DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2002/97

Progress Report Mining Sector Development and Environment Project

NDF Credit 156-14
Adviser to the Director of the Geological Survey Department (GSD)

Feiko Kalsbeek

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF THE ENVIRONMENT

GEUS

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Republic of Ghana

Ministry of Mines

Minerals Commission

Progress Report

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Executive summary

The project is following the overall plan stipulated in the ToR and the Inception Report.
It has been found that the combination of a team leader using approx. 50% of the available hours and a number of specialists using the other 50% is beneficial both for the project and for the GSD.

Funding and staff
The funding available for the GSD is not sufficient to allow for investments in necessary equipment, such as instrumentation for the thin section laboratory, for the maintenance of the vehicles etc.
The geoscientific staff constitutes at present only 15% of the total of ca. 300 members of GSD staff. This proportion is too low, and the GSD plans gradually to improve the ratio between scientific and auxiliary staff.

Semiautonomous status
As stated in numerous earlier reports, for the GSD to become an effective Survey, it must develop into a semiautonomous organisation. In accordance herewith a plan for this development is being discussed, and Mission & Vision statements as well as a draft structure have been prepared in the first half of 2002. The contents of these have been completed and mutually agreed upon by the GSD and GEUS; they are described in the present report. In its effort to become semiautonomous, the GSD has prepared a draft 'Geological Survey Act'; GEUS has helped the GSD with this document.

Geological mapping
Geological mapping has been going on in several areas during the period, and it is envisaged that drafts of a few new map sheets at 1:100 000 can be produced based on these data by the end of 2002. A number of existing maps have been scanned and are in the process of being digitised, in support of future digital map production and publication of traditional as well as digital maps.

Human Resources Development
The Survey's plans for its Human Resources Development have been set out in a document 'Draft Training Policy' (1999). GEUS envisages to play an active role in this matter. The Adviser has taken part in the fieldwork, in order on the one hand to increase the skills of the staff, and on the other hand to evaluate the need for further training. Additionally he has given a course of lectures for the assistant geologists. During this process it has been realised that a general lack of training of the junior geologists (and to a certain extent also of some of the other geologists) may well be one of the main problems for the GSD. This aspect must be addressed in future projects involving the GSD.

Geophysical Surveys
The geophysical department is functioning well, and is producing geophysical and interpretational maps of international standard. However, it is felt that better cooperation

between the Divisions of Geophysics and Geological Mapping would be beneficial for the GSD.

Records and library

Through the 'Archives Rehabilitation Project' major progress has been made in updating, saving and reprinting of old records and maps. The library has been reorganised.

Databases

The GSD is currently going through the first stages of creating a meta-database describing its data with the assistance of GEUS. This activity will be intensified during a study tour for Mr. Kwame Boamah, head of the GSD's Division of Data Management, to GEUS in Copenhagen.

Regional offices

The low productivity of the regional offices is a reason for concern. GEUS suggests the GSD to analyse this problem carefully, not excluding the possibility of a total closure. If this is practically unrealistic, a special programme should be devised to activate the regional offices by giving them well defined jobs to do.

The project period

The SYSMIN (MSS) project, which will follow after the present project, is likely to be delayed relative to the original plan, not starting in 2003 but more likely early 2004. In order to better prepare the GSD for the SYSMIN programme, it is recommended that the present project is continued until the end of 2003, as indicated in the Draft Project Implementation Plan in the Inception Report (p. 19).

1. Activities in the period

Under the contract between the Geological Survey of Denmark and Greenland (GEUS) and the Minerals Commission, Ghana, the Geological Survey Department (GSD) was visited by officers from GEUS as follows:

After the inception period (October – December 2001) the team leader (Dr. Feiko Kalsbeek) was at the GSD from January 3rd to February 4th, March 15th to May 1st, and June 1st to July 6th 2002.
Dr. Christian Knudsen, Head of GEUS' Department of Geological Mapping visited the Survey from January 12th to January 18th and June 24th to June 30th 2002.
Mr. Bjørn Hermansen, GIS specialist at GEUS, visited the Survey from January 29th to February 10th and from April 23rd to May 7th 2002.
Mr. Leif Thorning, Head of GEUS' Department of Economic Geology, and specialist in the organisation of Databases, visited the Survey from May 3rd to 11th 2002.
Mrs. Marianne Thorsen, Chief Consultant and legal expert at GEUS, visited the Survey from June 24th to June 30th 2002.

Mission reports of these visits are attached to this report.

Apart from these activities GEUS has supported the GSD in various other ways, see Appendix 1.

2. General conditions

2.1. Funding

As concluded in the Inception Report, the performance of the GSD cannot be significantly improved unless more money becomes available, and the Survey is changed into a semi-autonomous institution. The general conditions as described in the Inception Report are largely unchanged. During the first half of 2002 only ¢ 203 million were released for Services; a portion of ¢ 271 million approved by the Government for the second quarter of 2002 had not yet been released in the beginning of July. The economic starvation of the Survey is illustrated, for example, by the fact that the various field teams had to be called back from the field at the end of June 2002, because the necessary money had not been released.

2.2. The status of GSD

The necessity for the GSD to become a semi-autonomous organisation has been recognised for a number of years. At a meeting at Akosombo, 2nd and 3rd December 1998, chaired by the then Minister of Mines and Energy, it was decided that "The GSD will continue to be under the Ministry of Mines and Energy but as an *autonomous* institution to be called *Ghana Geological Survey*". Since then, the GSD has been preparing for this new status, and at present the Survey is finalizing a 'Draft Geological Survey Act'. This Draft was discussed in detail with GEUS' legal officer, Mrs. Marianne Thorsen, during meetings in the period 24 – 30 June, 2002. Mrs. Thorsen has submitted her recommendations to the Survey (Appendix 10), which is now continuing its work with the Draft Act. The Survey hopes to be able within a few months to present the Draft Act to the Minister and to the Attorney General's Department for final drafting, and, hopefully, have it accepted by the Parliament by the end of 2002 or early in 2003. GEUS strongly supports this development and offers further help should this be needed.

As a semi-autonomous organisation the Survey will have the possibility to generate funding for its core activities by providing services to outside organisations. Moreover, the Survey will have the option to 'right-size' the number of staff, and be able to allocate the money freely for salaries, education, investment and services. The Survey has prepared a 'Draft Memorandum to the Minister' in which it presents estimates for the earnings that could be gained by its various activities. GEUS has the feeling that these estimates may be too optimistic and recommends caution with respect to GSD's future revenues. Under all circumstances it will take time before significant earnings can be realised, particularly because large investments will have to be made to set up the services (e.g. drilling) from which the Survey expects future earnings to be made.

In order to prepare for its future activities, the GSD has worked out several strategic documents, among other papers a draft 'Strategic 10-year plan' and a draft 'Ghana

Geological Information Management Strategy'. These documents have been prepared without the involvement of the Adviser, in part because the work on them started already before the beginning of the present project. GEUS will discuss these documents with the GSD during the next half year.

2.3. GSD's personnel

In the Inception Report mention was made of the large numbers of GSD personnel that, because of the Survey's economical difficulties, could not do much useful work. The tables below give an overview of the staff employed at the different GSD offices, their age distribution and the number of geoscientific staff compared to the number of auxiliary staff.

