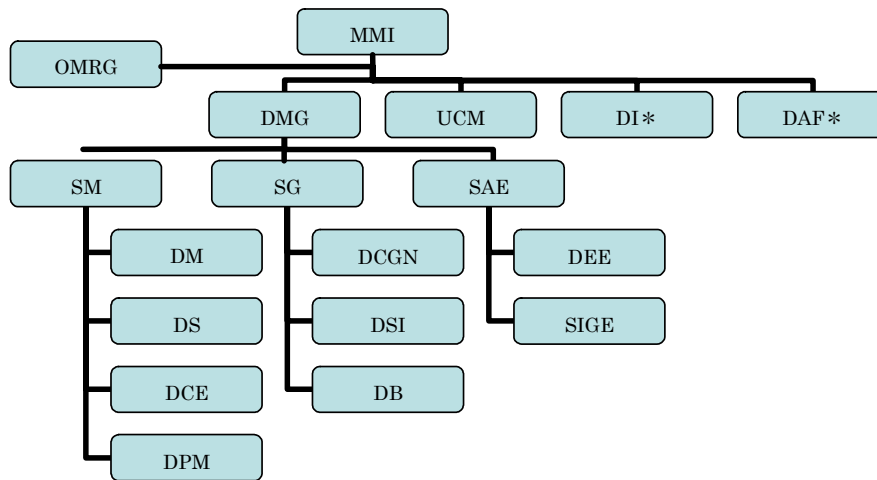


A. Comparison of Self/Supported Finance B. Details of Supported Finance
Location and Details of Foreign Support in Investment Enhancing Budget

Appendix 3 Measures for Reducing Poverty

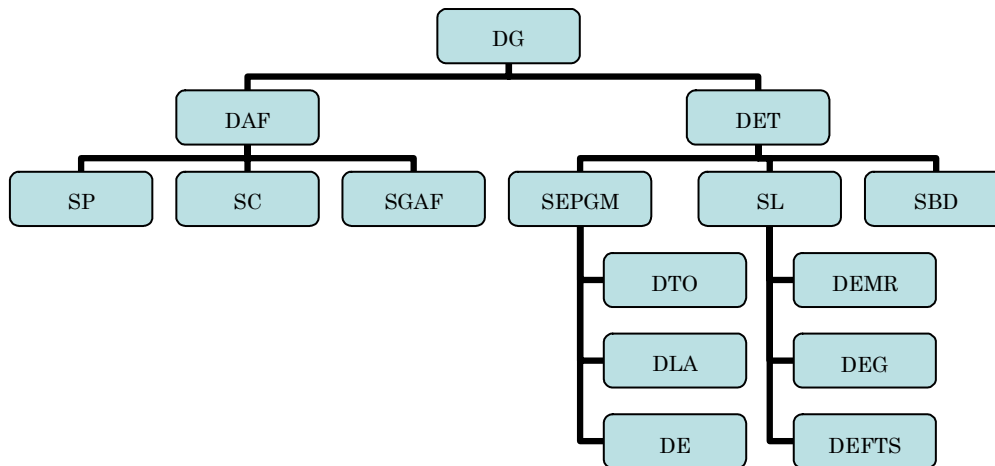
Objectives	Actions
Accelerated Growth	<ul style="list-style-type: none"> ▪ Stabilize macroeconomic framework ▪ Legal and judicial reforms in business promotion ▪ Promotion of mining activities ▪ Strengthening of fishing sector ▪ Arrangement of basic infrastructure <ul style="list-style-type: none"> ◊ Maintenance, construction and expansion of roads ◊ Electricity and gas supply ◊ Water supply system
Growth in Economic Environment of the Poor	<ul style="list-style-type: none"> ▪ Rural development <ul style="list-style-type: none"> ◊ Improvement in agricultural production ◊ Implementation of environmental protection ◊ Establishment of monitoring arrangements ◊ Development of manufacturing products from livestock ▪ Urban development
Strengthening of Governance and Institutions	<ul style="list-style-type: none"> ▪ Support NGOs participation in decision-making process ▪ Implementation of budget programs ▪ Improvement of government accounting office management ▪ Introduce information systems into management process ▪ Update of PRSP

Appendix4 Organization of MMI



(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

Appendix 5 Organization Chart of OMRG



(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

Appendix

Appendix 6 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
License Area Limit	1,500km ² , perimeter of deposits	100 hectares	1,000 hectares	350 hectares
License Transfer	Yes	Yes	Yes	Yes
Ore Reserve Management			Govm' t 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

Appendix 7 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.

