NGU Rapport 95.077

Fact-finding Mission to Ethiopia and Eritrea

NORGES GEOLOGISKE UNDERSØKELSE

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RAPPORT

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Sammendrag:

Rapporten gir en kortfattet oversikt over geologien i Etiopia og Eritrea, samt en oversikt over de viktigste mineralske ressurser. Videre beskriver rapporten de Geologiske Undersøkelser i begge land, samt deres ansvarsområder og tjenestetilbud. Det gis en statusoversikt over geologisk kartlegging og prospektering i Etiopia og Eritrea, samt en oversikt over hvilke offentlige institusjoner som har ansvar for og arbeider med oppgaver relatert til grunnvann. De viktigste oppbyggingsbehovene for de Geologiske Undersøkelser i Etiopia og Eritrea blir diskutert. Rapporten omtaler også fremtidige muligheter for samarbeid mellom disse institusjonene og NGU. Noen mineralutviklingsprosjekter med interessant utviklingspotensiale på kort sikt er beskrevet. Til slutt gir rapporten en kortfattet oversikt over bakgrunnen for oppdraget, NORADs "Terms of Reference", samt en opplisting av avholdte møter i Etiopia og Eritrea.

Emneord: NORAD	utviklingsbistand	mineralressurser
mineralproduksjon	databaser	grunnvann
geologi	organisasjonsstruktur	oppbyggingsbehov

CONTENTS:

1.0 INTRODUCTION.

1.1 Ethiopia

The economic development strategy that Ethiopia is to follow, over the next two decades, aims at effecting a transformation of the structure of the economy such that output from the industrial and service sector will grow relative to that of agriculture.

The central aspect of the strategy is an "Agricultural Development Led Industrialization (ADLI)", and is to be attained mainly through the improvement of productivity of smallholder agriculture and industrial development based on indigenous raw materials and labour intensive technology. An integral aspect of the strategy is the expansion of exports to feed growth.

In this strategy the potential role of minerals in the expansion of export trade is recognized and mineral production is to be encouraged. Mining has also the potential for contributing to the objectives and agricultural and industrial development through the provision of primary and intermediate inputs.

Ethiopia has a wide range of useful minerals (Fig.1) of grades and extent comparable to deposits that are under exploitation in other countries. The potential for increased gold production is especially good.

Due to the under-development of the country's economy, mineral use and indigenous production remained limited. Mining could not develop based on mineral exports due to its isolation from the world market for capital, technology and mineral commodities especially during the most favourable periods of the 1970s and 1980s.

In the context of economic reform measures that are being undertaken by the Transitional Government of Ethiopia, conditions are being created that are favourable for mineral resource development with the active participation of both indigenous and foreign private investors.

While the policy and legislative climate has thus improved, a number of factors constrain the development of mining from reaching its full potential for contributing to the expansion and diversification of economic output. Some of the major constraints are:

* inadequacy of available information on the country's mineral resources

* insufficiency of the government institutions and their resources for carrying out exploration and development support tasks that are pre-requisites for mineral development

* small size of indigenous mineral end-user industries

With this background the Ethiopian Government has approached NORAD for technical assistance and support in institutional capacity strengthening of Ethiopian Institute of Geological Surveys. During a meeting held on 19.04.94 between the Norwegian Minister for Development Ms. Kari Nordheim and Minister Abdulmejid from the Ministry of External Economic Cooperation it was agreed that NGU should carry out a fact finding mission. The objective of the mission is to provide a background for the possible future cooperation between Norway and Ethiopia in the field of geology, with special reference to mineral resource management. The Terms of Reference for this mission is enclosed in annex 1.

1.2 Eritrea.

After a long period of war and drought which has left Eritrea impoverished the country can at last look forward to an era of peace and stability which will provide an urgently needed opportunity to rebuild the economy. Eritrea's economic base has been devastated to such an extend that all available resources are at present committed to survival and reconstruction of basic infrastructure such as water supplies, roads and housing. However, an early start needs to be made on establishing industries that will provide the hard currency needed to sustain further development.

Besides playing a major role in the provision of the needed infrastructures, the development of mineral industry is one of the industries that show greatest promise for early returns in Eritrea.

Eritrea has a wide range of mineral deposits (Fig.2) but due to the extremely low level of geological mapping and mineral exploration over the past 50 years only sparse and mostly out-dated information is available about these mineral deposits. There is an urgent need to develop Eritrea's embryonic mineral industry (salt, cement, glass, pottery, bricks, dimension stone, etc.). The country's logistical position is superb, a very long coastline right on the major Red Sea trading routes and surrounded by very populous countries are positive factors for Eritrea's future development. There are also potential deposits of oil/gas and possibilities for geothermal energy development in the coastal plains and the off-shore.

In this context the establishment of a well organized and equipped modern Geological Survey with a primary aim to map, investigate and present an inventory of the country's mineral resources are pre-requisites. Such a geological organization would play a central role in the evaluation and development of the country's natural resources.

With this background the Eritrean Government has approached NORAD for technical assistance and support in institutional capacity strengthening of Eritrean Geological Survey (Department of Mines) and Department of Water Resources. During a meeting held in the second half of April 1994, the Norwegian Minister for Development and Eritrean Authorities it was agreed that a NGU delegation should carry out a fact finding mission. The objective of the mission is to provide a background for the possible future cooperation between Norway and Eritrea in the field of geology, with special reference to mineral resource management. The Terms of Reference for this mission is enclosed in annex 1.

2.0 SUMMARY OF ETHIOPIAN AND ERITREAN GEOLOGY

The basement upon which all the younger formations were deposited contains the oldest rocks in both countries, the Precambrian, with ages of over 600 million years. They are exposed in areas where the younger cover rocks have been eroded away, namely in parts of Hararge, Sidamo, Bale, Illubabor, Gojam, Welega, Begemdir and Tigre provinces in Ethiopia and parts of Eritrea.

The Precambrian contains a wide variety of sedimentary, volcanic and intrusive rocks which have been metamorphosed to varying degrees. The basement in the south and west of Ethiopia, where granitic rocks and gneisses predominate, has been more strongly metamorphosed than the Precambrian sequences in the north. Though in many cases strongly folded and foliated, the rocks in the north (including Eritrea), which include the youngest formations yet known in the Precambrian, have generally undergone only weak metamorphism, reflecting the relatively low temperature and pressure to which they have been subjected since their deposition.

GENERALISED GEOLOGICAL AND MINERAL OCCURRENCES MAP OF ETHIOPIA

Fig. 1

METALLIC MINERALS

KNOWN RESERVES

①	BIKILAL IRON ORE	57,800,000 Ton
②	LEGE-DEMBI PRIMARY Au	30 - 40 Ton
③	YUBDO Pt	12·5 Ton
④	SERKOLE ALLUVIAL Au	0·1 - 0·7 Ton
⑤	DEGERO ALLUVIAL Au	0·07 Ton
⑥	ADOLA Ni	17,000,000 Ton
⑦	KENTICHA RARE METALS	25,000 Ton

UNDER STUDY

⑧	MELKA ARBA IRON ORE	
⑨	TIGRAY PRIMARY Au	
⑩	TIGRAY ALLUVIAL Au	
⑪	TSEHAFI-EMBA Cu	
A ②	DUL	PRIMARY Au, BASE METALS
⑬	ABETSELO	BASE METALS
⑭	ODA-GODARE	BASE & PRECIOUS METALS
⑮	ADOLA	PRIMARY Au
⑯	ABEBA R.	PRIMARY Au & RARE M.
B ⑰	MOYALE	PRIMARY Au
C	MEGADO SERDO	
D	DAWA DIGATI	

NON-METALLIC MINERALS

KNOWN RESERVES

㉑	BWAMBWA-WEHA KAOLIN	500,000 T.
㉒	KENTICHA FELDSPAR	300,000 T.
㉓	ABIYATA SODA ASH	400,000,000 T.
㉔	LAKES REGION DIATOMITE	40,000,000 T.
㉕	MUGER SILICA SAND	3,400,000 T
㉖	DALETI MARBLE	50,000,000 T.
㉗	MUGER LIMESTONE	100,000,000 T.
㉘	DIRE DAWA LIMESTONE	46,000,000 T.
㉙	HULA-KUNI DOLOMITE	1,434,000 T

UNDER STUDY

㉚	DANAKIL SALT
㉛	GEWANE-MILLE BENTONITE
㉜	BIKILAL PHOSPHATE
㉝	HAKIM-GARA MARBLE
㉞	CHEMBI KYANITE, TALC & GRAPHITE
㉟	SHINLE LIMESTONE & MARBLE
㊱	MEGA OLIVINE
㊲	KOMBOLCHA KAOLIN (HARAR)
㊳	MEKELE LIMESTONE

ENERGY MINERALS

㊶	CALUB GAS	35 BILLION METRIC T.
㊷	LANGANO (ALUTO) GEOTHERMAL	30 M. WATT
㊸	YEBA DELBI MOYA LIGNITE & COAL	
㊹	OIL SHALE	
㊺	TENDAHO GEOTHERMAL	
㊻	KORBETI GEOTHERMAL	
㊼	NORTHERN LAKE ABAYA GEOTHERMAL	
㊽	MUSH (DEBRE BIRHAN) LIGNITE	
㊾	WUCHALE LIGNITE	
㊿	CHILGA LIGNITE	
(51)	NEJO LIGNITE	

GEOLOGY

- Q — Quaternary Cover (Undifferentiated)
- QTsV — Quaternary - Tertiary Rift Sediments & Volcanics
- Ts — Tertiary Sediments
- Tv — Tertiary Highland Volcanics
- Ms — Mesozoic Sediments
- Ps — Paleozoic Sediments
- Pr m — Proterozoic Metamorphic Rocks
- Ar — Archaean

ERITREA

DJIBOUTI

SOMALIA

SUDAN

KENYA

UGANDA

0 20 40 60 80 100 km

Drawn by Kebede Tafesse

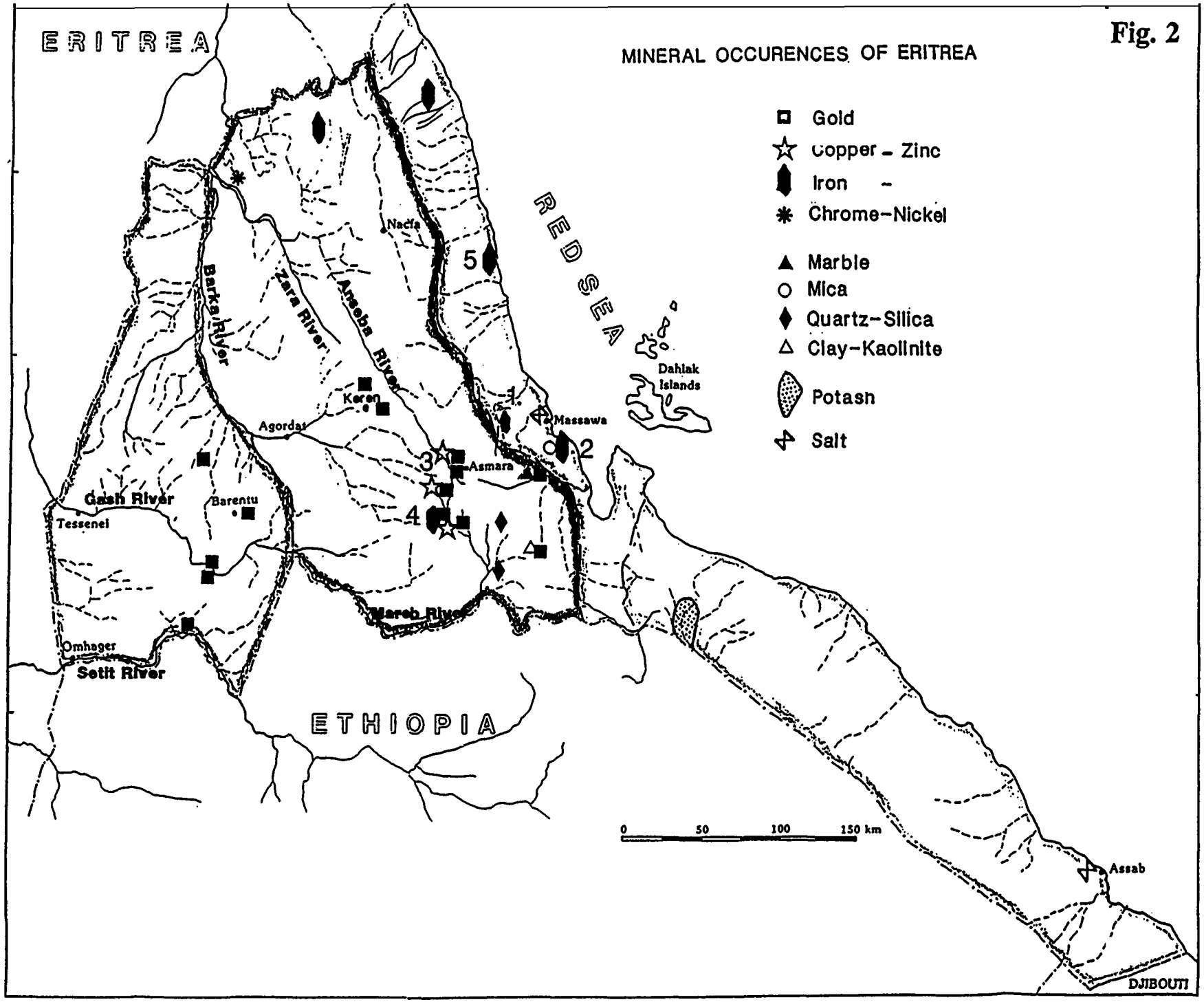

ERITREA
MINERAL OCCURENCES OF ERITREA
Gold
Copper – Zinc
Iron –
Chrome–Nickel
Marble
Mica
Quartz–Silica
Clay–Kaolinite
Potash
Salt
RED SEA
Dahlak Islands
Nacfa
Barka River
Zara River
Ameba River
Keren
Agordat
Massawa
Asmara
Gash River
Barentu
Tessenei
Mareb River
Omhager
Setit River
ETHIOPIA
0 50 100 150 km
Assab
DJIBOUTI
1
2
3
4
5

Fig. 2

The Precambrian or Basement rocks contain most of the present known metallic mineralizations of Ethiopia and Eritrea. In particular, the gold deposits of Eritrea and the northern, western and southern provinces of Ethiopia all occur in these rocks, where they are associated with fracturing, quartz reefs or sulphides. Under favourable conditions these deposits have given rise to major placer deposits along river beds, as in the Kibre Mengist-Adola area. Copper, zinc and lead sulphides have been found in the weakly metamorphosed volcanic facies (greenschists) of the Precambrian basement rocks. These greenstone belts are at present the primary targets for gold prospecting in Ethiopia. Similarly occurrences of potentially exploitable talc and nickel mineralizations are associated with ultrabasic bodies, and it is in the layered types of such bodies that platinum mineralization occurs at Yubdo in Welega Province of Ethiopia. There are considerable possibilities of finding other potential economically exploitable mineralizations of these minerals in the Precambrian, while abundant occurrences of pegmatites, major intrusions and dykes hold good potential for other minerals, for example feldspar, quartz, beryllium, molybdenum, tungsten, rare earths, niobium, tantalum, barite and many others.
Precambrian rocks contain at several places noteworthy graphite mineralizations, while intensive weathering of granitoid rocks lead to the formation of interesting kaolin deposits. Iron and iron-manganese deposits are reported from the Precambrium, especially from the northern territories (Eritrea). Dimension stone occurrences (marbles, granites, gneisses, etc.) partly renowned of their quality on the world market occur in the western and eastern parts of Ethiopia.