GSD staff at Accra and at the Regional Offices

	Total staff (No)	Scientific staff (No)	Scientific staff (%)	Mean age (years)	Mean age Sci. Staff
Accra	136	29	21	42.7	38.9
Tamale	23	3	13	48.9	
Takoradi	26	4	15	45.2	
Saltpond	33	2	6	49.2	
Kumasi	29	3	10	48.4	
Koforidua	36	2	6	45.0	
Ho	28	3	11	47.0	

Age	Total staff (No)	Scientific staff (No)	Scientific staff (%)
20 – 25	7	1	14
26 – 30	24	9	38
31 – 35	22	10	45
36 – 40	19	5	26
41 – 45	61	8	13
46 – 50	86	7	8
51 – 55	57	4	7
56 – 60	35	2	6

It is apparent that this large number of staff, which can only be inefficiently utilised, is one of the major problems facing the GSD. At present all wages are being paid directly by the Government. As soon as the Survey becomes semi-autonomous this situation is likely to change, and in that case it will be necessary to resize the Survey to a level corresponding to its financial possibilities. The Adviser has understood that, for socio-economic reasons, it is nearly impossible in Ghana to lay off superfluous staff, unless this is government policy. GEUS is not in the position to suggest a solution to this problem. However, steps will have to be taken to seriously address the issue.

2.4. Geological Mapping

Geological mapping is at present going on in the Upper West Region (two teams), the Upper East Region (one team), the Volta Region (one team) and the Greater Accra Region (one team). During the six-month period following the inception period, the Adviser has been in the field with all these teams. Most of the mapping is going reasonably well (see Appendix 2, attachment 3), and will hopefully result in new geological maps by the end of the year. However, several geologists and most assistant geologists still have much to learn.

Shortage of funding is seriously hampering the mapping projects. One team in the Upper West Region had continuous problems with its vehicle, which needed repairs, but because of lack of funding this was seriously delayed. Although mapping had not been finished, all teams were called back from the field at the end of June, because no more money was available.

The preliminary 'Field Instructions and Standards' (see Inception Report) have proved to serve their purpose in standardising the collection of information. Thus, it will be possible to enter the data into an electronic format in order to simplify map compilation. It is planned to produce the final maps in-house at the GSD's GIS laboratory, if needed with GEUS support. If possible brief explanatory notes to the maps will also be available by the end of 2002.

Surprisingly, no aerial photographs were used during the mapping. In principle, aerial photographs can be obtained from the Ghana (geodetic) Survey Department, but, for reasons not well understood by the Adviser, it has not been possible to get them for use by the mapping teams. There have been contacts between the GSD and the Survey Department to improve this situation, but at the time of writing no aerial photographs have been forthcoming. Geological maps compiled without use of aerial photographs will lack important information.

Under the coming SYSMIN programme geologists from the GSD will have the opportunity to cooperate with geologists from other countries, thereby increasing their experience. SYSMIN will also provide new field equipment. It is likely that these activities will considerably improve the Survey's field geological mapping.

2.5. Human Resources Development

Before co-operation with GEUS began in October 2001 the Survey had worked out a document describing its ambitions for Human Resources Development. Because of economic restrictions most of these ambitions have not been realised. GEUS has therefore used a significant part of its efforts on in-house training of Survey staff. In January 2002 the Adviser visited most of the mapping teams in the field, to give instruction in the proper description of common rock types and the most important structural features encountered. It showed clearly that most of the younger (assistant) geologists had and still have an urgent need for further instruction (Appendix 2, attachment 3).

In April the Adviser gave a course in elementary field mapping, the use of stereograms, the reading of simple geological maps etc., as well as the use of the petrographic microscope and the interpretation of geochemical and isotopic data. Most of these topics belong to the standard syllabus of undergraduate geology training at most Universities. Although most young geologists took part with enthusiasm, it was evident that their experience with these matters is very limited (Appendix 3, attachment 2). Furthermore, a seminar was held, during which a number of the assistant geologists presented short talks on topics chosen from papers in international journals. The aim of this seminar was (1) to train the participants in reading and digesting scientific literature (with the help of the Adviser), and (2) to present their topics for a wider audience. Although a few of the participants performed well, the overall results of this exercise were not encouraging, and it is clear that the young geologists need much more training in order to become a firm basis upon which an effective Survey can be built. GEUS is of the opinion that this is one of the most important issues to be addressed during the second half of the project.

During his stay in Denmark, May 2002, the Adviser has prepared a collection of thin sections, comprising all common minerals and rock types, for the junior geologists to study (Appendix 4, attachment 1). During the Advisers subsequent stay in Ghana June – July 2002 the assistant geologists extensively and eagerly studied this collection. Good progress was noted for most participants.

A large part (ca 1/3) of Ghana consists of sedimentary bedrock of Upper Proterozoic to Lower Palaeozoic age of the Volta Basin. There are important natural resources (water, minerals, energy) related to these rocks, which are also to be the focus of the future SYSMIN geophysical activity. However, there is a severe lack of experienced sedimentologists and stratigraphers in the GSD, which would be needed in associated programmes directed towards understanding the geology of the Volta Basin. This is an example that underlines the need for careful matching of the personnel with the work at hand, in order to exploit the benefits of externally funded projects. In practice, however, this is difficult – the GSD has earlier sent Survey geologists abroad for further training in stratigraphy and sedimentology, but soon after their return to Ghana they left the Survey for better paid jobs.

2.6. Laboratories

At present neither the Petrographic (thin section) Laboratory nor the Geochemical Laboratory is functioning. However, this situation will soon be improved. According to the plans of the upcoming SYSMIN programme new facilities will be established for the production of thin sections, for rock crushing etc.

Moreover, after several years of application, the Ghana Government has now allotted money to the Survey for the purchase of a new Spectro X-2000 X-ray Fluorescence spectrometer, which will permit to analyse geological materials for a large range of chemical elements.

GEUS has stressed that, when investing in such expensive equipment as the X-ray Fluorescence spectrometer, it is important that the following issues have been taken care of:

- All XRF instruments need a stable power supply; this can be a problem in Ghana because of the common power failures, and it may be necessary with an alternative power source.
- The Spectro X-2000 needs cooling with liquid nitrogen. Sufficient funding must be available for this on a daily use basis.
- Spare parts, service and repairs are very expensive and sufficient funding must be available for quick repairs or replacements.
- The necessary equipment for sample preparation must be in place and function routinely.
- 3 days of in-house training is included in the price of the XRF instrument. This is likely to be far too little for the GSD staff to get sufficiently familiar with the instrument, and further training will be badly needed.

The GSD has taken steps to address these issues.

2.7. Records and Library

The 'Archives Rehabilitation Unit', which operates under a two year Ghana-Germany co-operation program, is reorganizing and restructuring the GSD's record keeping system, and helps to update and secure numerous records, maps and books kept in the Department's Archives. The Unit has been able to achieve a number of its targets. Since its establishment in February 2001 it has successfully implemented the following tasks in order to reach its final goals:

- 60 out of 100 'Archive Reports' printed during the late 1980s and early 1990s, which had faded due to unstable printing media used at the time, have been recovered and re-edited, and 52 out of them have been reprinted.

- At the time of writing the 'Drawing Office' had recorded 368 geological and related maps as part of an ongoing inventory exercise to systematically capture the number and nature of maps stored at the GSD.

- During the same period the 'Records Office' has registered 5,706 copies of Bulletins, 98 of Memoirs and 1,034 of Geological Reports in computerized forms specially designed by the Archive Rehabilitation Unit for that purpose.

- The Archive Rehabilitation Unit has begun to develop a database in conjunction with the Data Management Division of the GSD, built on a software program developed by the United Sates Geological Survey named 'Metadata'. Eventually all of the above mentioned records would be stored within this database for convenient use.

Plans are far advanced to possibly extend the present project, which draws to a close by the end of January 2003, for a further two-year period. The 'German Development Cooperation (GTZ)' and its partner, the 'Center for International Migration and Development (CIM)' have signaled their support. Realization very much depends on the provision of funding by the German Government.

The library has been reorganised. However, few modern textbooks or international journals are available, and the library is therefore as yet of little practical use.