Appendix 8 Royalty for Mineral Groups

Item	Peru	Chile	Indonesia	Philippines	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, pyrophyllite, onyx, chalcedony, opal. Group 6: Ruby, sapphire, emerald, beryl, topaz and other precious stones. Group 7: Diamond

Appendix 9 Tasks for Mining Management Capacity-Building and Current Status

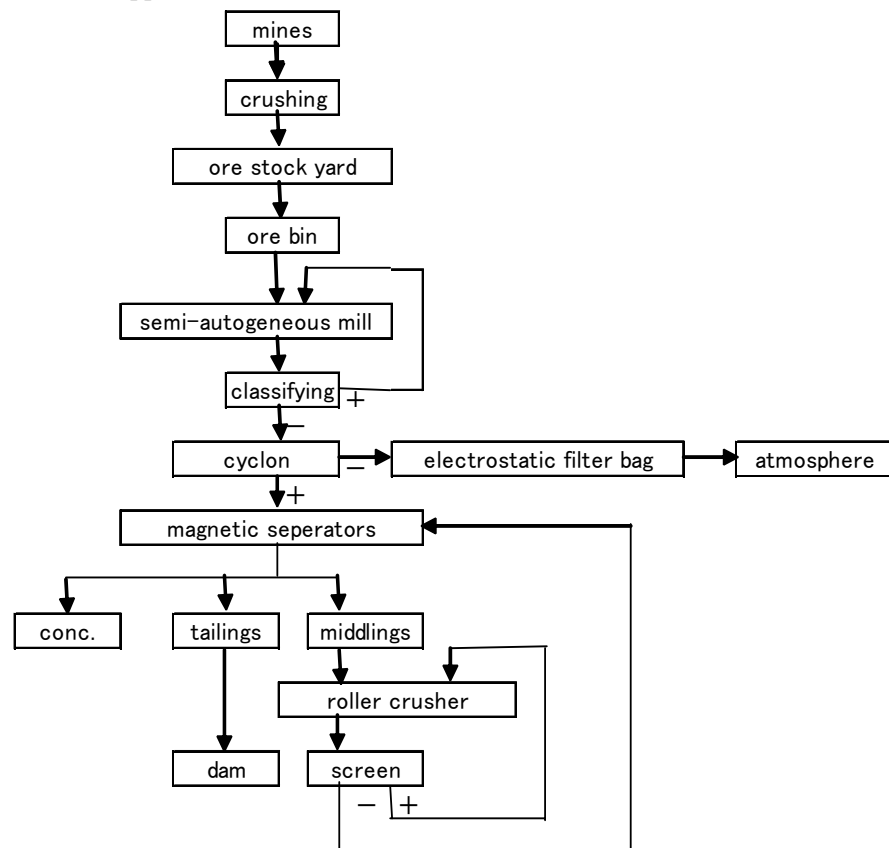
Item	Task	Status
Organization with competent authority	To make draft policies, laws and regulations	Implemented by PRISM 1, will strengthen the capacity in the future
	To establish a monitoring system for mining promotion	Task in PRISM 2
	To clarify the responsibility to companies	Clarifying
	To simplify the administrative procedures	Simplified by PRISM 1
Administrative mining organization as a central core	To clarify mining administration	Insufficient
	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
Cooperation between internal and external organizations	To provide information on geology, ore deposit and laws	Implemented by PRISM 1
	To manage and protect the environment	Implemented in PRISM
	To coordinate information between Ministries	Insufficient
Organization functions	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
	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
Relationship with private companies	To establish an environmental approval system	Will start functioning in the future
	To add and produce basic geological information	Future task
	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
Fund raising for the mining organization	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
	To raise funds through tax revenues and concession fees for mining activities	Future task
Fund raising for the mining organization	To allocate funds appropriately	Future task
	To provide funds indirectly (staff training, monitoring education, and monitoring tools)	Insufficient