Most of the Precambrian rocks have been subjected to several orogenic episodes since their formation. This process, combined with the rifting associated with the development of the Red Sea and the East African-Ethiopian Rift Valley, has resulted in considerable fracturing and shattering. Major water resources are associated with these fracture zones.

At the end of Precambrian times uplift occurred, which was followed by a long period of erosion. Any sediments which were deposited during the Palaeozoic interval, which lasted some 375 million years, have been largely removed by erosion, except for shales and deposits partly of glacial origin laid down in the northern part of the region towards the end of Palaeozoic times.

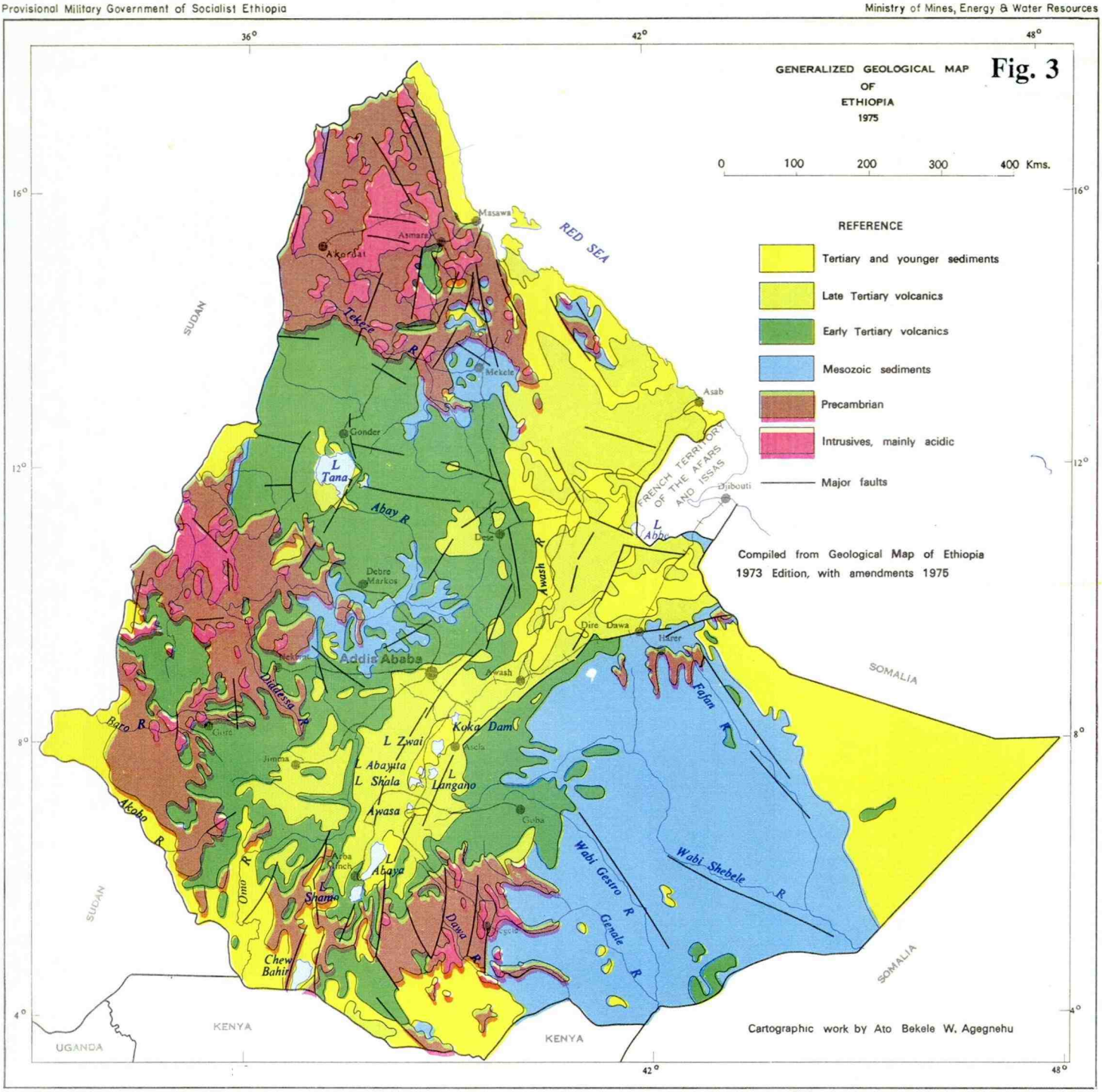
The main orogenic stages in the Precambrian are related to several major tangential movements which correspond to similar orogenic stages of other East African countries. Epeirogenic movements after the Precambrian rejuvenated these fault systems from Early Mesozoic through Recent times, and Mesozoic and Cainozoic sedimentary basins (with different lithologies) developed accordingly.

Subsidence occurred in the Mesozoic, which began some 225 million years ago, and a shallow sea spread initially over the Ogaden and then extended farther north and west as the land continued to subside. Sand, now sandstone, was deposited on the old land surface. Deposition of mudstone and limestone followed as the depth of the water increased. The subdivision of the Mesozoic sequence and younger sediments (indicated on the geological map, Fig.3) into approximate age categories is largely based on palaeontological evidence.

In the western part of the region sedimentation ended with the deposition of clay, silt, sand and conglomerate brought in from the land as the sea receded due to uplift of the landmass. In the southeast gypsum and anhydrite were precipitated on inter-tidal flats. In the Ogaden there was a new invasion of the sea in Late Mesozoic times during which the sequence of sedimentation was repeated, ending again with the precipitation of gypsum and anhydrite. The same cycle of sedimentation was repeated yet again in the Ogaden during the Tertiary period. It ended with the deposition of conglomerates, sandstones and mudstones with some interbedded marls, and finally erosion as the area was uplifted.

Provisional Military Government of Socialist Ethiopia

Ministry of Mines, Energy & Water Resources



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Geological Survey of Ethiopia

Mesozoic rocks are considered to have the greatest potential for hydrocarbon deposits. The presence of such deposits is dependent on the original existence of organic materials, mostly of marine origin, in sediments which were buried to form the so-called source beds. In these beds, which may now be represented by shales or stromatoloidal reef limestones, the organic matter was altered by pressure of the overlying sediments and a build-up of heat, into oil and gas which migrated into nearby permeable (reservoir) rocks. The Mesozoic of southern Ethiopia contains few favourable structures for oil, being only weakly folded, but nevertheless there remains a reasonable possibility for the occurrences of stratigraphic traps. Outcrops of the Mesozoic in the north and west are considered as less favourable due to the possible terrestrial nature of the rocks in the north, and the probable thinness of the rocks in the west. As only little geological information is available from these areas more investigations have to be carried out before conclusions can be drawn. In the Eritrean Red Sea there have been a number of investigations of the hydrocarbon prospects and an upgrading of this activity is a prime priority of the Eritrean Ministry of Energy, Mines and Water (MoEMW). Pre-war surveys and shallow drilling established indications of hydrocarbons on the Eritrean Red Sea area. However, deep wells were not drilled until about the 1960's and 1970's when Mobil, Gulf and Shell carried out exploration drilling. A total of 8 wells has so far been drilled. The Mobil C-1 well is considered as a gas discovery even though the exact quantity was not established due to the blow-out. A hiatus of 20 years occurred before new exploration agreements were signed with BP/IFC (1989) and Amoco/IPC (1988). BP carried out geophysical, gravity/magnetic surveys and geological studies but did not drill, and relinquished its acreage in 1992. Amoco invoked the Force Majeure provision in their contract with the MME in Ethiopia, after they had run 374 line km. seismic and some limited geological surveys.

A number of regional studies (BEICIP), World Bank Regional Red Sea Project, BP Interpretative Report (1990), have established that there is potential for commercial hydrocarbon discoveries in the Eritrean Red Sea. Immediately to the north, in an identical geological setting, substantial amount of gas has been discovered in Sudan (Suakin).

Metallic minerals have not been discovered to date in the Mesozoic rocks but the occurrences of limestones and saline deposits as shown on the geological map, point out the need to prospect these formations further for lead, zinc and silver mineralizations which might be associated with reported barite occurrences in fracture fillings. On the other hand rocks of the Mesozoic sequence represent major reserves of glass grade quartz sands, limestones, dolomite, gypsum and other industrial minerals. Clay from several levels in the Mesozoic stratigraphy are locally used for pottery and cement production.

Extensive fracturing occurred in the Cainozoic, the earliest rocks of which are dated at 65 million years, although major displacement along the fault systems which approximate to the alignment of the Red Sea, Gulf of Aden and East African rift systems did not occur until later in the Tertiary. Faulting was accompanied by widespread volcanic activity and the two processes, which are partly related, have largely determined the form of the landscape in the western half of Ethiopia and in the Afar Depression. The outpouring of vast quantities of basaltic lava over the western half of the country was accompanied by, and alternated with, the eruption of large amounts of volcanic ash and coarser fragmental material, forming the Trap Series. Several shield volcanoes, also consisting of alkali basalts and fragmental material, then developed around the eastern edge of the Lake Tana depression and southwest of Goba. More recent vulcanism is associated with the development of the Rift Valley, activity being concentrated within this structure and along the edge of the adjoining plateaux.

Volcanism has persisted into the present time in the Afar region within small eruptive centres. The composition of the lavas produced ranges from basalt to siliceous types. Basalts and basaltic scoria

represent an excellent and abundant source for a wide variety of construction materials. While the siliceous types represent a good source for light weight construction materials and weathering of siliceous tuffs are a primary source for the formation of bentonite clays. Alkaline plugs of Late Tertiary age in the northern region have a economic potential for rare earth elements and niobium-tantalum mineralizations.

The youngest sediments are of Quaternary age. These include conglomerates, sand, clay and reef limestones which accumulated in the Afar Depression and the northern end of the main Rift Valley. Sediments which accumulated in former lakes occur in the south end of the Afar, in the main Rift Valley, and in the Omo valley. Extensive diatomite deposits are reported from the main Rift Valley. Undifferentiated Quaternary sediments and superficial deposits occur intermittently along the Sudanese and Kenyan borders.

Hydrocarbons may be present in some of the Tertiary sequences, but in general the rocks of Cainozoic age in Ethiopia and Eritrea are of potential economic importance because of their extremely large salt deposits. These include not only the common rock salt traditionally worked in the Afar, but also deposits of potassium and magnesium salts and possibly sepiolite. Furthermore the geothermic activity associated with many of the Cainozoic deposits has given rise to metallic mineral occurrences, copper and manganese in particular, concentrated as a result of leaching of the rocks by saline solutions. Iron-rich (possibly also aluminium-rich) laterites developed on the volcanics as a result of intensive weathering and may prove to be possibly of economic interest.

The underground water resources of the Cainozoic are of great importance. The often lenticular nature of the beds necessitates detailed investigations, but generally, subject to suitable recharge areas, the aquifers can be considered as highly favourable for water exploitation.

The great geothermal potential in Ethiopia is related to the major faults of the Rift Valley system, and active projects are underway in SE-Ethiopia.

3.0 0VERVIEW OF THE NATIONAL GEOLOGICAL SURVEY UNITS

3.1 Ethiopian Institute of Geological Surveys (EIGS)

The Ethiopian Geological Survey was formally established in 1967. It was, however, restructured in 1982 as the Ethiopian Institute of Geological Surveys (EIGS). It is an autonomous government organization and is accountable to the Ministry of Mines and Energy (MoME).

A. responsibilities

The responsibilities of EIGS are as follows:

- undertake geological mapping, prepare and publish the results
- carry out geophysical surveys
- prospect, explore and delineate mineral deposits
- explore for hydrocarbons and promote petroleum activities
- carry out geothermal exploration
- carry out hydrogeological exploration and quantify groundwater resources
- investigate natural hazards
- collect and store earth science information and make this information available

Two proclamations, Nos. 229 and 230 of 1982, established the Ethiopian Mineral Resources Development Corporation (EMRDC) and EIGS as the two mining sector public institutions under MoME with responsibilities in mineral resources development (EMRDC), and in geological mapping and exploration of mineral resources inclusive of solid minerals, petroleum, geothermal and groundwater resources (EIGS).

In the draft report (March 1994) "Improvement of the Resource: Population: Sustainibility Balance" the economic development strategy that Ethiopia is to follow over the next two decades is outlined. Mineral Resources Development is one of the five Components under Sub-Programme 2B on the utilization of Natural Resources for Balanced Development. In Annex III, component area: Mineral Development it is stated that EIGS is planned to continue as the sole geological survey agency under the supervision of the MoME with tasks to be fulfilled by the central headquarters in:

* Execution of special geological surveys and mineral exploration projects.
* Provision of specialist consulting, analytical, other technical back-up services and supervision to branch offices.