GEUS has presented the GSD library with a number of publications, mainly on African geology. A number of journals in the GEUS library had become superfluous when the libraries of GEUS and the Department of Geology, University of Copenhagen, were joined. From these the GSD has selected a number for its library in order to improve, among other topics, its coverage of African geology.

As soon as the GSD's economical situation will make it possible, the Survey should acquire a restricted number of modern textbooks in order to keep its staff informed on recent developments in their various fields of activity.

2.8. Digitising of geological maps

A small group of assistant geologists has been engaged in the digitising of existing geological maps under the direction of the Head of the Division of Data Management, Mr. K.O. Boamah. This work is being supported by GEUS, and one of GEUS' experts in GIS applications, Mr. Bjørn Hermansen, has visited the GSD for two periods, January 29th to February 10th and April 23rd to May 7th 2002 (Appendices 7 and 8). Moreover, Mr. Hermansen has been continuously in contact with the GSD by e-mail to help solve ad-hoc problems.

This work is progressing well. Until recently the work has been seriously hampered by the lack of a computer network and a sufficient number of modern PC's. Recently two new powerful computers have been acquired, significantly increasing the output of the GIS laboratory.

To support the process the BGR (in Germany), at the request of GEUS, has scanned the 12 maps they have made in co-operation with the GSD in the 1990's. Moreover GEUS will be helping the GSD by scanning most of their other maps in Copenhagen. At the time of writing the first set of 20 maps has been scanned, and a CD-ROM with the information will be given to Mr. Boamah during his stay at GEUS in September – October.

It is planned that the GIS group of the GSD will prepare the new geological maps for the field teams working in the Upper West and Upper East Regions and the Greater Accra Region by the end of 2002.

2.9. Regional Offices

It is generally agreed that, due to the economic starvation of the GSD, the Regional Offices are unproductive. As pointed out in the Inception Report, the present situation has several major disadvantages: (1) The experience and knowledge of the Regional Geologists are not used to the best benefit of the Survey. This problem is enhanced by the difficulties of communication in Ghana. (2) Although not much money is being spent at the Regional Offices, the money and the vehicles would be of better use in Accra. (3) The geologists at the Regional Offices cannot easily take part in the courses and other training provided in Accra. It is GEUS opinion that, at least for the present, all activities should be concentrated in Accra, and all Geologists and assistant geologists transferred to the main office.

If this is not possible, ways will have to be sought to revitalize the Regional Offices and find well defined jobs for them to do. This might be possible with support from the upcoming SYSMIN project or from similar programmes.

In its ‘Strategic 10-years plan’ the Survey envisages future geological mapping to be undertaken by the Regional Offices.

3. Mission and Vision

As mentioned in the Inception Report, in the present formulation of the GSD's Mission statement:

"*GSD exists to provide reliable and up-to-date geological information for accelerated national development through cost-effective geological mapping, research and investigation"*

it did not clearly come out that, in order to *provide* information; it should be *collected, stored* and *disseminated.*

The Mission statement was extensively discussed at meetings between GSD and GEUS officers on June 25 – 27, 2002, and the following, more detailed statement was formulated:

"The Ghana Geological Survey, as the principal curator of all national geoscientific data, has the main task to continuously generate, collect, store and archive geoscientific data, and to disseminate data and information in a user-friendly way to the government, industry and the public at large. Generation of geoscientific data is done through geological mapping, research and investigation. The Survey has the responsibility to advise the State to make informed decisions on geoscientific issues concerning mineral resources, environment, groundwater management, land use planning and geohazards".

Simultaneously, the visions of the future Ghana Geological Survey were discussed. They express the ideals to be aimed at, and can be used as guide lines for coming activities:

"The Ghana Geological Survey endeavours

- To develop into a Geological Survey which is highly recognised internationally and which has a competitive reputation world-wide.
- To create an attractive and inspiring working environment, based on ethical and social values, and thereby maintain a skilled work force.
- To produce up-to-date geological maps, based on the integration of geological, geophysical, geochemical and remote sensing data in a GIS environment.
- To re-establish a national digital seismic network in order to define earthquake-prone zones in the country as input for effective land-use planning.
- To contribute to the continuous exploration and sustainable exploitation of rocks, minerals, hydrocarbons, and underground water resources.
- To establish and maintain a national geological information system consisting of reports, maps and other data in an easily accessible manner for end-users. This should include all borehole information such as reports, logs and cores.
- To continuously publish its new geological findings nationally and internationally.
- To be pro-active in promoting the public understanding of the relevance of geosciences to key issues for society and the importance of the Survey for sustainable development".

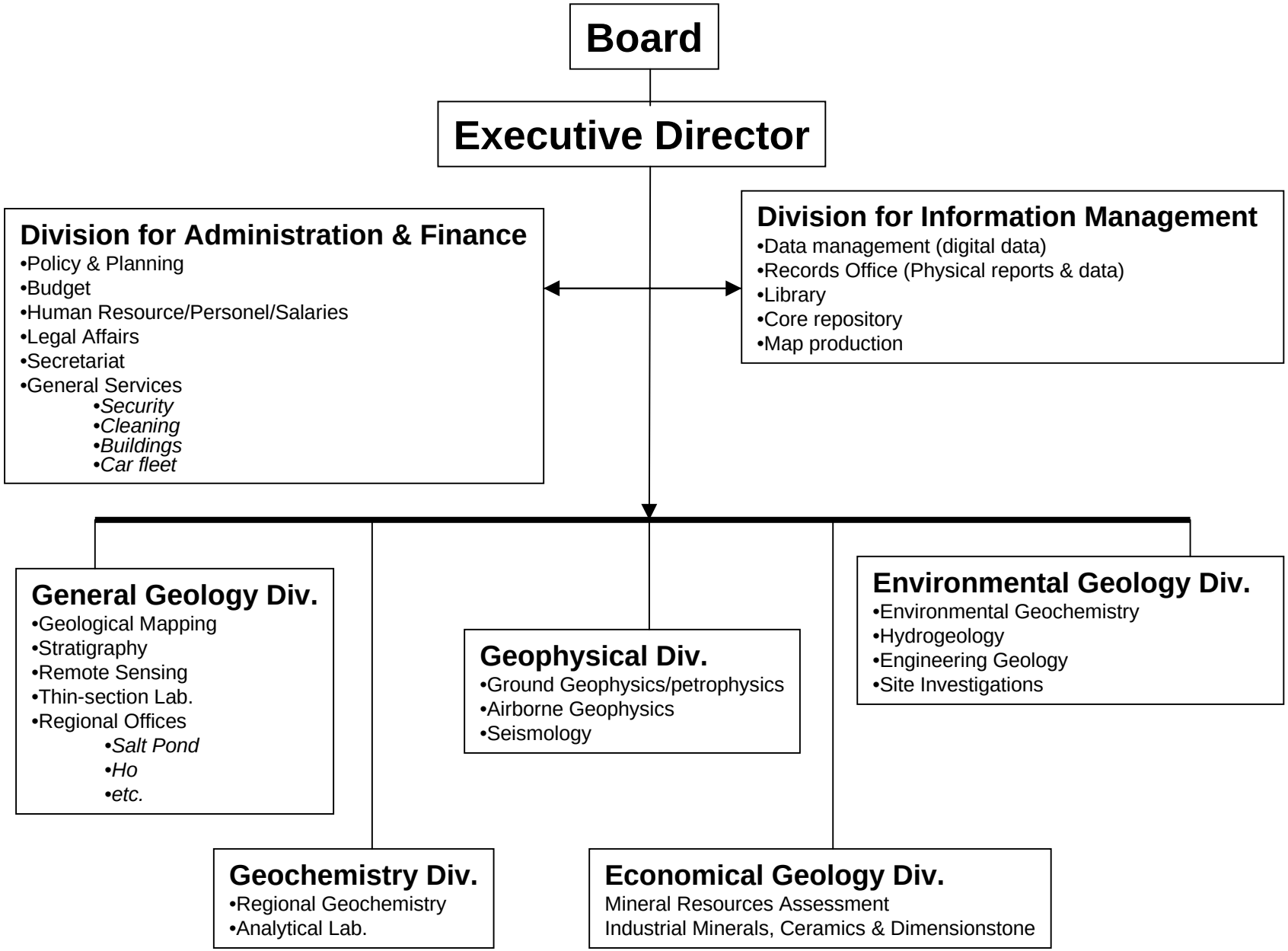
4. The Structure of the Survey

The temporary structure, established during the inception period, involved the following Divisions (earlier referred to as 'Departments'):