Appendix

Appendix 10 Currently Existing Websites on Mauritania

Representative websites	Contents	Links	Update
Overseas <ul style="list-style-type: none"> The World Factbook, CIA USGS, Mineral Information The World Bank, Mauritania 	<ul style="list-style-type: none"> Reliable and rich in information Mainly in English 	<ul style="list-style-type: none"> Few links to relevant Mauritania sites 	Frequently
UN related <ul style="list-style-type: none"> United Nations mission in Mauritania Partners for development of Mauritania 	<ul style="list-style-type: none"> A lot of relevant project information Mainly in French 	<ul style="list-style-type: none"> Several sites with many links 	Frequently
Mauritania government related <ul style="list-style-type: none"> Premier Ministere Government Official Web site Office of National Statistics MMI, PRISM Authority of Regulations 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Links to government sites Few links to private sector sites (MMI site is reasonable) 	There are some rarely updated
Private sector <ul style="list-style-type: none"> Top Technology MAURITEL SNIM CIMENT DE MAURITANIE 	<ul style="list-style-type: none"> Several sites presenting company, activity, and product information Mainly in French and Arabic, partially also in English regarding mining companies 	<ul style="list-style-type: none"> No links at most sites 	Appropriately updated
Search engines and others <ul style="list-style-type: none"> University of Nouakchott Inforim-Mauritania Online Maghreb Union Search Engine 	<ul style="list-style-type: none"> Some websites with much information (university and linked site) Mainly in French and Arabic, in English at University website 	<ul style="list-style-type: none"> A lot of links at Inforim as a portal site 	Appropriately updated

Appendix 11 Flow Sheet of El Rhein Plant



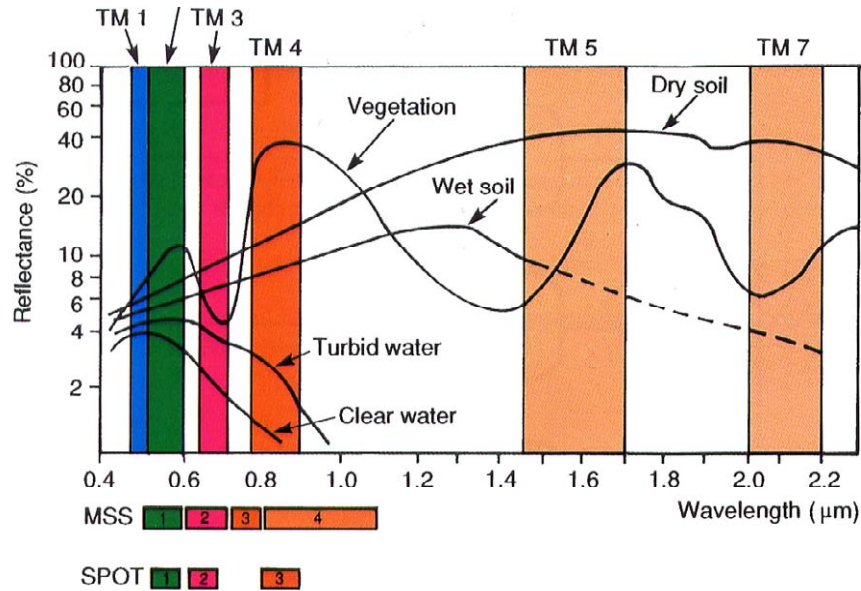
Appendix

Appendix 12 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	llat 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