* Provision of technical assistance to other economic sectors, agencies, and the industry.
* Maintenance of national geological and mineral data bases, laboratories, research and development facilities, museum, etc.

B. **organization**

The position of EIGS in the Ministry of Mines and Energy is seen from the flow chart (FIG 4). EIGS as a whole (FIG 5) is administered by a General Manager (position vacant), and the active work programmes are supervised by the Chief Geologist (Ketema Tadesse). In the interim until a General Manager is appointed the Chief Geologist is also acting as General Manager.

EIGS is further organized into 5 major departments (with department heads):

* regional mapping (Amenti Abraham)
* mineral exploration (Aklilu Assafa)
* geophysics (Berhanu Bekele)
* hydrogeology, engineering geology & geothermal (Getahun Kebede)
* hydrocarbon (Abiy Hunegua)

These scientific divisions are backed by 5 technical units which provide support services:

* central geological laboratory (Zelalem Adam)
* data processing, documentation and publication central service (Metasebia Demessie)
* drilling (Toshome Aberra)
* cartography and surveying service (Bekele Mulate)
* scientific equipment and maintenance service (Gadissa Giorgis)

C. **financing**

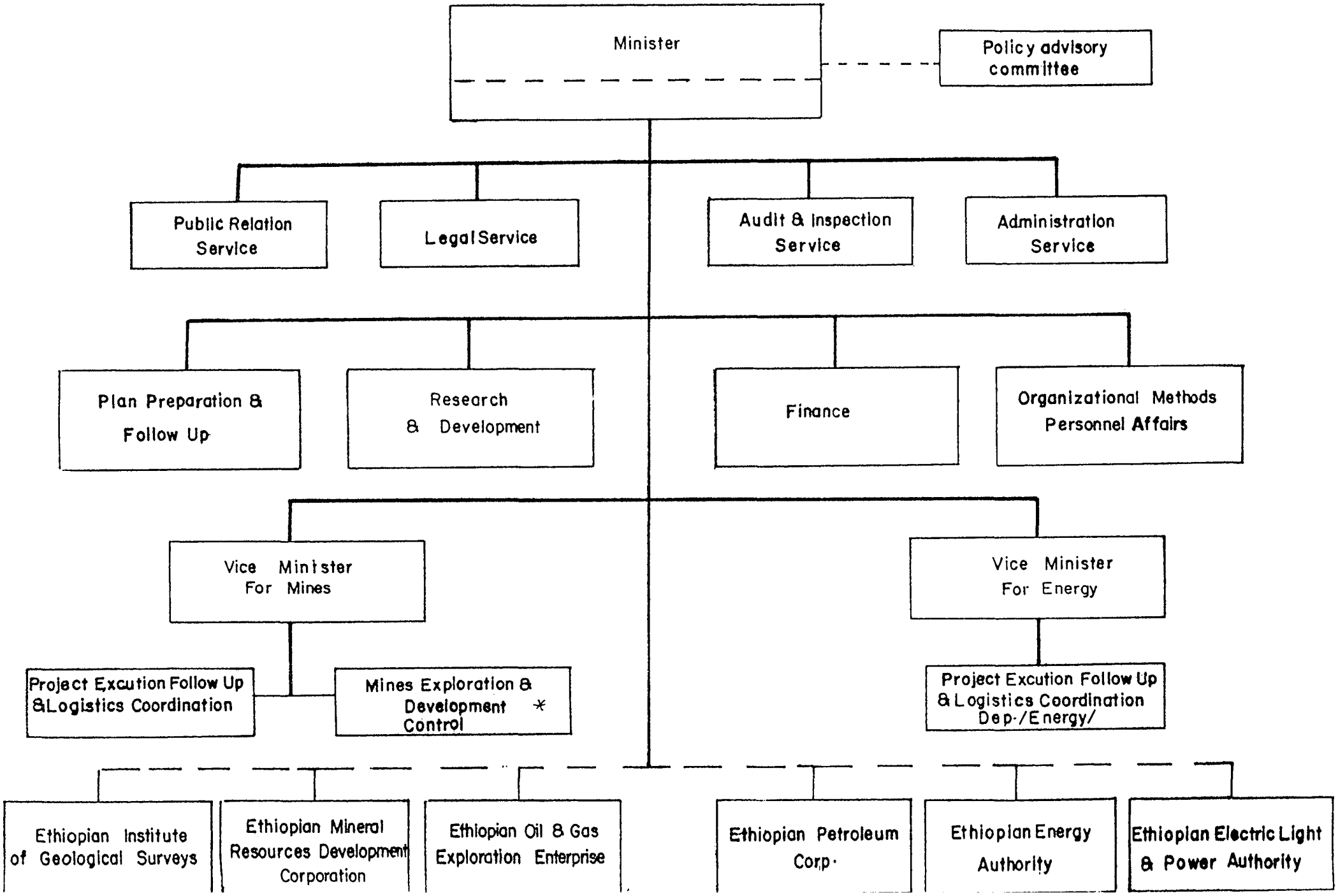
The EIGS receives direct financing from MoME:

- 4 million Birr recurrent funding (salaries, building maintenance, water, electricity, etc.)
- 56 million Birr annual non-recurrent funding (programme and project activities)

In addition EIGS has received funding from:

MINISTRY OF MINES AND ENERGY

Fig. 4

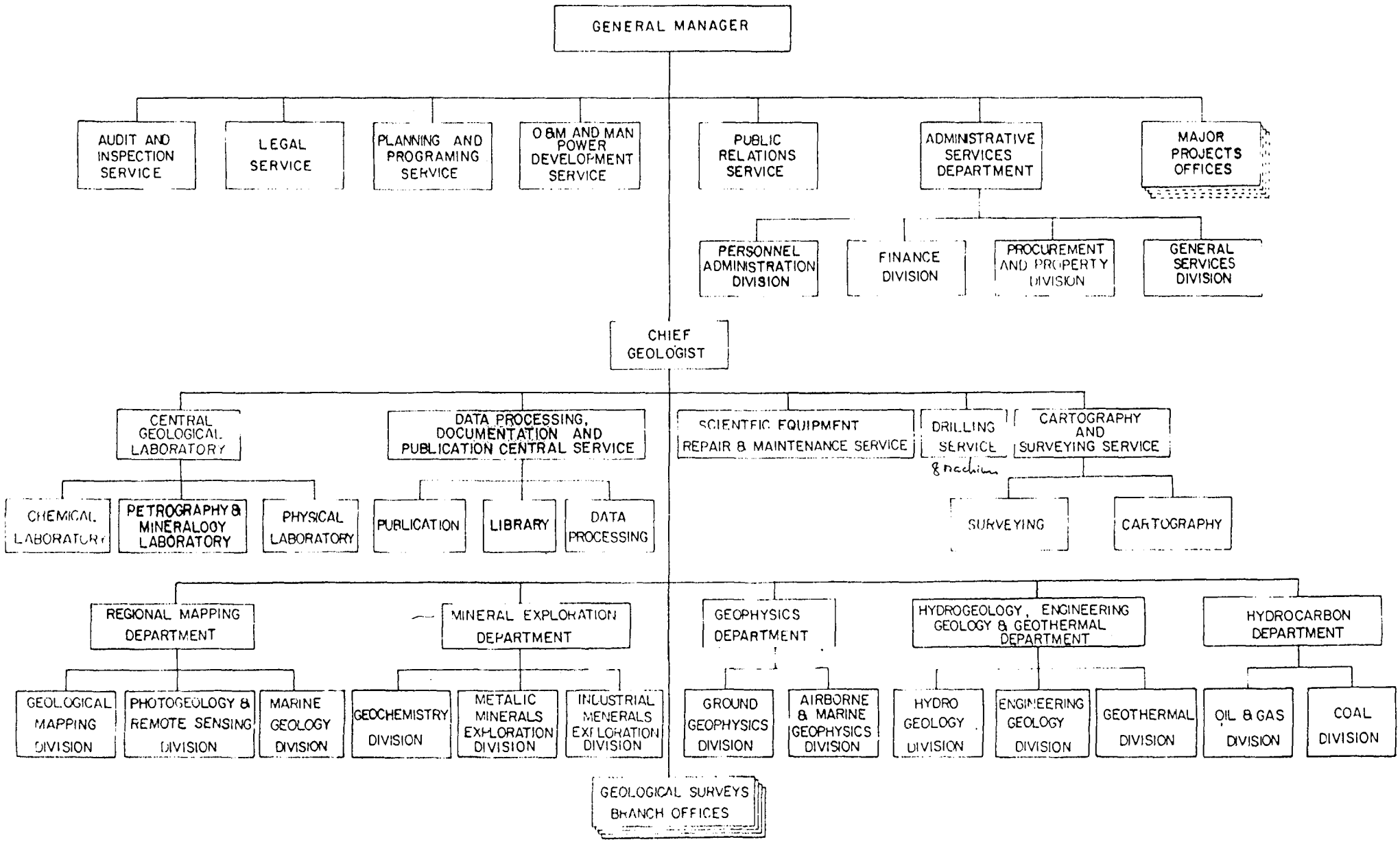


MINISTRY OF MINES AND ENERGY

ETHIOPIAN INSTITUTE OF GEOLOGICAL SURVEYS

ORGANIZATION CHART

Fig. 5



- UNDP, training in mineral exploration
- World Bank, training in hydrocarbon exploration
- Italian aid Programme, geothermal exploration

D. **staffing**

At present EIGS has an establishment of 1174 employees of which there are 274 geoscientists, 91 other natural science experts, 21 social science professionals, 6 cartographers, 101 drillers and 681 other support staff. The General Manager has an administrative staff to provide administrative support for EIGS which have "staff function services that are standard features of public sector institutes as reflected in the structure of MoME". The NGU mission was informed by the Chief Geologist that the total establishment will be cut by approximately 40% during the current and coming fiscal year. This staff reduction will not necessarily be detrimental to EIGS as long as:

- the organization and administrative structure is streamlined
- that the scientific staff is not reduced
- that the non-recurrent funding is not reduced

These points are very important as a number of the deficiencies that can be observed at EIGS can be redressed in this context.

E. **physical facilities**

EIGS staff is at present scattered on two different campuses which have too great a geographical separation to achieve the necessary integration and close working relations in such a complex multi-disciplinary organization that characterizes any geological survey. Many of the buildings are run-down and this again impairs the efficient working of the organization. There have been plans, now for some years, to provide a new building(s) for EIGS sited on a common campus. The NGU delegation was informed by the Chief Geologist that EIGS expects to move into this new campus in approximately one year.

It is further expected, in the future, that EIGS will open five branch offices to expedite the needs of the major regions. This is planned partly because of the serious communication difficulties within the country as a whole and because of the requirements of National/Regional Self-Governments.

3.2 The Eritrean Geological Survey (EGS)

The EGS is part of the Department of Mines and was established in 1992. The Department of Mines is expected to play a central role in the evaluation and development of Eritrea's mineral resources. The Department of Mines is an integral part of the Ministry of Energy, Mines and Water Resources. At present the Department of Mines is divided into three main sectors:

- Administrative Department

- Mines Control Development Sector (MCDS)

- Geological Survey Institute (EGS)

The Department of Mines is administered by the Department Head (Asmerom Nesfin) and a

Deputy Head (Alem Kilbreab) supported by a relatively small administrative group.

The MCDS is responsible for the legal aspects (Mining Act) dealing with mineral exploration and exploitation e.g. prospecting claims, prospecting licences, mining concessions, etc. This office is also responsible for promoting mining activities based on knowledge of the country's mineral deposits and of areas with a high mineralization potential. In this context the office will cooperate very closely with EGS and will jointly develop and share a database for mineral deposits of Eritrea.

The total staffing of the Department of Mines is approximately 70 persons (including support staff), of which about 30 are placed in the EGS. The Department of Mines (DoM) is at present retraining 70 of the EPLF veterans for support tasks and during 1994 these will be absorbed in the structure of the DoM. Thirty of these will come to EGS and thirty five to MCDS.

Of considerable significance to the future development of EGS are the following organizations:

- Hydrocarbons Unit (part of Department of Energy), HcUDoE

- Department of Water Resources (DoWR)

A. Responsibilities

The EGS is expected to be the central geological mapping and prospecting agency in Eritrea and is intended to provide an important interface between industry and other Governmental Departments. The Department of Mines has set-out a number of important functions for EGS:

* Geological Mapping: here the priority for geologically mapping the country at a scale of 1:250.000 is given, to be followed up by more detailed mapping of areas with the best mineral potential.

* Ore Deposits: Investigations of mineralized areas and specific deposits will be undertaken by EGS to provide evaluation studies aimed at promoting the interest of local and foreign mining enterprises. A top priority is producing an inventory of the country's mineral deposits.

* Industrial Minerals: EGS will be involved in the evaluation of sources of industrial minerals such as materials for the cement industry, aggregate for roads and concrete, dimensional and ornamental stone and of other minerals with industrial application.

* Hydrogeology: WRD is involved in the mapping to show the distribution of aquifers, analysis of rainfall statistics and an assessment of surface and sub-surface water supplies. EGS is expected to specialize in detailed research on aquifers and in the development of new techniques and methodology for hydrogeological studies.

* Sedimentology: A specialist group should be created, capable of undertaking an evaluation of the sedimentology and structure of the Red Sea and Danikil Rift Zones. This will provide important information on the economic possibilities of extensive evaporite deposits and of hydrocarbons.

* Remote Sensing: A facility should be established at EGS.

* Laboratory: This would provide a key facility. It should be equipped to undertake rock specimen cutting, preparation of polished mounts and thin sections. It should provide for the needs of EGS with a range of geochemical analytical facilities which would also be utilized by other governmental departments and private companies on a payment basis.

* Cartography: Facilities for drafting and production of geological maps and figures and the compilation of reports must be established. EGS will provide drafting facilities also for the Superintendent of Mines.

* Drilling: It is necessary for EGS to provide drilling facilities for mineral evaluation and hydrogeological purposes.