Division of Geological Mapping (Head of Division Mr. G.K. Loh)
Division of Geophysics (Head of Division Mr. S.K. Amedofu)
Division of Geochemistry (Head of Division Dr. D. Boamah)
Division of Data Management (Head of Division Mr. K.O. Boamah)
Division of Clay Mineralogy and Ceramics (Head of Division Mr. J.H.K. Addo)
Division of Environmental Geology (Head of Division Mr. E. Efa).

This structure, which is very similar to the one proposed by the GDS and captured in the Fact-Finding Mission of the Finnish Geological Survey, has worked reasonably well. However, when the Survey becomes independent and more effective, the structure of the Survey will have to embrace new activities. During the meetings between the GSD and GEUS in Accra, June 25 – 27, 2002, the structure shown on the next page emerged. This structure operates with 5 'data collecting' Divisions, more or less equal to the existing divisions, but with a new Division for Economical Geology (embracing the present Division of Clay Mineralogy and Ceramics), and 2 more general Divisions, one for Administration and Finance, and one for Information Management. The sections under the various divisions, as shown in the diagram, have not yet been finalised. It is envisaged that a Director will head the various divisions. For the time being the Regional Offices (to be headed by Deputy Directors) have provisionally been organised under the Division of General Geology, because the Survey plans in the future to have most geological mapping organised from the Regional Offices.

Although there is general agreement on the main lines of this organisational structure, details will have to be discussed before it can be finally accepted by the Survey.


Board
Executive Director
Division for Administration & Finance
•Policy & Planning
•Budget
•Human Resource/Personel/Salaries
•Legal Affairs
•Secretariat
•General Services
•Security
•Cleaning
•Buildings
•Car fleet
Division for Information Management
•Data management (digital data)
•Records Office (Physical reports & data)
•Library
•Core repository
•Map production
General Geology Div.
•Geological Mapping
•Stratigraphy
•Remote Sensing
•Thin-section Lab.
•Regional Offices
•Salt Pond
•Ho
•etc.
Geophysical Div.
•Ground Geophysics/petrophysics
•Airborne Geophysics
•Seismology
Environmental Geology Div.
•Environmental Geochemistry
•Hydrogeology
•Engineering Geology
•Site Investigations
Geochemistry Div.
•Regional Geochemistry
•Analytical Lab.
Economical Geology Div.
Mineral Resources Assessment
Industrial Minerals, Ceramics & Dimensionstone

5. Data Bases

Mr. Leif Thorning of GEUS has visited the GSD from May 3rd – 11th in order to obtain an insight into the present situation and future needs regarding GSD's data bases. He had meetings with all GSD's Divisions to discuss their wishes in this respect (see Appendix 9).
With respect to its future information management the Survey has prepared a draft 'Ghana Geological Information Strategy' (4 June, 2002). GEUS has not been involved in the preparation of this document.

In order to make further progress with GSD data bases, it is planned that the Head of GSD's Division of Data Management, Mr. K.O. Boamah, will work for one month at the GEUS offices in Copenhagen to become familiar with the various kinds of data bases used there. During this period and using the required databases for GSD as the study material, Mr. Boamah will get on the job training with full access to all relevant GEUS experts, while working with GSD databases according to his own choice.

6. Appendices

Appendix 1. Other GEUS services to GSD

Outside the contract, and without outside funding, GEUS has supported the GSD as follows:

- In order to support the fieldwork in Ghana, 216 thin sections were prepared at GEUS for microscopic investigation. Seventy-three samples were, or are being, chemically analysed for major elements by X-Ray Fluorescence Spectrometry (XRF), and 58 samples were analysed for a range of trace elements by Inductively Coupled Plasma Mass Spectrometry (ICP-MS).
- GEUS has carried out ICP-MS test analyses to establish if the rock grinding system at the GSD is sufficiently contamination-free to be used for the preparation of samples for chemical analysis, see Attachment 1 in Appendix 2.
- Two officers of the GSD have for six weeks taken part in GEUS' fieldwork in Greenland for further training in an international group of geologists (Appendix 4, attachment 3).
- A collection of 50 thin sections was prepared from Greenland rocks for instruction of GSD assistant geologists (Appendix 4, attachment 1).
- While in Denmark, Mr. Bjørn Hermansen has regularly provided support to the GIS group at the GSD by e-mail and telephone contact.
- GEUS has scanned 20 geological maps from the files of the GSD in Copenhagen.
- GEUS has provided the GSD library with a large number of (mainly African) geological journals, selected by the GSD from material that had become available by the joining of the GEUS library with that of the Department of Geology, University of Copenhagen. GEUS paid the transport.

Appendix 2.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

The Advisers 2nd visit to the Geological Survey Department

Mission Report – 4 January to 4 February 2002

Prepared by Feiko Kalsbeek
Geological Survey of Denmark and Greenland (GEUS)

Report on the Advisers 2nd visit to the Geological Survey Department, 4 January – 4 February 2002

Feiko Kalsbeek

When I arrived at the Survey on January 4th there was no electrical power in the main building. I was offered another office in the 'World Bank Buiding', but I preferred to keep my old office and use the laptop instead of the large PC that the Survey had provided for my use.

From talking with different members of staff I understood that the Director's meetings with the Heads of Departments had been continued on a regular basis, that the preliminary field instructions had proved to be helpful, that registration of all existing geological maps was going on under the direction of Dr. Mauer, that several young assistant geologists/ geophysicists had been employed, and that the fieldwork of the Survey's geologists had been postponed because of economic problems.

The Survey's Acting Director, Mr. P.Y.O. Amoako informed me that the GSD this year will get a new XRF instrument. He was aware of GEUS' reservations in this matter (see Inception Report), but the instrument had been on the GSD's list of badly needed laboratory equipment for years, and now that the Governement had included it into the budget, the GSD could hardly object. The rooms where the new instrument is to be installed has been cleaned out and will have to be partly rebuilt.

For the time being GEUS will carry out the chemical analyses needed in connection with the ongoing fieldwork. In this connection Mr. Loh (Head of the Survey's Department of Geological Mapping) and I tested the rock crushing facilities at the Survey. There is one functioning jaw crusher, and a Siebtechnik swing-mill with both an agate mortar and a mortar of unknown composition – chrome-steel or tungsten carbide. In order to see if this second mortar can be used to crush rock samples for standard chemical analyses, pieces of quartz were pulverized in this mortar and analyzed at the GEUS laboratories. No contamination with iron or chromium was detected, but there were traces of tungsten and cobolt (Attachment 1), showing the mortar in question to consist of tungsten carbide, and therefore suitable for the preparation of samples for nearly all analytical purposes.

At a Heads of Departments meeting on 8 January I suggested to organise courses for the junior geologists at my next visit to the Survey; this was accepted. Mr. Loh asked if I could include training in the petrographical study of rocks; two new petrographic microscopes are present in the GSD stores. I enquired whether it was possible to buy a few modern text books, but with the present state of the Survey's economy this is difficult. Mr. Amoako stressed the necessity for the GSD to closely cooperate with other State organisations such as the Geology Department at the University at Legon.