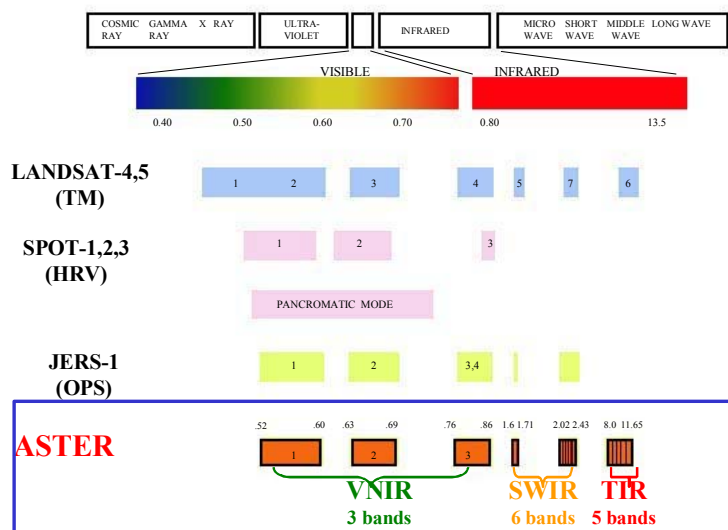
Appendix

Appendix 13 Spectral Signatures for the LANDSAT Thematic Mapper (TM), LANDSAT MSS and SPOT sensors (source: Lawrence *et al.*, 1994).



Appendix 14 Spectral Resolution of ASTER versus other Satellites (source: ERSDAC)

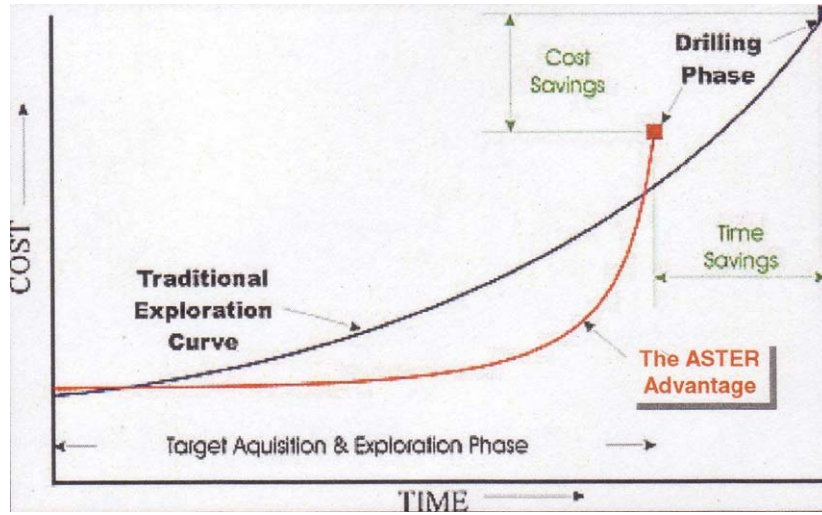
Spectrum Composition of Optical Sensors



Appendix

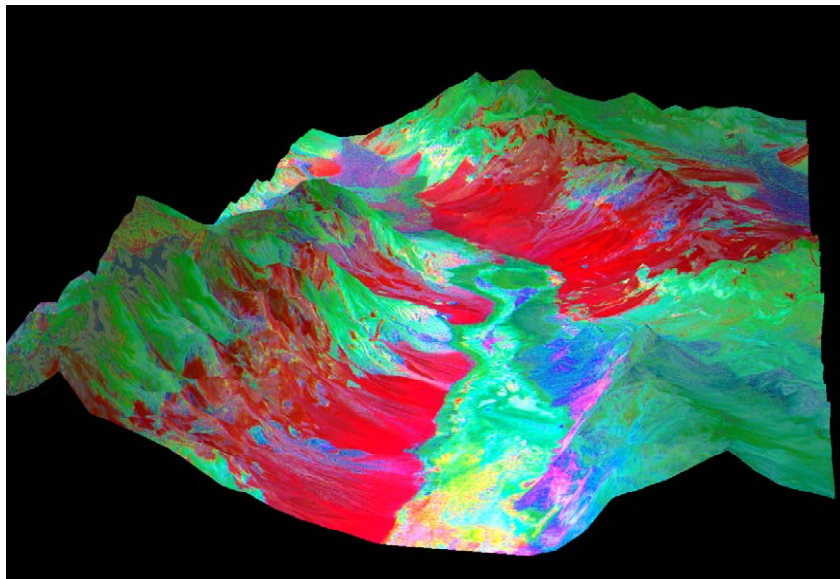
Appendix 15 Savings in Exploration Time and Money: the ASTER advantage

(Source: T. Coudahy, CSIRO, Australia)