* Library/Information Service: EGS must build-up adequate library facilities and maintain important geological archives. An information service on Eritrean geology and mineral deposits must be built-up.

B. Organization.

The position of EGS in the Department of Mines (Director Asmerom Mesfin) is seen in the flow chart (FIG 6.). EGS is administered by a Director (Tesfamichael Kelata) and a Deputy Director (Michael Abraha). It is planned that EGS will eventually have five scientific divisions and a Training Centre plus a General Service Division comprising 5 component sections (FIG 6).

At the present time only 2 scientific divisions are established:

- Regional Geological Mapping/Mineral Exploration (combined)
- Geophysics

In the General Service Division units are established for:
- General Laboratory
- Cartography
- Drilling
- Library

C. Financing.

At present the DoM does not operate a budgetary procedure in terms of it's constituent organizations EGS and MCDS. All salaries are paid by DoM from their central funding, they also pay for maintenance, water, lighting, etc. Due to the general lack of financial resources requests from e.g. EGS are funded each time on a emergency basis and no general recurrent or non-recurrent granting is made.

EGS has at present only one externally funded project via the Australian Aid Authority for a specific project in part of the Asmara Mineral Belt. This is a project with a 2-year span and has total funding at AUST $ 467.000. This includes the offshore expenses of the Australian project supervisor, overseas sample treatment and analysis, logistical items related to the field investigations e.g. transportation (3 vehicles), field supplies, investment in one PC and 3 laptops for project purposes, etc.

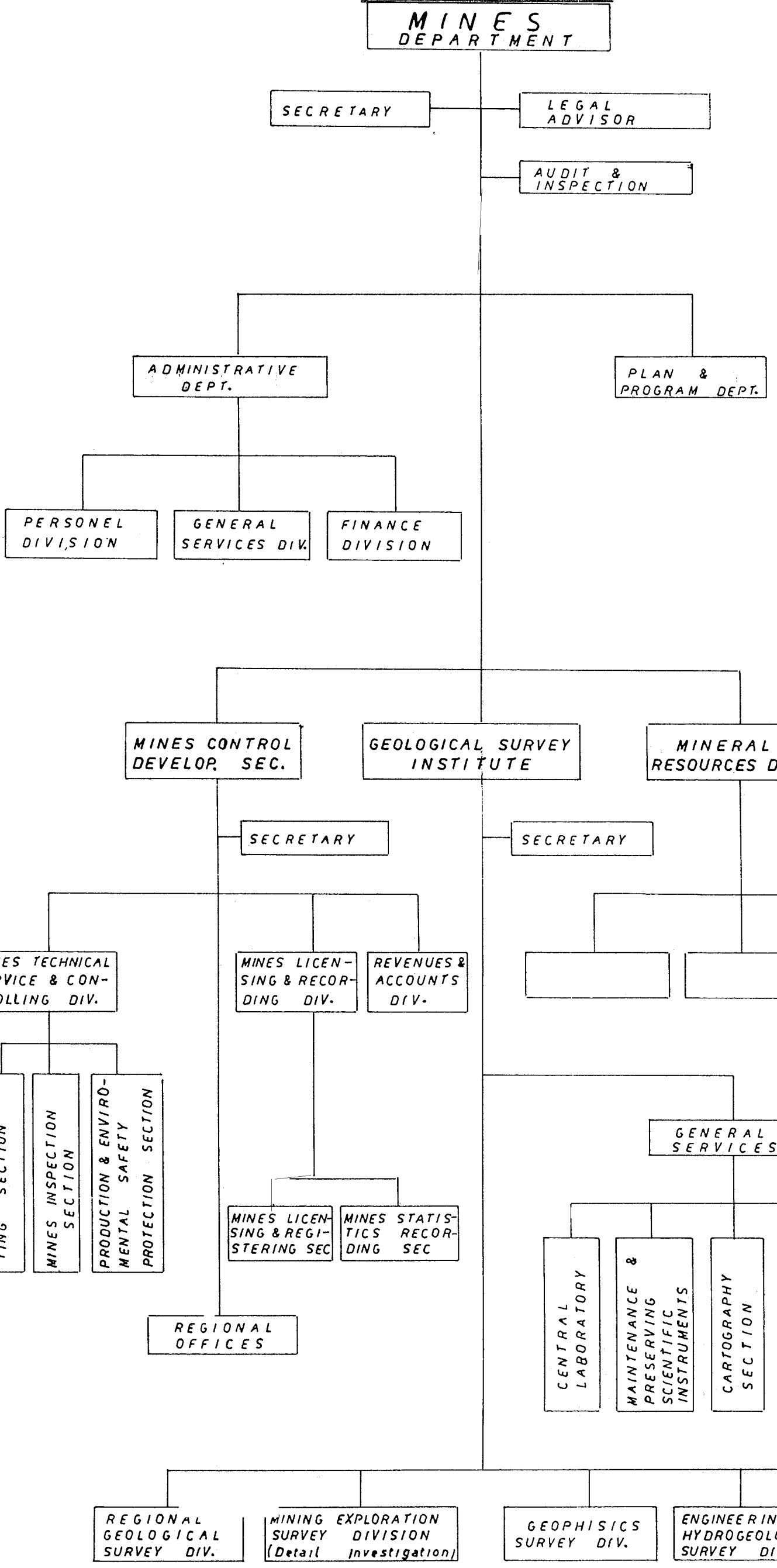

MINES DEPARTMENT
SECRETARY
LEGAL ADVISOR
AUDIT & INSPECTION
ADMINISTRATIVE DEPT.
PLAN & PROGRAM DEPT.
PERSONEL DIVISION
GENERAL SERVICES DIV.
FINANCE DIVISION
MINES CONTROL DEVELOP. SEC.
GEOLOGICAL SURVEY INSTITUTE
MINERAL RESOURCES DEV. SEC
SECRETARY
SECRETARY
MINES TECHNICAL SERVICE & CONTROLLING DIV.
MINES LICENSING & RECORDING DIV.
REVENUES & ACCOUNTS DIV.
SURVEYING & DRAFTING SECTION
MINES INSPECTION SECTION
PRODUCTION & ENVIRONMENTAL SAFETY PROTECTION SECTION
MINES LICENSING & REGISTERING SEC
MINES STATISTICS RECORDING SEC
REGIONAL OFFICES
GENERAL SERVICES
CENTRAL LABORATORY
MAINTENANCE & PRESERVING SCIENTIFIC INSTRUMENTS
CARTOGRAPHY SECTION
DRILLING SECTION
LIBRARY
REGIONAL GEOLOGICAL SURVEY DIV.
MINING EXPLORATION SURVEY DIVISION (Detail Investigation)
GEOPHISICS SURVEY DIV.
ENGINEERING & HYDROGEOLOGY SURVEY DIV.
TRAINING CENTER

Fig. 6

D. Staffing.

At present EGS has a staffing of about 30; management (3), general services (9) and scientific divisions (17). In addition some 30 former war veterans are being retrained and will be given positions in EGS, principally as support staff.

The plans are that over the next 3 - 5 year period the staff of EGS will expand to approximately 80. Of these, 50% will be scientific and 50% support staff. Those ambitions appear to be both modest and realistic.

It is obvious that in this initial period a considerable emphasis is placed by EGS on training and it is proposed that fellowships should be arranged for professional members of the scientific staff at the rate of 2 per year for training abroad in overseas Geological Surveys. Similarly they envisage intensive courses for support staff to be given in-house by overseas experts. This training is envisaged financed by bilateral and multilateral Development Cooperation Funding. EGS also prioritizes the need for short-term (1 - 2 years) secondments of expatriate professional staff with similar funding, in the following fields:

- economic geology (2 positions)
- sedimentologist/structural geologist

E. Physical facilities.

EGS is placed in the central building of the Department of Mines. There are considerable advantages in this arrangement, but in view of the planned development of EGS and MCDS the facilities are clearly inadequate.

3.3 The Eritrean Hydrocarbons Unit ((HcUDoE)

The Hydrocarbons Unit is part of MoEMW and placed in DoE. HcUDoE has the following functions:

* together with the Ministry of Justice to draw-up and administer the licencing of oil/gas concessions

* to acquire and archive all pertinent geological and geophysical data relevant to hydrcarbon prospecting

* to store and curate all drill-core material resulting from hydrocarbon and geothermal energy prospecting

* together with EGS to promote prospects for hydrocarbon and geothermal energy

* together with EGS to check the modelling made by companies, to reprocess geophysical data to make presentation models

HcUDoE has a small professional staff (5 persons) plus a limited support staff. There is as yet no allocated recurrent or non-recurrent budget for HcUDoE:

- DoE pays directly salaries and infrastructure
- funding for activities is on an ad hoc basis according to specific requests

The immediate concern of the Hydrocarbon Unit are:

1) Institutional Structure and Functions

* define the functions and operational methodology of the Hydrocarbon Unit to ensure that the Unit is properly structured to achieve these functions

2) Training

* determine the staffing requirements of the Hydrocarbon Unit

* initiate a short and longer term training programme for the Unit's staff

3) Data Acquisition/Archive Facilities

* access all Eritrean hydrocarbon and geothermal exploration data and reports from MoEMW, previous oil company operators and other sources

* acquire hardware/software systems to run a simple data management system

4) Technical Studies

* reprocessing of geophysical data

* reinterpretation of exploration data and reports to prepare a new integrated report on the petroleum geology and exploration potential of the Eritrean Red Sea to support the promotion programme

* determine the requirements for new surveys and studies

5) Legal, Fiscal and Contractual Framework

* analyse the existing legal framework for investment in this sector and propose appropriate modifications

* devise an economic model of the fiscal aspects of the law and model contract, for use in bid evaluation and negotiations

6) Environmental Assessment

* carry out environmental study to ensure that exploration activities do not adversely impact fishing, tourism or other industrial potential and the Red Sea marine environment is not damaged

7) Natural gas

* develop a strategy for natural gas usage for domestic consumption

8) Petroleum Exploration Promotion

* determine licensing strategy (exploration blocks size, bid rounds vs. open negotiation, scheduling, bid documents and regulations)

* advertise and promote the exploration investment opportunities by direct mail, attendance at conferences, articles and brochures

* hold exploration promotional seminars in major centres; arrange one-on-one meetings with oil companies

* oil company bid and promotional evaluation

* negotiations assistance

The input needs of HcUDoE are dealt with together with those of EGS.

4.0 STATUS OF GEOLOGICAL MAPPING AND PROSPECTING.

An extensive coverage of accurate geological maps at appropriate scales is essential for any country to be able to assess and develop the mineral resources of that country. This is particularly important for third world countries such as Ethiopia and Eritrea which will be dependent for a long time on primary production in order to increase their GNP. Mining and quarrying for metal ores, for industrial minerals, dimension stone, aggregates and other construction materials represent one of the essential sectors for which industrial growth and hence natural wealth will depend.

4.1 Ethiopia

In Ethiopia geological map coverage by EIGS at the 1:250.000 scale is about 25% (FIG 7). This includes 7 published maps, 2 maps prepared for publication, 2 maps under compilation and mapping is in progress on 5 further sheets. When these latter 9 sheets are completed the coverage will be approximately 225.000 km^2 of the total national territory of 1.158.000 km^2. A number of areas have also been mapped at the above scale in relation to Development Cooperation supported projects totalling 83.000 km^2, but this mapping does not appear to have been formalized in the general EIGS format. In addition some 125.000 km^2 of the Afar has been mapped in the 1970's on the scale 1:500.000 by a French-Italian team. Thus the total available geological map coverage (though incomplete) is not more than 37% of the country on a scale of 1.500.000 or larger.

The 1:250.000 map-sheet is probably the minimum scale which is really useful to the mineral prospecting industry, and it is essential that coverage be rapidly extended in the mineral prospective areas of the country. Indeed, if substantive progress is to be made in assessing the mineral potential and hence encouraging the international mining industry to invest in interesting prospects, certain priority areas have to be mapped on larger scales of eg. 1:100.000 or even 1:50.000.

There is also smaller scale coverage in SE. Ethiopia where a 1:1.000.000 scale map has been compiled for some 330.000 km^2 by BEICIP for MoME in 1986. EIGS has recently completed the second edition of the 1:2.000.000 scale Geological Map of Ethiopia.

It is obvious that the geological mapping of the country is a clear national priority and this is emphasized by MoME in "Mineral Development Component" where it is stressed that "EIGS is planned to be strengthened and its operations decentralized in order to enable it to generate the geological and exploration data that is required for a sustained pace of mineral development". It is pertainent here to remark that it is also necessary to devise a priority plan for the systemmatic geological mapping of the country. For such a plan to be effective it is essential that the activity is well-organized and that sufficient funding is allocated according to the priorities of the programme. It is also essential that adequate facilities are available for processing and compiling the acquired data and for presenting that data in an acceptable form.