In connection with the GSD's plans to engage in geochemical work, Mr. Amoako had arranged for a meeting with the Ghana Atomic Energy Commission (GAEC, 20 km north of Accra) which has both an XRF spectrometer and a little reactor with Instrumental Neutron Activation Analytical (INAA) facilities. The GAEC laboratories can analyse up to 4000

samples per year, the main limiting factor being the high cost of liquid nitrogen needed for the analyses.

Mr. Amoako suggested possible cooperation between the two organisations. It proved that GAEC is interested in true scientific cooperation, but not in just providing analyses to the GSD. I suggested a geochemical study of lateritic soils to see if it is possible to assess from the composition of the laterite what kind of rock lies beneath it. I worked out a formal project proposal which was accepted at a later meeting (Attachment 2). Funding for the project will have to be found.

Dr. Christian Knudsen of GEUS visited the GSD from 12 to 18 January. During his visit we compared the areas to be mapped during the upcoming SYSMIN project with the areas in Ghana where modern maps are already available. It proved that (1) some of the areas suggested in the draft SYSMIN tender documents overlap with areas mapped earlier during the Ghana-Germany cooperative project, and (2) that errors had been made in the draft, such that some of the areas mentioned lie outside Ghana. It will be necessary to draw the SYSMIN authorities' attention to this problem.
On Friday 18 January, at the end of Dr. Knudsens visit, Mr. Amoako presented us with a 'Draft Strategic Plan 2002 - 2007'.

At this time of the year most of the geologists are doing field work, and twelve days of this visit to the GSD were spent in the field, first to get an insight into the geology of the country and, second, to get an impression of the capability of the Survey's geologists. Two days were spent in the Greater Accra Region, four days in the Upper West Region, around Jirapa and Nandom, and two days in the Upper East region, around Bolgatanga. Most of the field work appeared to be of a good quality, and it may be expected that by the end of 2002 new geological maps of the mapping areas can be prepared. A report on these field trips was delivered to Mr. Amoako, and is attached to this report (Attachment 3).
One important finding was that the field geologists did not have air photographs (and no camera unless they own one themselves). In principle, aerial photographs can be obtained from the Ghana (geodetic) Survey. However, although several attempts were made to acquire the necessary photographs, it proved that there are practical problems in getting them out of the Ghana Survey's stores. By the time of writing (25 March) no air photos were yet available.
It appears that when money has to be transferred to the field teams, the Accountant travels personally to the various mapping teams, literally to hand over the money. The Adviser asked why the money was not transferred through a bank. Mr. Amoako explained that the reason to pay by hand is to minimise the possibility of fraudulent practices. In this connection he told me that, although the Accountant works at the GSD, he is not employed by the Survey but by the Ministry of Finance.
Due to the lack of sufficient funding it was decided to wait with the thin section laboratory until SYSMIN money, or other sources of outside funding, become available. GEUS will provide thin sections in the mean time.

On Tuesday 29 January Mr. Bjørn Hermansen (GEUS) arrived to assist the GIS group at the Survey under the direction of Mr. K.O. Boamah (Head of the Department of Data Management). Three newly appointed members of staff are engaged in digitizing old

maps, and it is hoped that the effectivity of this work can be enhanced with GEUS support. The new PC that had been provided to the Adviser was transferred to the GIS group to work with; it is the fastest PC available at the Survey, and because of the power break at the main building it cannot be used there.

Attachment 1

Test of Swing mill

The Siebtechnik Swing mill at the GSD has two mortars, one made of agate and one made of an unknown metallic substance, either chromium steel or wolfram carbide (WC). In order to test the composition of the metal mortar, four samples were prepared from pure quartz, one by milling in the agate mortar, and three by milling for 2, 3 and 5 minutes in the metal mortar. Milling in the agate mortar did not provide a fine powder, and this sample was therefore re-ground in the WC mortar at GEUS. The following report was received from the GEUS laboratory (translated from Danish):

Dear Feiko,

We have analysed your quartz samples by the ICP-TotalQuant method, which yields semi-quantative determinations of 'all' elements. Since we treat the samples with HF, silica could not, of course, be determined.

The conclusion is that the mortar is made of WC.

The most important numbers are (concentrations in parts per million)

	Agate	WC, 2 min.	WC, 3 min.	WC, 5 min.
Fe	372	356	301	157
Cr	4	3	1.7	1.6
Ni	3.6	0	0	0
Co	196	340	309	460
W	337	550	711	511

The agate sample has been milled in our own WC mortar.

(Report prepared by Mr. Jørgen Kystol, GEUS)

Milling in WC mortars causes hardly any contamination for elements other than Co and W. The conclusion is that the metal mortar at the GSD is adequate for crushing samples for nearly all chemical analyses.

Attachment 2

Draft project proposal
Geochemical comparison of laterites overlying different types of bedrock

Aim
Reliable geological maps are an important element in the infrastructure of any country. This is particularly the case for countries like Ghana, where mining plays an important role for the economy. However, in Ghana, like in other tropical areas with high to moderate rainfall, the bedrock is often covered by a thick laterite cover so that the bedrock is rarely exposed, which makes geological mapping very difficult.
Laterites are formed by weathering and leaching processes going on for very long periods, commonly of the order of tens of millions of years. During that period a number of elements are dissolved in percolating water, and partly or wholly removed. Among these are some of the major elements (e.g. Na, K, Ca, Mg, Si) that characterise common rocks; therefore the chemical composition of laterites is often totally different from that of the underlying bedrock. Nevertheless, it would seem reasonable to assume that laterites overlying different types of bedrock would retain some kind of 'memory' of their original composition. The aim of the proposed project is to see if, and how far, it is possible from the composition of the laterite to deduce the character of the underlying bedrock.

Geochemical background
For a number of elements the range of concentrations in different rock types is so vastly different (e.g. very high Mg, Cr and Ni in mafic and ultramafic rocks compared to granitic rocks), that the possibility exists that these differences still might be observable after lateritisation, despite the fact that the elements are quite mobile. Alternatively, it is known from numerous studies of altered rocks, that some elements (e.g. Ti, P, Zr, Nb, Y, REE) are much less mobile than other elements under most weathering processes (this is related to their very low solubility in natural waters). Although the *concentrations* of these elements are (passively) changed during weathering (because other elements are removed), the *ratios* between their concentrations will be much less affected. It can therefore be expected that trace-element ratios could be used to differentiate between different rock types. To our knowledge no detailed studies have been carried out to testify these possibilities.

Approach
Five different and contrasting types of bedrock are selected from different parts of Ghana, and ten samples of laterite collected for each bedrock type. The following common rock types are suggested: (1) ultramafic rocks, (2) gabbros or basalts, (3) granodioritic to tonalitic granitoids, (4) true granites, (5) quartzitic sandstones. The resulting 50 samples are analysed for all elements that can be handled by the available equipment. The analytical results are statistically studied to see if the different rock types have significantly different chemical signatures.

Work to be done
The job can be divided into a number of steps, for each of these steps the responsibility should be discussed:

1. Literature study to see if similar work has been done earlier.
2. Selection of suitable areas from where samples can be selected.
3. Sample collection.
4. Preparation of samples for analysis.
5. Analysis.
6. Interpretation of analytical data.
7. Report writing, if possible submission to a scientific journal.

Time frame, *provisional*

1. Literature study: February – March 2002
2. Selection of areas: February – March 2002
3. Sample collection: April – June 2002 (?)
4. Sample preparation: June – July 2002 (?)
5. Analysis: August – November 2002 (?)
6. Interpretation: October 2002 – February 2003 (?)
7. Reporting: November 2002 – March 2003 (?)