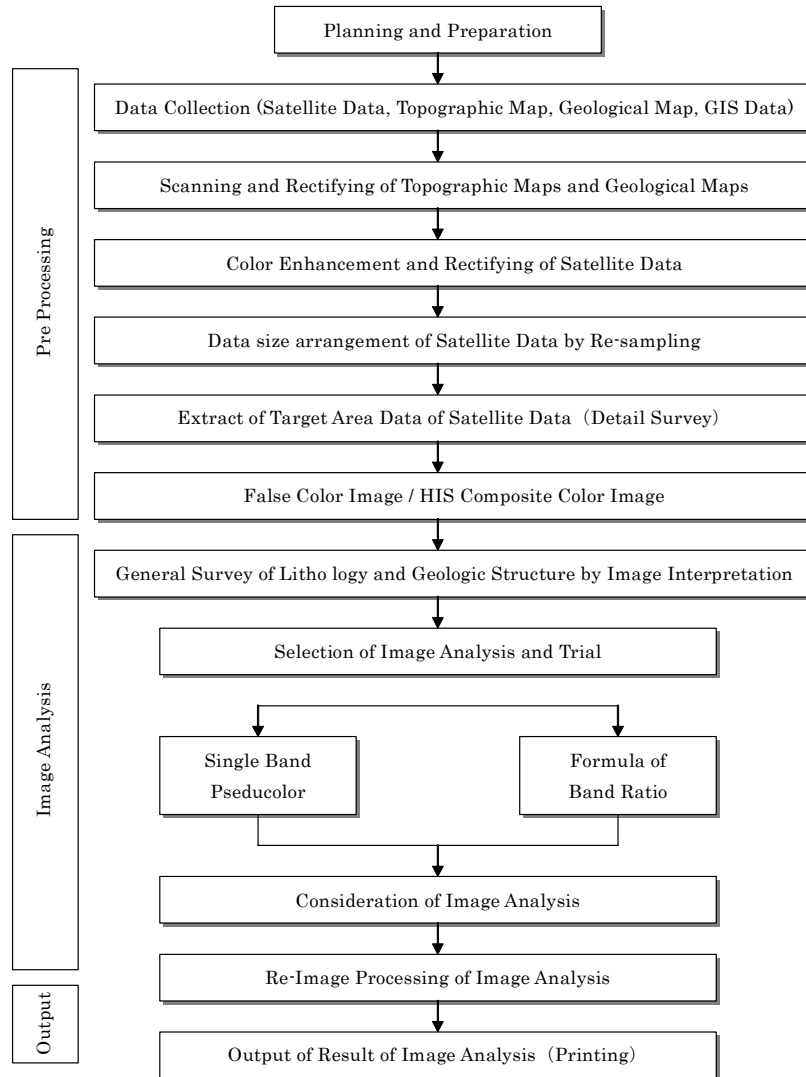
(source: T. Coudahy, CSIRO, Australia)

Appendix 16 Death Valley: ASTER DEM overlain with an ASTER-derived mineral map.



Red = Quartzite Green = Carbonate Yellow-Pink = Evaporites (source, USGS)

Appendix 17 Flowchart of Image Analysis



Appendix

Appendix 18 Image Processing Technique of ASTER

Mineral Commodity	Spectral Absorption (μm)	ASTER	
		Band	Image processing
Ironic oxide	0.4~0.6 0.8~1.0	Band1	RGB: 321 false color image (green) Ratio:(Band1/Band2 or Band1/Band3)
		Band2	
Calcite		Band8	RGB: 865 false color image (greenish-blue) Ratio:(Band6+Band9)/Band8
Kaorinite Montmorilonite		Band6	RGB: 865 false color image (reddish-violet)
Alunite		Band5	RGB: 865 false color image (yellow) (Band5+Band7)/Band6
Silicate	8~12		(Band11 \times Band11)/(Band10 \times Band12)
Carbonate		Band14	Band13/Band14
SiO ₂			Band13/Band12
Vegetation		Band2	Band3/Band2

Image Processing Technique of LANDSAT

Mineral Commodity	Spectral Absorption (μm)	LANDSAT	
		Band	Method of image analysis
Ironic oxide	0.4~0.6 0.8~1.0	Band1	RGB: 321 false color image (green) Ratio:(Band1/Band2 or Band1/Band3)
		Band2	
Vegetation			Band4/Band3