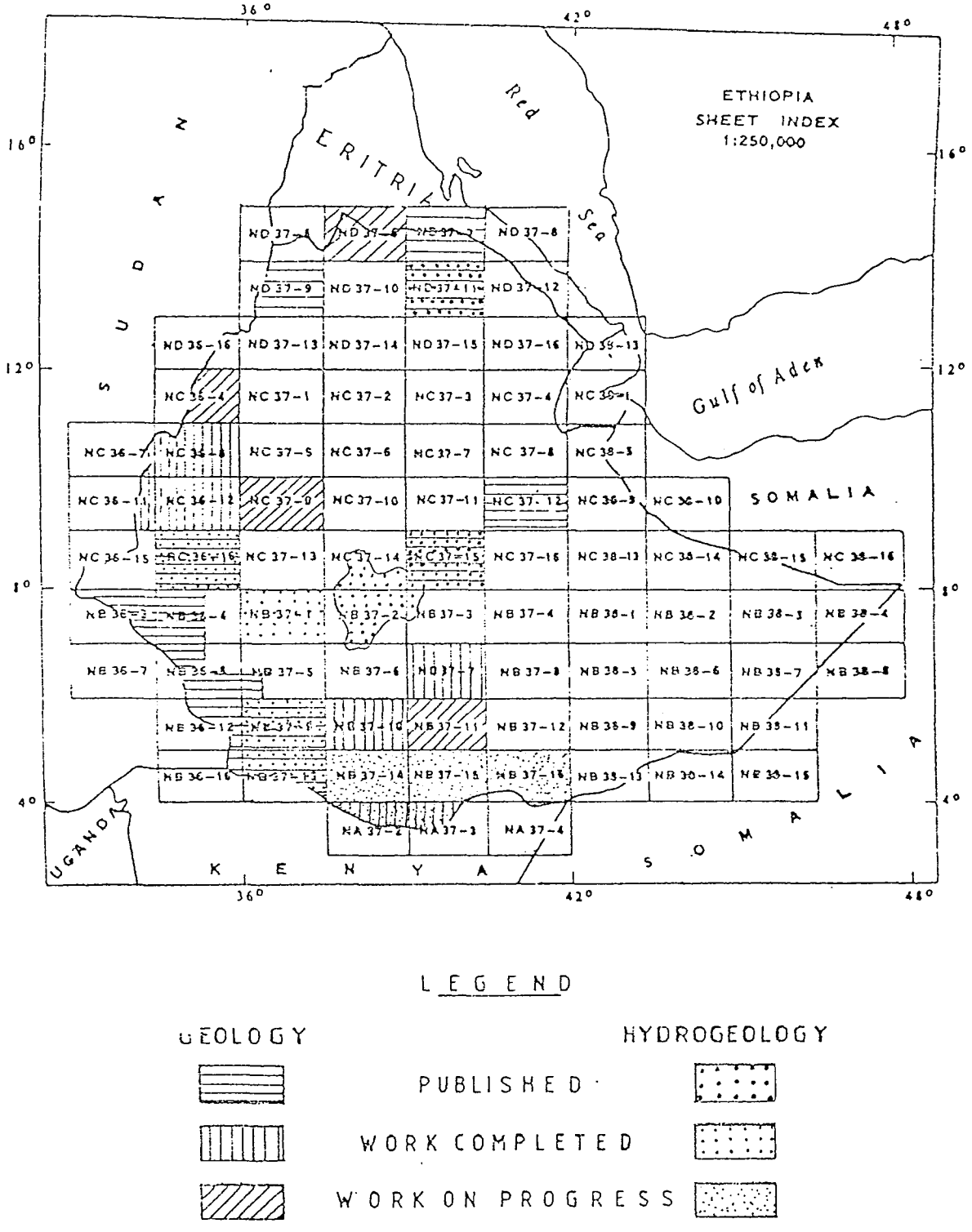

ETHIOPIA
SHEET INDEX
1:250,000
Red Sea
Gulf of Aden
ERITREA
SUDAN
SOMALIA
KENYA
UGANDA
36°
42°
48°
16°
12°
8°
4°
LEGEND
GEOLOGY
HYDROGEOLOGY
PUBLISHED
WORK COMPLETED
WORK ON PROGRESS

Fig. 7

Very essential to the national geological mapping programme is the progress in the national coverage of geophysics, particularly for gravity and aero-magnetic mapping. at present the national gravity coverage is estimated at 49% at a nominal 5 km station interval. The national database for aeromagnetic mapping represents an approximate 20% coverage (or one of the least in Africa), and only 65% of the surveys are at a spacing of less than 5 km which is a minimum requirement for the mining industry in terms of general information. Only 40% of the surveys is at a spacing of 1 km or less (1 km spacing was the minimum requirement for the national aeromagnetic map of Norway), and only 8% of the surveys is at a spacing less than 1 km.

It is obvious that much effort has to be put in to provide even an embryonic national survey of geophysical data. Here improvements in methodology, organization, training and properly constituted database systems are essential. It must be emphasized here that potential field geophysics (gravity, aeromagnetics/radiometrics) is the most important remote sensing technique, and is an essential addition to the geology.

In hydrogeology a national map (including Eritrea) at scale 1:2.000.000 was published in 1988, 3 maps at scale 1:250.000 have been published, 4 sheets being compiled and 3 sheets are being mapped (FIG 7). Other authorities dealing with water supply problems and the national water policy have underlined the need for an increase in hydrogeological map production.

The main cause of the lack of national geological map coverage are:

- insufficient prioriting of field mapping
- insufficient funding for field vehicles, field work, etc.
- antiquated cartographic facilities and in part, methods
- poor national printing facilities

It is obvious, that if EIGS is to provide a major information base towards a future extractive mineral industry, that major changes in priorities must be made in order for the primary data to be assembled. One bright spot emerged during the NGU mission's visit to the Ethiopian Valley Development Studies Authority (EVDSA, which is part of the Ministry of Natural Resources Development and Environmental Activities), which have acquired and developed highly sophisticated GIS systems (SPANS/ILWIS/AUTOCAD) in three different project centres in Addis Ababa. In their major planning projects for catchment areas they have digitized geological maps together with geochemical and hydrogeological data as part of their treatment package. EIGS were encouraged by the NGU delegation to make a formal agreement for cooperation with EVDSA as this could bring them rapidly into GIS world and provide excellent preliminary coloured maps which are also digitized.

Prospecting for minerals and construction materials have traditionally been carried out by EIGS and to some extent also by the Mineral Resources Development Corporation (MRDC). Under new statutes, however, MRDC has only the same prospecting rights as any private company i.e. within its license areas.

The state of general prospecting at EIGS is fairly reasonable, though there are deficiencies conditioned partly by the economic circumstances of EIGS. A generalized geological and mineral occurrences map of Ethiopia has been produced and many reports and file listings on both regional mineralization patterns and mineral deposits of potential economic interest. EIGS is obviously not yet experienced in the presentation of data for the international prospecting/mining industry. The staff in their mineral exploration department contains a number of well qualified scientists in terms of knowledge and general competence. EIGS suffers, on the other hand, because of a general disorder in its paper archives and the total lack of organized mineral exploration/deposits data base

systems for storage, management, retrieval and presentation of the vast data in existence at EIGS. Indeed, this data is being rapidly added to. With the possibilities offered by the excellent GIS facilities at EVDSA it is essential that the data related to mineral deposits is placed into an orderly database system as a matter of urgency.

EIGS prospecting activities have resulted in the discovery of a wide range of metallic mineralizations, industrial minerals, construction materials and dimension stone. EIGS lacks, however, modern expertise in deposit assessment analysis in relation to the international market requirements. This latter is particularly important for industrial minerals with specialized uses and where value-added products can be produced by beneficiation. It is also important where a mineral product can only be produced or refined by fairly advanced technology.

Prospecting techniques at EIGS are fairly traditional, involving geological mapping, stream sediment geochemistry, sample collection, some ground geophysics, drilling and core acquirement, etc. Due to financial constraints field investigations are often not supported by adequate geophysical and geochemical surveys. Only in the Adula area has prospecting included a well designed detailed helicopter geophysical component and geochemical survey.

4.2 Eritrea.

Eritrea was not priorited by the Ethiopian Geological Survey for it's 1:250.000 mapping programme. As a result of this and the effects of a long war of attrition, the geological map-coverage of the country is minimal. Some mapping was carried out by geologists serving with EPLF, but this type of mapping is only of a preliminary nature and probably in total does not constitute more than 30% of a 1:250.000 map sheet. Geological mapping of a developing country such as Eritrea is, however, vital if the natural resources of that country can be identified, assessed and evaluated. The only readily available geological map is the 1: 2.000.000 scale map of Ethiopia.

Eritrea, however, has a complete coverage of 1:100.000 topographic maps, a 60% coverage at scale 1:250.000 and a very limited number of areas with 1:50.000 coverage. A complete set of air-photographs and satellite imagery is also available.

No hydrological maps have yet been produced, though Eritrea is included in the 1:2.000.000 hydrogeological map of Ethiopia published in 1985.

The state of general prospecting in Eritrea is deplorable. Thirty years of war, preceded by 20 of benign neglect, did little to develop Eritrean mineral resources. Most of Eritrea's mineral records date back to the old Italian colonial days, but Eritrean mineral and oil potential appears to be considerable. The geology of the country consists of well-exposed Precambrian terranes variously intruded and rifted, and of promising sedimentary basins off-shore. Eritrea's mineral potential has attracted international attention in the past. Although many mineral occurrences have been reported in Eritrea, no accurate assessment of the economic viability or geological control of these deposits have been established. The Mines Department should play the leading role in systematically mapping the geology of Eritrea, assessing the existing mineral prospects and finding new deposits. This work should encourage researchers and mineral companies to help in basic mapping, exploration and exploitation of mineral deposits. However, these can not be undertaken without a serious effort on the part of the government and staff to establish a strategic plan with the necessary resources to accomplish the task.

After the liberation of Eritrea the Mines sub-commission was reorganized into the Mines Department. The Mines Department in Eritrea was formed in 1992 to play a central role in the evaluation and development of the country's mineral resources. For some time to come this will be the only institution responsible for geological investigations, including basic exploration for mineral resources. Mining companies are unlikely to take up joint ventures until a clear picture of likely economic targets have been identified independently by Mines Department. Eventually some exploration activities may be financed by multilateral or bilateral joint-venture partners.

A "Petroleum Operation Code" has recently (1993) been legislated and a "Mineral Code" is under study. Also the Eritrean Government has started systematic inventories of the country's mineral occurrences with some assistance (technical and economical) from the Australian Aid Authority.

The Mines Department faces the task of establishing an organizational infrastructure. At the same time it is confronted by demands of technical assistance from governmental and private enterprises such as the ceramics industry, the glass factory and various companies dealing with industrial and constructional materials.

5.0 OVERVIEW OF GOVERNMENT AGENCIES RESPONSIBLE FOR GROUNDWATER

5.1 Ethiopia

The responsibilities for the water sector are carried out by the following organizations:

* **The Water Resource Development Authority (WRDA)** was established in 1981 as an autonomous government organization responsible for conducting studies regarding the utilization, administration, regulation and protection of the country's inland waters, and for supervising in detail the implementation of government policies and plans for water resources development.

* **Ethiopian Valleys Development Studies Authority (EVDSA)** was established in 1987 as an autonomous government organization responsible for delineating the boundaries of the country's valleys on the basis of water flows, preparing master plans for the development of valleys, preparing policies and directives pertaining the utilization of the waters of transboundary rivers, allocating the country's inland waters for irrigation and other purposes and collecting and processing hydrological data.

* **The Water Supply and Sewerage Authority (WSSA)** was established in 1981 as an autonomous government organization with responsibility for providing water supply and sewerage services in all parts of Ethiopia, except the city of Addis Ababa and such other chartered urban centres as may be considered by the Ministry to be capable of running their own water supply and sewerage services.

* **The National Meteorological Service Agency (NMSA)** was established in 1980 as an autonomous public agency responsible for providing meteorological services, controlling air pollution and discharging Ethiopia's international obligations regarding meteorological activities.

* **The Arba Minch Water Technology Institute (AMWTI)** is administered by the MoNRDEP but its academic standards and curricula are governed by the Ministry of

Education. It began its academic programme in September 1986. The academic programme comprises courses at diploma, advanced diploma and degree level in hydraulic engineering, irrigation engineering and sanitary engineering as well as in meteorology, basic sciences and the humanities.

In addition other organizations are important in the water sector:

Ministry of Agriculture	Plans and develops rural infrastructure including small-scale irrigation and water supply.
Ethiopian Water Works	Constructs irrigation schemes, dams, hydropower and water supply projects.
Addis Ababa Water and Sewerage Authority	Provides water and sewerage services for Addis Ababa.
Ethiopian Electricity Light and Power Authority	Constructs, operates and maintains hydropower stations.
Ethiopian Institute of Geological Surveys	Carries out hydrogeological exploration and studies.
UNDP and FAO	Assists in capacity building and human resources development.
UNICEF	Aids rural water supply and sanitation activities.
Bilateral organizations, NGOs	Focus on rural water supply and sanitation.

In addition to visiting the hydrogeological division at EIGS, the NGU mission also visited WRDA, EVDSA and WSSA.

WRDA	have the mandate for preparing and administering the National Water Proclamation. They also hold a paper-file database on water-wells deeper than 30 m and have mandatory powers to obtain such information.
EVDSA	make special studies of all major catchments and prepare master plans for the development of catchments. They have excellent facilities for GIS studies and are furthermore well equipped and appear to function extremely well.
WSSA	has responsibilities for providing supply and sewerage facilities in all parts of Ethiopia except Addis Ababa. They are the only organization that makes analysis of water quality and have functioning laboratories.

these three organizations all stressed the need for increased cooperation with EIGS and strongly favoured the establishment of a national groundwater database system.

5.2 Eritrea

In Eritrea the overall responsibility for groundwater is with the Department of Water Resources (DWR) which is a constituent part of the Ministry of Energy, Mines and Water Resources. DWR has the following responsibilities:

* To study and assess the water resource potential of the country and ensure it's proper utilization

* Make efforts to find an adequate source of reliable clean water for both urban and rural areas

* Protect groundwater resources of the country from any pollution

* Study the meteorological and hydrogeological condition of the country

* On the basis of natural water policy, which will be promulgated, to monitor and control water utilization

The organizational chart for DWR is given as FIG 8. It will be noted that their work is split accordingly to the major administrative regions of Eritrea. DWR has submitted a draft of the eventual legislation concerning groundwater, and when this is accepted by the Government DWR will in fact be the regulatory body.

The scientific staff concerned with groundwater are:

Head of National Water Point Survey
2 Hydrogeologists
2 Geologists
1 Geophysicist
+ support staff

DWR has 4 - 5 water well drilling rigs. Neither the staffing or the available equipment are sufficient for DWR to fulfil it's mandate and it is hoped to upgrade these resources. DWR made a number of points:

* general lack of trained staff
* lack of water analytical facilities, here the planned national laboratory at EGS is expected to cover this area
* major problem, in some areas, of non-renewable groundwater resources
* lack of possibilities to carry out water-table monitoring due to lack of resources
* DWR has responsibility for drill-hole records which it keeps on paper file
* need for national groundwater database jointly with EGS
* need for increased cooperation with EGS
* need for international cooperation to increase the activities in groundwater in Eritrea.