Cost (apart from manpower)

1. No cost
2. No cost
3. Vehicle, fuel and maintenance
4. Drying, milling at GSD, no cost; further treatment at GAEC no cost (?)
5. Analysis, liquid nitrogen
6. No cost (?)
7. No cost

Responsibilities

to be discussed

F. Kalsbeek
12 January 2002

This draft was later accepted with minor modifications

Attachment 3

Visits to field mapping teams, 10, 16, and 19 – 28 January 2002

Greater Accra Region

On the 10th and 16th of January Mr. Loh and I joined the field party in the Greater Accra Region (Mr. Edmund Efa, Miss Amanda Ibeneme and Mr. Maxwell Boateng; Field Sheets 0501B3 and 0501B4). On January 16th Christian Knudsen also joined the group.

This area is very difficult to map; the geology is complex and outcrops are few. We saw rocks of several age groups: Birimian migmatitic granitoids (c. 2100 Ma), quartzitic rocks believed to belong to the Togo succession, high-grade metamorphic sediments, including marbles, of the Dahomeyan system (c. 500 Ma?), Devonian cross-bedded sandstones and shales, and Tertiary 'beach-rocks'. It is not always possible to group a specific outcrop into one of these categories, and it is suggested that the rocks are formally grouped into 'Formations', without trying to force them into an age-related nomenclature.

Field work will be finished before the rain period, and the maps compiled later this year.

Upper West Region

Mr. Geoffrey Loh, Mr. Robert Owusu, Mr. Kwasi Duah and I left Accra on the 19th of January 10 o'clock a.m., and arrived at Techiman at 17:30. We stayed overnight in Hotel Agyeiwaa. We continued next morning at 6 o'clock, and arrived at 4 o'clock p.m. at Nandom where Mr. S. Anum had his base. We stayed here for five nights at the Zeno Motel which was good and inexpensive.

The next 4 days were used to do field work with the two groups operating in the Upper West Region – Mr. Solomon Anum with two assistant geologists, Mr. Eric Oduro and Mr. Senyo Akpanya, and Mr. Charles Damalie with Mr. Jacob Kpofor and Mr. Ebenezer O. Annan as assistants. They were all very helpful and showed great hospitality. The first two days we (the whole group) visited localities in Mr. Anums area (Field Sheet 1003A2, around Nandom); the following two days we visited Mr. Damalies area (Field Sheet 1003A4, around Jirapa). Field work in these map sheets and the adjoining sheets 1003B1 and 1003B3 is expected to be ready later this year.

There are a fair number of outcrops in this region. Granitoid (*sensu lato*) rocks are the main rock types. They vary from relatively felsic (granitic to granodioritic ?) to dioritic and, locally, (perhaps) gabbroic in composition, and commonly show no signs of deformation. In most cases hornblende appears to be the main mafic mineral. Proper classification of the rocks will have to await petrographic investigation before the final legend of the maps can be compiled. One of the granites had numerous mafic inclusions, which showed a distinct preferred orientation parallel to the general structural grain (~ N-S) in the region. A granite sample (CD021/2) was collected for possible age determination.

Side by side with the granitoid rocks there are rocks of supracrustal origin, both metasedimentary and metavolcanic rocks. Phyllites are commonly badly weathered; some may be of pyroclastic origin. Locally they contain quartz veins, up to 1 metre wide. Loh pointed out that, where phyllitic rocks form hillocks, this is probably due to the presence of quartz veins. Metabasaltic rocks are now fine grained amphibolites, suggesting a fairly high grade of metamorphism, but the phyllites would appear to be of lower grade, perhaps due to retrograde metamorphism.
Most of the granites we saw are clearly of I-type (>10% mafic minerals; hornblende prominent). At one locality there are more aluminous muscovite bearing granites which could be S-type granites (formed by fusion of sedimentary sources). They have inclusions and schlieren of metasedimentary material. Loh told that such granites are termed 'basin-type' granites in Ghana, whereas the I-type granites are termed 'belt-type', because they tend to be associated, respectively, with the sedimentary basins that separate the different vocanic belts, and the belts themselves. This is an interesting confirmation of the genetic difference between I-type (formed from igneous sources) and S-type granites.

Upper East Region

On Friday 25 January we moved to Bolgatanga where we met with Mr. Mensah and his group. Mr. Paul Amoako-Atta had also come. On Saturday and early Sunday we joined them into the field (Field Sheet 1001A4). The area is dominated by the same rock types as Anum's and Damalie's areas further west, but in the Bolgatanga region supracrustal rocks are more prominent. They also seem to be better preserved (very low grade of metamorphism). At one locality Mr. Loh demonstrated pillow lava structures. We saw granites (s.l.) at several localities; they commonly have a typical greenish colour, evidence of epidotisation of the plagioclase. Side by side with basaltic rocks we saw quartz-feldspar porphyries. They have a very fine grained groundmass, and are either extrusive or hyp-abyssal rocks. A granite sample (EM088/01/1) was collected for possible age determination. Another sample was collected of sand from the Red Volta (dry at this time of the year) for investigation of heavy minerals, possibly including age determination of detrital zircons.
We also visited the artisan mining villages of 'Tarkwa' and 'Oboasi'. For a visitor from Europe this was extremely interesting. The village of Tarkwa is quite large, and all these people live from one relatively narrow gold-bearing quartz vein.

At 10:30 a.m. Sunday we left Bolgatanga, we stayed overnight in Kumasi, and arrived back in Accra Monday 28 January around 1:30 p.m.

Assessment of the quality of the work done and the qualifications of the field teams

In several instances distinct errors in rock nomenclature were observed. However, with careful petrographic inspection of the rocks this can be remedied, and it can be expected that all the field teams visited will be able to produce maps of a good quality.

Most of the geologists visited appear to be fully competent to carry out their field work. The assistant geologists all need further training. Severe lacks were observed in three-

dimensional understanding, and serious errors in the recognition of common minerals were encountered. Perhaps none of the assistant geologists would as yet be able independently to map an area of his (her) own. It is planned to provide further training in Accra in the most essential aspects of field geology before the beginning of next field season. Thereafter each assistant geologist should have the opportunity to map a certain area on his own in order to gain experience. This should be supervised by an experienced geologist. It is suggested that no assistant geologist is promoted to geologist before he/she has proved to be able to carry out geological field work of good quality.

F. Kalsbeek, 31 January 2002

Appendix 3.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

the Advisers 3rd visit to the Geological Survey Department

Mission Report – 15 March to 1 May 2002

Prepared by Feiko Kalsbeek
Geological Survey of Denmark and Greenland (GEUS)

Report on the Advisers 3rd visit to the Geological Survey Department,

15 March – 1 May 2002

Feiko Kalsbeek

I stayed at the GSD from March 15th to May 1st 2002. One week within this period was used for field work, and ten days were used for instruction of the Survey's assistant geologists. I also helped Dr. Mauer, Head of the 'Archives Rehabilitation Unit' with the new edition of old Survey reports.

Several new assistant geologists and one assistant geophysicist have recently been appointed. By appointing young geoscientific staff the Survey hopes gradually to improve the ratio between scientific and auxiliary staff.

From 20 to 26 March I visited a mapping team in the Volta Region. This is an area of sedimentary rocks, shales and quartzitic sandstones. Mapping of such areas is not easy, and the work did not progress well. The lack of aerial photographs, which could have given a clue as to the structure of the area, was another problem. As a result no reliable map can be expected from this work. A short report on this visit (Attachment 1) was presented to the Director.

On 26 March I visited the Regional Office at Ho. Like at the Regional Offices visited earlier, no great activity (apart from the ongoing field work) was apparent.

During my stay at the GSD I got more information on the new X-ray fluorescence spectrometer the Survey will get later this year, it is a Spectro X-lab 2000. According to the description this is an 'Energy-dispersive polarisation X-ray fluorescence spectrometer', apparently a different kind of instrument than the more common (Philips) sequential spectrometer used for most geological purposes. This instrument has a very large capacity, and it is much cheaper than sequential instruments.

At a meeting with the Heads of Departments on April 3rd we discussed the problem of the Regional Offices and the all too large number of auxiliary workers at the GSD. It appears that, for socio-economic reasons, it is at present (near) impossible to cut down on the Regional Offices or the number of auxiliary workers.
I suggested, if it was possible for some time to retain the cooperation of some of the retiring staff in order to properly document their knowledge on important topics (Dr. Brantuoh on the Voltaian; Mr. Addo on Ghana clay deposits).

From Thursday 4 April to Friday 12 April I gave a course on various geological topics to a group of assistant geologists. The following subjects were briefly treated: General aspects of geological mapping, use of the stereonet, basics of geological map reading, plotting of geochemical data, basic aspects of isotope geology and dating of rocks. Most of the time was used to work out practical examples. This course was followed by a two-day seminar in which the various participants presented topics from papers in international scientific journals in order (1) to get some experience with scientific literature, and (2) to learn to present a subject to a wider audience. Finally, a short course was given on the study of rocks in thin section.

It became clear during this week of teaching that the young geologists of the Survey still have much to learn. Basic skills, such as the use of the stereonet to plot structural data, and the recognition of the most common minerals in thin section, were nearly lacking. This is a major problem, because without these skills the young geologists will be unable to do much useful work for the Survey. Fortunately, all the junior geologists were very eager to learn something new, and took actively part in the teaching. It is my opinion that further training of these young people may be one of the most important tasks the Adviser can do for the Survey. A short report on this course (Attachment 2) was presented to the Director.

On the afternoons of Thursday 11 April and Friday 12 April the Director gave a lucid overview of the budget system to all the Survey's geoscientists. This was very interesting. One aspect is that (unlike the situation at GEUS) there is very little flexibility in the system. Items that have not been specifically (and in details) described in the budget, and approved, cannot be paid for.

On Monday 15 April I met with Mr. Kwasi Barning and Mr. Amponsah Tawiah at the Minerals Commission. I had asked for this meeting to keep in contact with the MC; Mr. K.O. Boamah, Head of GSD's Division of Data Management, took part in the meeting. I reported on the progress of our work.

On Tuesday 16 April I visited the Akwatia (alluvial) diamond mine and the Med Mining Co Ltd. (alluvial) gold mine at Takyiman with Mr. Amoako-Atta. Both mines were very interesting. The Akwatia mine is not very profitable and much of the equipment is in a poor state of maintenance. The mine at Takyiman appears to be more profitable. On Wednesday 17 April we visited the Cocoa Research Institute at Tafo. This is a semi-autonomous organisation, and could be an example for a future more autonomous Ghana Geological Survey.

On Wednesday 24 April I took part in a number of interviews with young people seeking employment at the GSD, most of them applying for the position of assistant geologist. Six persons were interviewed. Among the interviewers was Mr. E.K. Adade from the Ministry of Mines. The applicants were given points for (1) Appearance, max. 5 points, (2) Background and education, max. 10 points, (3) Geological knowledge, max 10 points, (4) Intelligence, max. 15 points, and (5) General knowledge, max. 10 points. The total maximum score is 50 points; the interviewed persons scored between 30 and 39 points.

Before my departure from Ghana the Director asked me to write a little note on our project for the Report to the Minister for 2001 (see Attachment 3).

Attachment 1

Visit to the field team in the Volta Region

From 22 – 26 March Mr. Loh and I visited the field team working in the Volta Region. The area consists of sedimentary rocks, and features a number of prominent steep ridges separated by flat areas. To map such an area it is of prime importance to establish the stratigraphic relationships. Using the stratigraphy it is then possible to work out the structure, and with this knowledge the area can be mapped relatively easily.
The geologist in question has not been able to do this. He is no longer young, and not physically strong, and he is therefore unable to climb the ridges (mainly sandstone) which may yield key information. Similarly, working along the Wawa river, that gives a good section across the stratigraphy, would for him not be possible. Instead he has restricted field work to areas that are more easily accessible.
The responsible geologist can, therefore, be excused for not doing a better job. However, no good map will be forthcoming from the work as it is being carried out at present. It is suggested that one or two teams of experienced geologists should be set in, together with the team already present, to bring this project to a good end.

F. Kalsbeek, 22 April 2002

Attachment 2

Report on a course given to a group of assistant geologists, April 2002, at the Geological Survey Department, Accra

At a senior staff meeting on January 8th, I proposed to give a training course to the younger geologists at the Survey on my return from Denmark in March 2002. This suggestion was accepted, and the course took place over the first two weeks of April 2002. It consisted of several elements, and some 15 young people took part.

Geological maps and analytical data

Thursday, 4 April. Introduction to geological mapping, the presentation of structural data on the stereonet, and the reading of geological maps in areas with topographic relief. Most of the time was used for the assistant geologists to work on practical examples. It seemed as if most of this (e.g. use of the stereonet) was completely new to them.

Friday, 5 April. Morning, introduction to the use of chemical data. Practical work with plotting of data in binary and ternary diagrams. It was again evident that the young geologists were not familiar with these procedures. Afternoon, introduction to isotope data and age determinations. Much of the time used in working out examples with a pocket calulator.

It was my impression from these two days that all participants were eager to learn something new, and all took part in the exercises with enthusiasm.

Seminar

I had brought with me from Denmark several geological textbooks and a number of papers on geochemical and isotopic topics. I handed these out to eleven of the junior geologists, for them to read and present these topics at a Seminar on 8 and 9 April. The purpose of this seminar was two-fold: first, to train the participants in the course to read scientific literature, and, second, to train them in presenting a subject to a larger audience. The program of the Seminar was as follows (the first two lectures outside my course):

Monday 8 April

1. Gravity surveys in Accra, John Asabere
2. Interpretation of airborne geophysics in Area 2, Sam Amedofu
3. Crystal fractionation, Maxwell Boateng
4. Mobility of elements, Desmond Edifor
5. Metasomatism, Daniel Somuah
6. I-type, S-type and A-type granites, Amanda Ibeneme

Tuesday 9 April

1. Rb-Sr and Sm-Nd isochron dating, Charles Damalie
2. Zircon dating, classical, Regina Brown
3. Zircon dating, SHRIMP (ion microprobe), Rosemary Okla
4. Rb-Sr model ages, Eric Oduro
5. Sm-Nd model ages, Ebenezer Annan
6. Pb-Pb dating and μ-values, Senyo Akpanya
7. Closure temperatures of isotope systems, Jacob Kpofor

I had anticipated that the subjects would be rather difficult for the participants. Therefore I was available for more explanation before and after teaching, as well as on Saturday April 6th, and many of them made use of this. Nevertheless, most presentations were rather poor. It appears that most of the young geologists are unable to read a scientific paper and extract the most important information.
Apart from the oral presentations I requested a written report on the various subjects. Some of these I have received by now; they are of very variable quality.

Petrography

Wednesday 10 and Thursday 11 April. These two days, and later on April 18th, I gave courses in thin section petrography. On Wednesday I gave a 1-hour introduction to the most important optical properties of minerals, and the most important minerals in common rocks. The rest of the time was used for practice. With very few exceptions the participants in the course proved to have little experience with the study of thin sections; many of them could not recognize common minerals like biotite and feldspar.