6.0 SERVICES TO BE OFFERED BY THE GEOLOGICAL SURVEYS

6.1.Ethiopia.

For Ethiopia the most important priorities for services of EIGS are:

* to speed up the geological map coverage 1:250.000 of the most prospective regions of the country

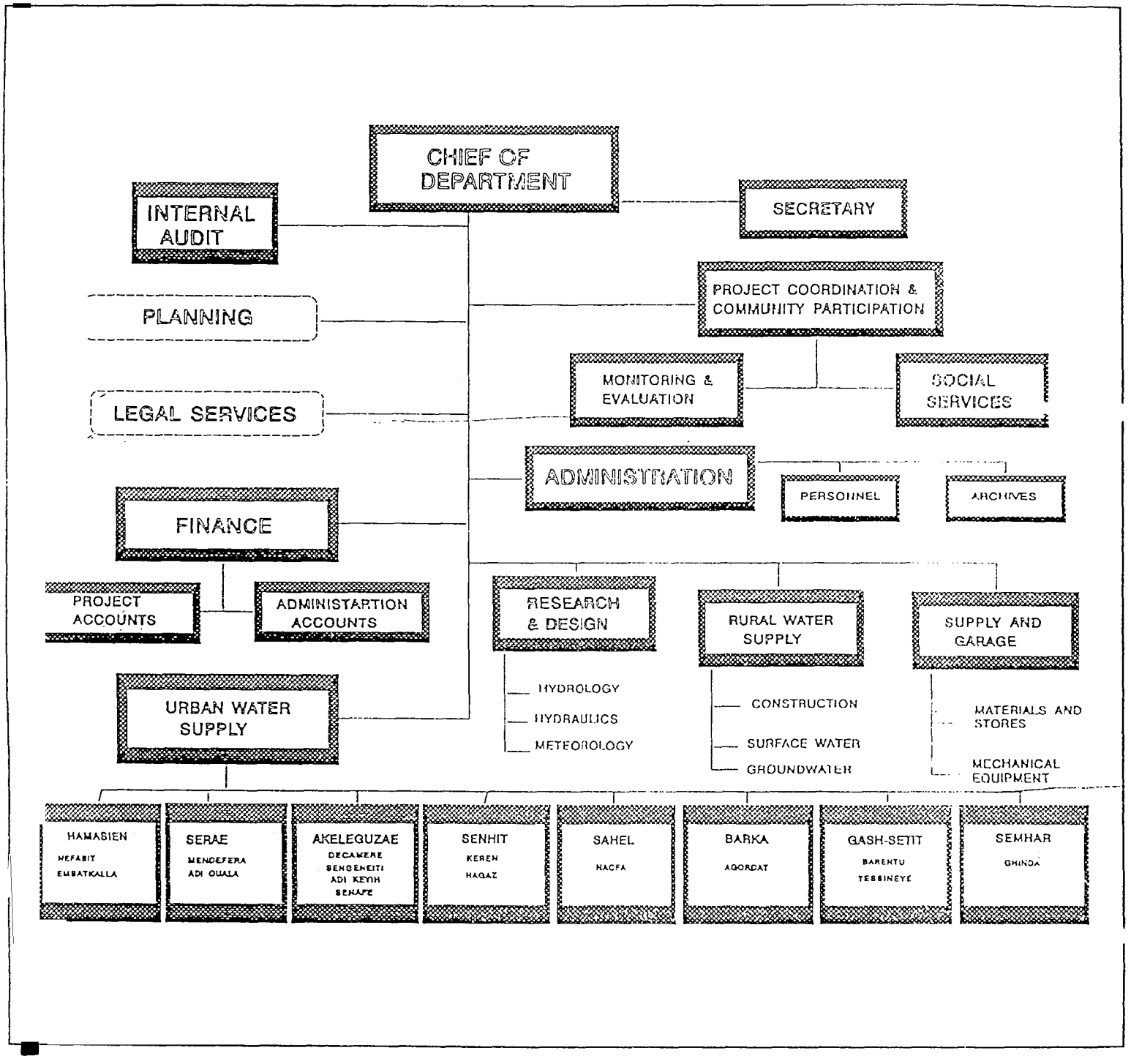


Fig. 8 Organizational Chart - Water Resources Department

* in areas of good known mineralizations detailed mapping at scales of 1:100.000 and 1:50.000 should be commanded

* the national coverage of potential field geophysics should be completed and more helicopter-born surveys made of the most interesting prospective areas, such surveys should comprise aeromagnetics, electromagnetics (EM), VLF and radiometrics

* EIGS should step up its prospecting effort and also training in mineral economics and in deposit/mineral product assessment

* the hydrogeological investigations should be increased and especially in drought prone regions. Full cooperation with other national agencies with responsibilities for groundwater should be achieved

* of considerable importance to all future investigations by EIGS will be the establishment of a national geoscientific database, based on a interactive modular system. Without this the institution will always be struggling with a poorly organized paper archive system which precludes modern methods of data-set integration and presentation as is embodied in modern GIS systems

* EIGS will have to provide good oversights of prospective hydrocarbon and other energy-mineral areas

* EIGS will provide the central national laboratory support for chemical and mineral analysis

* EIGS should establish a national data centre for storing diamond drill-cores acquired via prospecting, mineral deposit evaluation and in the energy-mineral sector

6.2 Eritrea.

For Eritrea the most important priorities for the services of EGS are:

* to initiate 1:250.000 mapping of the most prospective regions of the country, starting with Western Eritrea (FIG 9). The long-term aims stated by the Department of Mines is for a national coverage at the above scale to be completed for the entire country.

* in well-mineralized areas geological mapping should be made at scales of 1:100.000 or 1:50.000.

* EGS must establish, in the short-term, an inventory of the known mineral deposits of Eritrea.

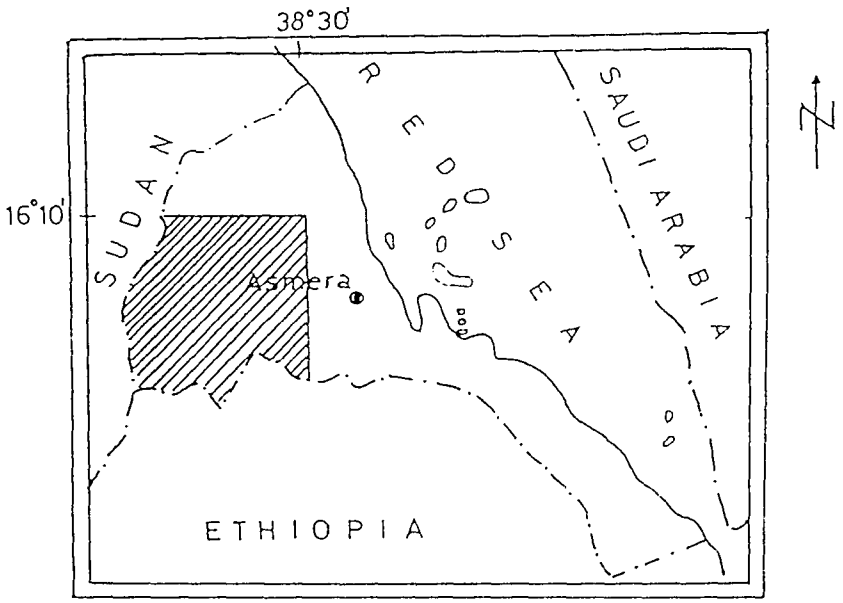
* The Department of Mines has given high priority to the establishment of a mineral deposits database - this will be a shared facility between EGS and MCDS.

* EGS will carry out prospecting for metallic ores, industrial minerals, dimension stone and construction materials. They will also provide a detailed description of these deposits.

* Together with MCDS they will use their prospecting, documentation and database information to promote the commercial utilization of Eritrea's mineral resources to both

PROJECT PROPOSAL FOR
GEOLOGICAL MAPPING OF
WESTERN ERITREA

LOCATION MAP



Scale 1:2000 000 (Reduced after Gherardi)

LEGEND

PROJECT AREA

INTERNATIONAL BOUNDRY

CITY

Fig. 9

national and international companies.

* EGS will provide a scientific support service to DoWR in terms of groundwater, and establish a common national groundwater database for the two organizations. Groundwater monitoring must be established by EGS/DoWR.

* EGS will provide a scientific support service to the HcUDoE particularly in the fields of sedimentology, structural geology and geophysics.

* EGS together with HcUDoE will plan and execute a national core storage facility.

* EGS will build-up laboratory facilities for the handling of rock, mineral and groundwater samples, their preparation and chemical analysis. This laboratory will be expected to be a national laboratory satisfying the needs of DoM, DoE and DoWR.

* EGS is expected to build-up its library facilities and information service.

7.0 NECESSARY INPUTS TO UP-DATE THE GEOLOGICAL SURVEYS.

7.1 Ethiopia.

* for improving the geological mapping basis it will be necessary for EIGS to make a clearly prioritised plan for the geological/geophysical mapping of the country

* this should be supported by appropriate funding from national sources supplemented by assistance from Donor Countries. Without the adequate map base it will be impossible to assess and develop the national mineral and groundwater resources of the country. Some assistance to modernize the cartography division at EIGS will also be necessary

* the capacity for potential field geophysics at EIGS must be increased. This can be done in a number of ways:

  -training

  -provision of easily handled modern systems for data processing, modelling and interpretation. This is important both in the mineral and hydrocarbon sectors. here it will be necessary for training in the use of special software packages such as the IMP system developed by NGU

  -obtaining access to airborne geophysical acquisition system either by direct purchase or preferably in the first instance by collaboration projects with for e.g. other Geological Surveys who possess such acquisition systems. Here, donor support is clearly essential

* it is essential that EIGS acquire and develop the necessary skills involved for establishing a modern operative system of operative modular databases which together will constitute a national geoscientific data bank. it is only by rapidly acquiring the means for efficient data-storage, management, retrieval and presentation in such a way that EIGS will be able to sustain its national commitments. Here EIGS will require considerable assistance in training

and for the necessary hardware and software involved. Here Donor support e.g. NORAD is essential

* particularly in the field of groundwater hydrogeology EIGS must increase its cooperation with the other appropriate national agencies/organizations which also have groundwater as part of their responsibility areas. It will be vital for the future planning of water supply that a national groundwater database is rapidly developed as part of the national geoscientific databank. In this relation it is essential that all of the organizations involved have full access (perhaps by modem line connection) to the Groundwater Database.

* for EIGS's prospecting work it is essential that their analytical laboratories are improved and able to function without the irritating shortages of often quite minor amounts of foreign currency for purchase of essential chemicals, consumables and spare parts. The laboratory will also have to have a planned investment programme so that its equipment park is put onto a satisfactory basis and maintained at that level. Here also considerable advantages can accrue in terms of shared facilities with other organizations e.g. Geology Dept. of Addis Ababa University, and the various organizations that carry out water analysis e.g. Ethiopian Water Supply and Sewerage Authority. Support for laboratory development should be on a cost-sharing basis between MoME and donor organizations

* Also essential to the prospecting activities will be an improvement in EIGS's ability for deposit assessment, commodity evaluation and insight into international product specifications/requirement and technologies for mineral processing and beneficiation. this can be perhaps best achieved by developing joint projects with international agencies e.g. UNDP, World Bank, Geological Surveys, etc. Here donor support will be essential. With an upswing in such activities, and a hoped raised level of interest by international mining companies, joint projects can be created with such companies. The model of NGU's cooperation with mining/mineral companies (national and international) could be an interesting example.

* EIGS must enter the GIS-world. Here the first essential is the establishment of the modular interactive database systems. This must be paralleled by the acquiring of GIS experience which can be excellently done by collaboration with the sophisticated GIS laboratories at EVDSA. EIGS should also acquire a modest development of GIS capacity, though for the heavy GIS involvement cooperation with EVDSA is vital. A limited investment by Donor agencies such as NORAD is required

* in the hydrocarbon sector considerable institutional strengthening can be made by contact via such organizations as NGU and NPD (Norwegian Petroleum Directorate). Here also substantial national collaboration is necessary with OGEDO which is also part of MoME

* for establishing a national drill-core store (data centre) for the creation of drill-core material acquired from prospecting, mining and hydrocarbon/geothermal investigations, similar cooperation to that listed above is important. It is also essential that full national cooperation with MRDC and MEDC is achieved. Here shared cost support by MoME and donor organizations e.g. NORAD will be required

7.2 Eritrea.

Eritrea has a particularly difficult position in having been a colonial outpost under a succession of colonial administrations and for 30 years fighting a war for independence. This means that essential national structures such as a Geological Survey, taken for granted in developed and even in most third-world countries, had never been established.

The establishment of a DoM in 1992 with a Geological Survey as its mapping and prospecting arm was thus a very important step towards the identification, assessment, evaluation, and eventually development of Eritrea's mineral resources. This also means that EGS has "started from scratch". As the result of the financial strictures of the Eritrean Government it has not been possible to develop the minimum facilities which can allow EGS to function effectively in the role chosen for it in Eritrean development plans. This implies that "inputs" are required, many of them urgently to allow EGS to make headway with the mandate given to that organization by the Eritrean Government. Fortunately the organizations particularly relevant to the day-to-day functioning of EGS are all placed within the Ministry of Energy, Mines and Water Resources. It is further expected by that Ministry, and restated by Tefsai Gebre-Selassie, Minister of Energy, Mines and Water Resources at meeting (17.05.94), that these organizations are expected to be inter-dependant and to develop on the resource-sharing and full cooperation principle. The Minister also stated that he wishes to see a gradual build-up of the resources of EGS so that it becomes a modern effective Geological Survey in terms of medium to long range planning. The inputs which are clearly required are as follows:

* support to enable EGS to commence the major task of the geological mapping of the country. The Ministry has clearly priorited the SW area of Eritrea which is well mineralized, and also the site of small-scale artisanal mining. Their urgent requirements are for simple basic field equipment, field expenses for EGS scientific and support staff, vehicles and minor laboratory costs. There is also a pressing need for training in modern field mapping and in map-compilation techniques.

* support for EGS's work in mineral prospecting. The eventual need here is very large but there are a number of immediate priorities - simple geophysical field equipment plus training in use and result's interpretation (this is also important for groundwater studies); provision of funding for purchase of geochemical analyses of rocks and minerals until the National Laboratory is sufficiently built-up; support for fieldwork expenses; simple GPS position finders; simple digital recording equipment. In addition training is required for geochemical sampling and result's interpretation, thin section microscopy (+ ore microscopy), deposit evaluation, deposit modelling and industrial mineral end-uses.

* support in terms of the promotion of mineral deposits. Eritrea has a number of known mineral deposits and a number of highly prospective areas. EGS and MCDS are very much in need of brochure material to attract the interest of national and particularly international companies to invest in the development of the mineral industry. They would also benefit from a number of quickly carried out pilot projects to detail a number of deposits. This will be dealt with in more detail in chapter 9.0.

* support to provide a Mineral Deposits Database is required. This has been given a high priority by MoEMW, and is of prime necessity to put the already voluminous though scattered information (now on paper files) into a structured modern data form that can be managed and retrieved. It is important, however, that this Mineral Deposits Database is compatible with all other databases to be developed, and that from the start a general

database philosophy is developed, preferably based on an existing framework within a Geological Survey, e.g. NGU.

* EGS requires special training in relation to industrial minerals, construction materials and dimension stone. This is because EGS does not at present have knowledge of the market requirements for export of mineral commodities, this applies also for knowledge of end-use specifications in modern industrialized production processes. Deposit evaluation should be a part of a training programme aiming at the above commodities.

* one of the areas where considerable input is required is the development of laboratory facilities. At present laboratory facilities are virtually non-existent. The establishment of a "national chemical and mineralogical laboratory" based at EGS is given high priority by MoEMW, particularly as it is intended to cover the needs of many different organizations within MoEMW and also for Ministries of Agriculture and Industry. MoEMW's stated objective is to "establish a laboratory that will analyze soil, rocks and water".

  It is obvious that it would not be possible or even advisable to immediately set-up a complicated integrated laboratory containing a plethora of modern sophisticated equipment, as this would be beyond the present or near-future capacity of EGS. However, there are a number of priorities which can be suggested:

  1) support for the establishment of facilities for rock-cutting, -crushing and thin/polished section making. Allied to this is the requirement for simple mineral separation methods to be set-up. These all represent fairly modest capital investments with a component of technician training. This is an urgent matter and requires action over a one year period.

  2) establishment of a chemical analytical laboratory with the basic equipment required for rock, mineral and water analysis. This will require support in terms of laboratory infrastructure including basic features such as proper ventilation, water supply and outflow, fittings, equipment, chemicals, etc. This should be a phased development coinciding with the appropriate training, establishment of methods and phased over 1 - 3 years period. During this time the basic framework of a geochemical laboratory should be established so that simple analytical and mineral identification procedures can be carried out.

  3) after 2) is completed a re-evaluation of laboratory facilities should be made and plans drawn-up for the eventual form of the complete laboratory made. This phase will be the most capital intensive and involve intensive training of a fairly high-level. The final phase of laboratory development should be phased over a 3 - 5 years period.

  During the phased development of EGS's national laboratory there will be pressing requirements for the input of short-term funding to cover the cost of analysis in overseas laboratories.

* there is both an urgent and long term need for input to the library. Naturally a library is an extremely important facility; at present the library possesses 167 books in English (less than 30% of reasonably modern vintage) and about 100 titles in Russian (largely useless). The library contains no serial publications. Certain help can be given by other Geological Surveys by providing their publications free of charge as basis of future "exchange". However, a cash-injection is urgently required to provide even a modestly satisfactory

library service and recurrent matter for the most important serial publications. It is also necessary to develop an information service, this should start with a reference database which is now available on paper file.

EGS together with HcUDoE has the responsibility for assessing the potential for hydrocarbon (oil/gas) and geothermal energy deposits. For this important field of activity within MoEMW there are several major requirements:

- assistance with legislation, at present HcUED has responsibility with the Justice Ministry for preparing legislation. In this context there is strong need for cooperation with a governmental agency e.g. Norwegian Petroleum Directorate (NPD).

- HcUDoE and EGS have responsibility to prepare a database for geophysical and geological information relevant to energy mineral deposits. This database should be made compatible with other databases to be developed at EGS.

- HcUDoE and EGS have responsibility for checking the interpretation modelling carried out by companies and in addition have to produce their own presentation models to attract investment. Here the IMP software developed by NGU could be a very attractive and useful tool.

- HcUDoE has the responsibility for storing and curating drill-cores generated from hydrocarbon and geothermal prospecting, and EGS has the responsibility for drill-cores generated during mineral prospecting. For MoEMW it is necessary that a properly ordered and curated drill-core storage is established in a reasonable short time. Here the combined experience of NPD and NGU with their modern core-stores could be valuable.

* EGS together with DoWR have the responsibility for establishing a national groundwater database. At present DoWR drills 2-300 water-wells per year and a similar amount is drilled by contractors. The well-data is kept as paper-records and urgently needs upgrading and converting to an EDP system based on PC use. This is important so that existing data can be used in modelling of water resources in a country with often chronic water shortages. The database should be designed to be compatible with other databases to be developed by EGS. It is also necessary that EGS/DoWR commence groundwater monitoring particularly with respect to changes in the water-table in drought-prone areas. Here donor support is obviously requested.

8.0 POSSIBLE FUTURE INSTITUTIONAL COOPERATION

NGU is fully aware of government policy in terms of development aid for both underdeveloped third-world countries and for assisting the economic and political reform process in Eastern Europe. This is given in detail in white paper (St.prp. nr. 1 ,1993-94, Utenriksdepartementet) of the Royal Norwegian Ministry of Foreign Affairs, and NGU's strategy for its international programme is in large-part based on this policy.

NGU is well-placed to undertake projects that involve the institutional strengthening of geological surveys in under-developed countries, and has a certain experience relevant to this matter:

- Since 1992 NGU has been involved in a major project in Lithuania. This project is designed to help establish and build-up a national Lithuanian Geological Survey (Lit. GS). The project is financed by UD (Norwegian ministry of Foreign Affairs), and aims, together with Lit. GS, to develope both an organizational and operative framework. When Lithuania achieved its independence there was in fact no national geological survey in existence.

- A similar request has been received by NGU/UD from the Latvian authorities to undertake a project aimed at strengthening the institutional structure of the national Latvian Geological Survey (Lat. GS).

- NGU has a major project in environmental geochemistry together with the Central Kola Geological Expedition (CKSE), financed by MD (Norwegian Environmental Ministry) - Kola Ecogeochemical Project. This project also involves a component of institutional strengthening for CKSE.

- NGU has a major "pilot" project for assessing and data-basing the mineral deposits of the Kola Peninsula financed by UD (Norwegian Ministry of Foreign Affairs).

In these examples there are a number of practical geological projects underway or in planning. NGU considers that such "hands-on" training in active practical projects are of unestimable value in promoting professional activity.

There are considerable and exciting challenges involved in the prospects of NGU being involved, together with NORAD, in long-term projects aimed at the strengthening of the institutional frameworks of the two geological survey units in Ethiopia and Eritrea. During Ethopian rule Eritrea was a constituent part of the brief of the Ethiopian Institue of Geological Survey. As a result much of the available data was acquired by EIGS and is in the process of transfer to Eritrea. The two geological survey units have fundamentally different problems based on the historical perspective. On the one-hand a long-existing geological survey - EIGS that requires much assistance to enable it to be better-functioning professional organization, and on the other hand an embryonic organization - EGS which is just starting the long-process of becoming a professional national institution.

NGU's board has discussed (3-4 May 1994) the principle of NGU being involved in projects, in third-world countries, via cooperation with NORAD. The NGU board has given its general approval for such projects to be carried out by NGU subject to the following considerations:

- NGU's central budget is provided essentially for NGU's national surveys of the Norwegian mainland and the continental shelf. Thus NGU's board consider that the general principle of full-financing of NGU's activities in NORAD programmes should be accepted.

- The scope and content of such programmes must be subject to discussion and planning between NGU and NORAD and the eventual third-party(ies) involved.

- The strengthening of geological surveys in third-world countries is recognized by NGU as a very important activity, and one which a geological survey in the developed world (such as NGU) is in a special position to give assistance. It is vital for developing countries to have highly professional geological surveys in order, for such countries, to identify, assess, evaluate and eventually utilize their mineral resources as a basis for industrial development. It is also essential that the national geological surveys are in a position to provide essential

information relating to groundwater, environment policy and planning. NGU considers that such "institutional strengthening" projects are of necessity of a long-term nature and must have a progressive build-up over a 5-10 year period.

- NGU has a number of cooperation agreements with other European geological surveys particularly with those in NORDIC countries; with the latter NGU have had a number of major regional projects. NGU would expect in the short-term to draw on expertise from these surveys where NGU has a temporary short-fall.

- special practical geological projects with specific aims will be essential. These have a variety of purposes:

  * to promote mineral resources
  * to provide "hand-on" training
  * to provide knowledge and technology transfer

- NGU accepts that it is desirable for national institutions, such as NGU, to use its expertise and experience towards providing assistance in third world countries. NGU consider that it is well placed to act in an advisory role on geological matters to e.g. NORAD in the same way as a number of other European geological surveys act in respect to the relevant national overseas aid and development programs.

9.0 SHORT TERM POSSIBILITIES FOR MINERAL DEPOSIT DEVELOPMENT.

9.1 Ethiopia

Ethiopia is endowed with a great variety of mineral resources. Economic development of these mineral resources is depended on market demand, both domestically as well as internationally. With it's land locked position and long transportation distances to seaports in Eritrea and Djibouti, only high priced mineral commodities will have an export development potential. Due to the under-developed stage of the domestic mineral end-use market, increased mineral extraction for domestic uses has to aim at import substitution and greater use of indigenous agro-minerals to increase soil productivity in agriculture.

At present only a few mineral commodities are exported of which gold with an export value exceeding Birr 21 million (1990) dominated. Exports of platinum, marine salt, dimension stone (marble), construction materials, etc. have always been small and very little export was recorded for 1990. Mainly as a result of the start of primary gold production from the 3000 kg annual capacity Lege Dembi mine in 1991 and the restarting of marble production at the Awash plant of the National Mining Corporation in 1993, mineral commodity export earnings for 1994 could be expected substantially higher than for 1990.

Other mineral commodities produced for the domestic market included: salt, limestone, shale, quartzite, feldspar, quartz sand, brick-clay, kaolin, gypsum, dimension stone (marble) and construction materials (sand, gravel, aggregate, stone), etc. The main domestic end-uses are cement, construction industry, manufacture of container glass, glassware and ceramics, pottery, fired and sun-dried bricks, sugar refinery, tannery products, etc.

The following mineral commodities are considered to be of interest for evaluation of short term development possibilities. They will possibly contribute to attract interest of both national and international companies to invest in the development of the mineral industry.

The proposed projects have in common that the need for capital input in the (pre-)/feasibility stages of necessary investigations is limited and the studies can be carried out in a rather short time-span e.g. 1 - 3 years. Through close cooperation with EIGS and other Ethiopian experts a training component will be an integral part of the projects.

Dimension Stone.

Both marble and granite have a very high value (USD/tonne) on the international market, this will allow for transportation to Red Sea harbours. Some of Ethiopian dimension stone qualities are well known internationally, but in the previous years little promotion work was done. One of the main problems is that the known occurrences of Ethiopian dimension stone lack sufficient in-depth investigations regarding: consistency of quality, possibilities of large block extraction, choice of appropriate quarry site, technical specifications of stone quality, lack of standard size polished samples for display on international stone exhibitions, etc.

Diatomite.

Imported diatomite is used domestically in sugar refinery, brewery processes, etc. estimated import around 3-5000 tonnes/year. Internationally diatomite is a rather high priced commodity with substantial international trade. Due to its structure (porous/high specific surface) and its chemical inertness (silica skletons) it is widely used in chemical/petrochemical processes, as a filter aid, in detergents, as cat/animal-litter absorbant, filler material, etc.
Large deposits are reported from the Rift Valley (lake areas), but no modern in-depth studies of these deposits have been made regarding their chemical quality, technical properties and quality distribution patterns in the deposits. Representative samples should be taken for testing and market evaluation abroad.

Agro-minerals.

Agro minerals or mineral-based commodities used to promote agricultural productivity e.g. fertilizers, soil conditioners, etc. Lime (burned and hydrated limestone) is widely used for improving soils with deficiency in CaO. As limestone is widely available in Ethiopia and lime readily can beLtransported in bulk it seems to be of national interest to investigate if Ethiopian agriculture areas are defecient
in CaO.

Due to climatic conditions (low rainfall and high evaporation rate) in many of Ethiopia's agricultural regions, soil contains too little moisture which hampers crop growth-rate and thus agricultural productivity. By adding porous material to this soil, moisture will be captured for a longer time and thus promotes the crop growth-rate. Abundant experiments on this subject have been carried out world-wide. As porous materials e.g. volcanics, scoria, etc. are abundant in Ethiopia and increased agricultural productivity in Ethiopa is strongly priorited a feasibility study on this subject should be carried out.

Yubido Platinum-Gold Deposit.

This is located in the western part of Wollega province. It can be reached by road from Addis Ababa. Platinum and other platinum group precious metals were discovered in early 1920's. The deposit is described as a strongly leached laterite fluvially reworked. According to EIGS the deposit which has a large areal extension, contains on average 0.031 gr Pt/m^3 and 0.375 gr Au/m^3 in very finely distributed magnetic and non-magnetic particles. The deposit has been worked in several periods, but with very limited success. To concentrate the ore, ground sluicing was employed but due to the very fine particle size the recovey was mostly very poor.

During the last 10-15 years a new technology for concentrating gold and other metals was developed by US Bureau of Mines (USBM), based on bio-chemical leaching. At present a Norwegian company NOREX A/S in close cooperation with experts from USBM are carrying out pilot-scale tests for bio-chemical leaching of copper-ore in Norway. The project is financially supported by the Norwegian Research Council. This bio-leaching process is already being commercially applied for gold-ore leaching in North America and South Africa. As part of a pre-feasibility study representative samples from the Yubido deposit could be sent to Norway for evaluation by NOREX A/S., but not before an in-situ evaluation of the deposit by Norwegian experts (e.g. NGU).

9.2 Eritrea

Considering the extremely low level of exploration (which is mostly out-dated) in Eritrea for more than 50 years, the country's known mineral resources are well diversified. Eritrea is a disciplined and pragmatic country now with low political risk, and as such would provide a good basis for both national and international mineral mining enterprises. Furthermore, its logistical position with a long coastline right on the major Red Sea trading routes, and surrounded by very populous countries, bodes well for Eritrea's future development in mineral mining.

Since 1991 artisanal gold production has started again in the Ubero region of south-west Eritrea. Present production (alluvial gold) is estimated to be around 10-15 kg of gold per year.

Major complex massive sulphide deposits (Pb, Zn, Cu) occur in several areas, of which the Debarwa deposit is the best known prospect. A Japanese mining company was granted exploration rights in 1971. Underground mining started in 1973 but operations were abandoned late in 1993 due to the war.

Potash is another potential resource, especially the Dallol evaporite deposit in the Danaki depression. Comprehensive studies were carried out by an American company during 1964-68, but data from their feasibility study are now somewhat obsolte.

Eritrea is a small but significant producer of non-metallics: bricks, glass, cement, salt, dimension stone, pottery clay, etc. Cement, an essential commodity for Eritrea's reconstruction, is produced near Massawa, utilising coastal limestone, shales and gypsum as raw materials. The 30 year old factory which now only produces 45.000 tonnes/year of cement is in urgent need of replacement.

Solar salt production in Eritrea (Massawa and Assab) is around 150.000 tonnes/year.

The development of the Asmara based glass industry dates from the 1940's. Glass raw materials, silica sand, dolomite, calcite and feldspar all come from domestic sources. The plant which

produces about 20 tonnes/day glassware (mostly bottles) is obsolete and is in urgent need for replacement.

Eritrea mines an attractive pink granite and a few other dimension stone deposits (good quality marble) are known at Barentu. Feldspar occurs at Shikili near Massawa, and kaolin at Adi Kwala south of Asmara. Barite occurs in the complex sulphide deposit at Debarwa. Many more industrial minerals will doubtless be identified once systematic mineral exploration begins.

The following mineral commodities are considered to be of interest for evaluation of short term development possibilities. They will possibly contribute to attract interest of both national and international companies to invest in the development of the mineral industry.

The proposed projects have in common that the need for capital input in the (pre-)feasibility stages of necessary investigations is limited. Furthermore, the studies can be carried out in a rather short time-span e.g. 1 - 3 years. Through close cooperation with EGS and other Eritrean experts a training component will be an integral part of the projects.

Debarwa Barite Deposit.

Associated with a complex massive sulphide deposit (Pb, Zn, Cu with 1-2 ppm Au) are massive layers of Barite, with an estimated tonnage of more than 1 million tonnes (at 95.5 - 97.8 % $BaSO_4$).

Barite (high specific weight) is used world-wide as drilling-mud additive in oil and gas drilling. Much information about the Debarwa deposit is available, but reports and drill-core material is scattered both in Ethiopia and Eritrea. (A Norwegian company is currently involved in barite production in Marocco).

The purpose of the project is to collect and re-analyse the available information of the barite and the polysulphide deposit and to present the results in a comprehensive report which at the same time will serve as an up-to-date information brochure for attracting mining interests. Such a presentation would be immensely improved with an airborne and ground geophysical input over a fairly restricted area.

Dimension stone.

Both marble and granite have a very high value (USD/tonne) on the international market, this will give the commodity access to the large European, Middle East and Far East markets. Some of Eritrea's dimension stone qualities are well known internationally, but so far no promotion work could be done. One of the main problems is that the known occurrences of Eritrean dimension stone lack sufficient in depth investigation regarding: consistency of quality, possibilities of large block extraction, choice of appropriate quarry site, technical specifications of stone quality, lack of standard size polished samples for display on international exhibitions, etc.

Cement and glass raw materials.

The Eritrean Ministry of Industry has firm plans to up-grade and expand the present cement and glass factory. For modern cement and glass processing more stringent quality requirements are needed than is the case for the present factory processes. Therfore, EGS is in urgent need for technical and economic support to cary out the necessary field investigations, chemical analysis

and laboratory testing.

Construction materials.

For the reconstruction of Eritrea's infra-structure, housing, etc. there is an urgent need for investigations for appropriate construction materials, preferrably located as close as possible to the major markets for construction materials. In order to rationalize production costs, large quarry sites for production of suitable raw materials should be the prime target for such investigations. In this context EGS needs technical and economic support for field investigations, laboratory analysis and necessary material testing.

Trondheim, 30 May 1994.

Brian A. Sturt
Research Director

Henri Barkey
Senior Geologist

ANNEX 1

TERMS OF REFERENCE

for

A FACT FINDING MISSION TO ETHIOPIA AND ERITREA

by

THE GEOLOGICAL SURVEY OF NORWAY (NGU)

1. Background

Norway has for a number of years been supporting various development activities in Ethiopia and Eritrea. The support has been financed from special allocations and has mainly been implemented by NGO's.

In October 1993 Norway decided to offer more long term Government to Government assistance to the two countries, based on formal requests from the local authorities. The fields in which Norway will offer assistance, are:

Ethiopia	Democratization, Natural Resources Management, Resource Mapping, Health, Energy, Financial Support.
Eritrea	Democratization, Rehabilitation of Refugees, Natural Resources Management, Resource Mapping, Education, Telecommunications.

Ethiopia and Eritrea have both requested Norway for assistance in strengthening their management of the mineral resources in the countries. As a first step, The Geological Survey of Norway (NGU) will undertake a fact finding mission to the two countries.

2. Objective

To provide a background for the possible future cooperation between Norway and the two countries Ethiopia and Eritrea in the field of mineral resources management.

3. Scope of Work

The review shall comprise, but not necessary be limited to, the following tasks in both countries:

3.1 Present a brief overview of the geology of the two countries, highlighting the importance of mineral deposits, deposits of building materials and hydrogeological conditions.

3.2 Present an overview of the National Geological Survey Units in the two countries, including their work responsibilities, organization, financing, staffing and physical facilities.

3.3 Present an overview of the status of the geological mapping and prospecting for minerals and construction materials in the two countries.

3.4 Present an overview of the Government agencies responsible for water affairs, in particular water as related to agriculture and human consumption in rural areas.

3.5 Discuss the most pressing services which should be offered by the Geological Survey Units during the next 5 - 10 years.

3.6 Discuss the inputs necessary in order to make the Geological Survey Units able to implement the recommendations under para 3.5.

3.7 Discuss possible future institutional cooperation between the two Geological Survey Units and the Geological Survey of Norway.

4. Participants, mode of work

4.1 The team shall consist of Brian A. Sturt and Henri Barkey from the Geological Survey of Norway.

4.2 The work shall be carried out in close cooperation with the appropriate authorities in Ethiopia and Eritrea, NORADs representative in the countries and NORAD in Oslo.

4.3 The work will include visits to the two countries and a review of relevant documentation.

4.4 The work shall be carried out during a three week period in May 1994. The field visit is expected to last for approximately 10 days. A preliminary, verbal report shall be presented to NORADs representative before the team returns to Norway and a written report, in English, shall be presented to NORAD in Oslo before 1.June 1994.

Agnete Eriksen
fung. avdelingsdirektør

Oslo, 18.5.1994

ANNEX 2

SUMMARY OF MEETINGS

04.05 **NORAD office** Addis Ababa, Ethiopia
Per Amund Gulden, Resident Representative NORAD
Leif B. Sauvik Ass. Resident Representative NORAD
Ketema Tadesse, Chief Geologist EIGS

05.05 **EIGS office** Addis Ababa, Ethiopia
Ketema Tadesse, Chief Geologist EIGS
Amenti Abraham, Head Regional Geology Dept. EIGS
Keith J. Luke, The World Bank, Technical Adviser MoME
Abiy Hunegua, Head Hydrocarbon Dept., EIGS
Metasebia Demessie, Head Data Processing, Documentation & Public Central Service, EIGS
Zelalem Adam,Head Central Geological Lab., EIGS

06.05 **Ministry of Mines and Energy**, Addis Ababa, Ethiopia
Wondemagegnehu Gebre-Selassie, Head Mineral Resources Exploration and Development Control Dept.
Shemsudin Ahmed, Vice Minister
EIGS office, Hydrogeology Dept., Addis Ababa, Ethiopia
Gebrebadik Eshete, Head Hydrogeology Division, EIGS
Getahun Kebede, Ass.Dept. Head Hydrogeology Div., EIGS
Berham Bekele, Deputy Head Geophysics Division, EIGS
Abebe Ayele, Senior Geophysicist, Geophysics Division, EIGS
Woldegiorgis Asfaha, Geophysicist, Geophysics Division, EIGS.
Ketema Tadesse, Chief Geologist, EIGS
NORAD Office; Per Amund Gulden

07.05 **Excursion Blue Nile Canyon**, geological section through Mesozoicum down to upper part of Precambrium. Guided by:
Keith J. Luke, Technical Adviser MoME

09.05 **Ministry of Natural Resources Development and Environmental Protection**, Addis Ababa, Ethiopia.
Gedion Asfaw, Vice Minister
Ato Sahle Sisay, Division Head Water & Sanitation, Water Resources Development and Protection Department
Ethiopian Mineral Resources Development Corporation, Addis Ababa, Ethiopia
Tebebe Tafesse, General Manager, EMRDC
EIGS office, Addis Ababa
Teshome Abera, Head Drilling Department, EIGS
Ahmed Mohamed Tuhaye, Deputy Head, Geochemistry Department, EIGS
NORAD office, evening arranged by Per Amund Gulden

10.05 **Water Resources Development Authority, MoNRDEP**, Addis Abeba, Ethiopia
Ato Tamene Tefere, Head of Planning and Programming Department
Ayalew Nigussie, Assistant Head Project Operations and Water Management Dept.
Reshid Abdelle, Hydrogeologist, Water Well Drilling, Construction and Rehabilitation Work, WRDA
Water Supply and Sewerage Agency, MoNRDEP, Addis Ababa, Ethiopa
Mesfin Tegene, Head Construction Control Department
EIGS office, Addis Ababa
Aklilu Assefa, Head Mineral Exploration Department, EIGS
Amenti Abraham, Dept.Senior Geologist, Head Regional Geology Department, EIGS

11.05 **EIGS office**, Addis Abeba, Ethiopia
Amenti Abraham, Amenti Abraham, Dept. Senior Geologist, EIGS
Aklilu Assefa, Head Mineral Exploration Department, EIGS
NORAD office, Addis Ababa, Ethiopa
Per Amund Gulden, Res.Rep. NORAD
Leif B. Sauvik, Ass. Res. Rep. NORAD
NORAD office, Asmara, Eritrea
Arild Jacobsen, Res. Rep. NORAD
Ambasoira hotel, Asmara, Eritrea
Arild Jacobsen, Res. Rep. NORAD
Michael Abraha, Deputy Head Eritrean Geological Survey
Gudrun Landbø, Senior Executive Officer Africa, NORAD
Marit H. Vedeld, Adviser, Education Division, NORAD

12.05 **NORAD office**, Asmara, Eritrea
Arild Jacobsen, Res. Rep. NORAD
Gudrun Landbø, Senior Executive Officer, NORAD
Michael Abraha, Deputy Head EGS
Mohammed Berhan, Senior Geophyscist, Hydrocarbon Unit, MoEMWR
Tesfon Haile, Project Officer, WRD, MoEMWR
Ghebremicael Tennewo, Head Planning & Programming, WRD, MoEMWR
WRD office, Asmara, Eritrea
Ghebremicael Tennewo, Head Planning & Programming
Tesfon Haile, Project Officer
Hydrocarbon Unit office, MoEMWR, Asmara, Eritrea
Mohammed Berhan, Senior Geophysicist
NORAD office, Asmara
Arild Jacobsen, Res. Rep. NORAD

13.05 **EGS office, Department of Mines, MoEMWR**, Asmara, Eritrea
Michael Abraha, Deputy Head, EGS
Mines Control Office, Department og Mines
Mebrathu Ekubarghi, Deputy Head, Mines Control
EGS office, Asmara
Michael Abraha, Deputy Head, EGS
Belai Abraha, Geochemist, EGS
Ermias Yohannes, Mineralogist, EGS
Duncan Dow, Technical Adviser, Australian Aid Programme
NORAD office, Asmara

Arild Jacobsen, Res. Rep. NORAD

14.05 **Field excursion, Asmara Mineral Belt**

15.05 **Field excursion, Asmara escarpment**, Precambrian section
Duncuan Dow, Technical Adviser, Australian Aid Programme

16.05 **Department of Mines office**, Asmara, Eritrea
Asmerom Mesfin, Head of Department
Alem Kilbreab, Deputy Head of Dept.
Michael Abraha, Deputy Head, EGS
NORAD office, Asmara
Arild Jacobsen, Res. Rep. NORAD
Ambasoira hotel, dinner meeting
Arild Jacobsen, Res.Rep. NORAD
Asmeron Mesfin, Head DoM
Alem Kilbreab, Deputy Head DoM
Michael Abraha, Deputy Head EGS
Ghebremicael Temnewo, Head Panning & Programming, WRD
Mebrathu Ekuberghi, Deputy Head, Mines Control
Mohammed Abdul Kadir, Head Hydrocarbon Unit
Mohammed Berhan, Senior Geophysicist, HcUMoEMWR

17.05 **Department of Mines office**, Asmara
Alem Kilbreab, Deputy Head DoM
EGS office, Asmara
Michael Abraha, Deputy Head EGS
Mebrathu Ekuberghi, Deputy Head, Mines Control
Ministry of Energy, Mines and Water Resources, Asmara, Eritrea
Tefsai Gebre-Selassie, Minister
Arild Jacobsen, Res.Rep. NORAD