Comments

From what I saw and heard during this course I must conclude that these young people have very much to learn. I cannot understand that they have studied geology without learning many of the topics that were touched upon during the course. Without much further training they will not be able to perform a geologist's duty at the Survey. Moreover, with their limited knowledge, it will be very difficult for them to follow more advanced courses at foreign universities.

In this connection it is encouraging to see how eager the younger geologists responded to the various courses presented. It may be suggested that each newcoming assistant geologist should be given a 3-month course on such practical geological subjects as treated at the present occasion. Such a course could be led by one of the more senior geologists at the GSD. Also, it is suggested that seminars, similar to the one organised by the Adviser, should be held at regular intervals, to give the junior geologists an incitment to read relevant literature (most suitably on the geology of Ghana), and to present what they have learned to a wider audience.

F. Kalsbeek, 19 April 2002

Attachment 3
(Advisers contribution to the Directors report to the Minister for 2001)

Mining Sector Development and Environmental Project (NDF Credit 156-14)
Adviser to the Director of the Geological Survey Department

Under the Mining Sector Development and Environment Project (MSDEP), supported by the Nordic Development Fund (NDF Credit 156), a contract was signed between the Minerals Commission, Ghana, and the Geological Survey of Denmark and Greenland (GEUS), Denmark, to the effect that GEUS should provide an Adviser to the Director of the Geological Survey Department (GSD) of Ghana, in order to advise and assist the Director in restructuring the GSD into a more effective organisation.

The overall objectives of the project are:

- Development of GSD resources (Human Resource Development)
- Rebuilding of GSD's capacity in regional geological mapping
- Developing GSD's capacity in the compilation of mineral inventories

To achieve these objectives the project is focusing on the following outputs:

1. Formulation of a mission and vision statement for GSD
2. Plan for reconstruction of GSD
3. Programme for Human Ressource Development
4. Plan for revitalisation of the Geological Mapping Division and preparation of a new GSD mapping manual
5. Plan for development of the Minerals Inventory for Ghana
6. Plan for development of the Geological Databank and Information sub-system, records office and library
7. Plan for the development of fully functional Mineralogical, Petrological and Chemical Laboratories

GEUS appointed Dr. Feiko Kalsbeek as Adviser to the Director. He will be the team leader of a group of GEUS specialists who will advise on specific topics. Dr. Kalsbeek visited the Survey from the beginning of October to medio November 2001, in order to obtain a first-hand impression on the status of geological mapping in Ghana and the present capacity of the GSD. Thereafter, the Director of the GSD, together with four members of the most senior GSD staff made a study tour to Denmark to become familiar with the operation of the Geological Survey of Denmark and Greenland and similar institutions. On the basis of the observations made in Ghana by Dr. Kalsbeek and by the GSD Director's group in Denmark, an Inception Report was prepared jointly by GEUS and GSD staff. This inception report will form the background for further work under the NDF project. The project has a budget of around $ 300.000 and will last until March 31st 2003.

Appendix 4.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

the Advisers 4th visit to the Geological Survey Department

Mission Report – 1 June to 6 July 2002

Prepared by Feiko Kalsbeek
Geological Survey of Denmark and Greenland (GEUS)

Report on the Advisers 4th visit to the Geological Survey

Feiko Kalsbeek

I stayed at the GSD from June 1st to July 6th 2002. A significant part of this time was used for instruction of the Survey's Assistant Geologists in the study of rock samples in thin section using the petrographic microscope. With this aim a study collection of 50 thin sections has been prepared in Copenhagen, and descriptions of the rocks in question have been compiled (Attachment 1). This collection can be used for self-study, also during the absence of the Adviser.

On Tuesday 4 June I had a meeting with Mr. Wim Olthof and Mr. Robert de Raeve of the EU delegation in Ghana, to talk with them about the changed SYSMIN programme. They told me that the SYSMIN mapping would be spread over a longer period than earlier planned. At the GSD this was regarded as a major disadvantage, but it appears that the decision is final.

Because of the matching of the libraries of the former Geological Surveys of Denmark and Greenland with that of the Department of Geology of the University of Copenhagen, a large amount of older geological literature has become available for use by other organisations. Mr. G.K. Loh and Dr. D. Boamah (Heads of the Departments of Geological Mapping and Geochemistry) looked through the relevant lists, and made their choice (among other materials journals on African geology) in order to strengthen the GSD library.

On June 12th GSD's Acting Director Mr. P.Y.O. Amoako, Mr. K.O. Boamah and I had a meeting with Mr. Kurt Klitten at the Danish embassy to talk about ways to have all information on water bore-holes transferred to the GSD. Mr. Klitten had talked with the relevant authorities, and there is a general understanding that these data are of great importance for the Survey. It was decided that Mr. Amoako and other senior GSD staff discuss with the Water Research Institute and other stake holders how to organise practical aspects of the data transmission.

On June 14th two of the Survey's geologists (Mr. G.K. Loh and Mr. S.A. Anum) left for West Greenland to take part in one of GEUS' field operations with an international group of geologists. The rocks in this part of Greenland are similar to those in Ghana (although of a different age), but the degree of exposure is so much higher than in Ghana that the rocks can be studied in much greater detail. All expenses for Mr. Loh and Mr. Anum were covered by GEUS. A short report on their experience in Greenland is attached (Attachment 2).

From 16 – 19 June I took part at a meeting which was held at Akuse with a selection of GSD staff, to discuss several documents that have been prepared to provide guide lines for the Survey's development in the coming years.
We discussed (1) a new version of the Draft Geological Survey Act, (2) a Memo to the Minister, setting out the possibilities for income generation when the Survey becomes semi-independent, (3) a new version of the Srategy document, which describes the

Survey's vision for the next 10 years, and (4) a new document 'Ghana Geological Information Management Strategy (GGIMS)'.

From June 19th to 23nd I visited the field teams in the Upper West Region. In general the work went on fairly well, but the team of Mr. Damalie was seriously hampered by technical problems with the vehicle. Since the other mapping geologist (Mr. Anum) had left for field work in Greenland, the two Assistant Geologists (Mr. Senyo Akpanya and Mr. Eric Oduro) had taken over. Both teams did reasonably well, although their insight in rock structures is limited. It proved, for example, that they were not familiar with the distinction between planar and linear rock fabrics.
Although an effort has been made to provide the field teams with aerial photographs during the field work (see Appendix 2), this has not yet met with success. At the end of my visit the field teams had got notice to return to Accra because no more money was available to go on with their work.

Dr. Christian Knudsen (Head of GEUS' Department of Geological Mapping) and Mrs. Marianne Thorsen (Chief Consultant and Legal Adviser at GEUS) visited the Survey from Tuesday 25 June to Friday 29 June. During several meetings the Draft Geological Survey Act was discussed in detail. Since the Mission statement of the Survey is an important aspect of the future Survey, this topic was discussed at length. The following Mission statement was agreed upon.

"The Ghana Geological Survey, as the principal curator of all national geoscientific data, has the main task to continuously generate, collect, store and archive geoscientific data, and to disseminate data and information in a user-friendly way to the government, industry and the public at large. Generation of geoscientific data is done through geological mapping, research and investigation. The Survey has the responsibility to advise the State to make informed decisions on geoscientific issues concerning mineral resources, environment, groundwater management, land use planning and geohazards".

At the same time the following visions for the future Survey were formulated:

- To develop into a Geological Survey which is highly recognized internationally and which has a competetive reputation worldwide.
- To create an attractive and inspiring working environment, based on ethical and social values.
- To produce up-to-date geological maps, based on the integration of geological, geophysical, geochemical and remote sensing data in a GIS environment.
- To establish a national digital seismic network in order to define earthquake-prone zones in the country as imput for effective land-use planning.
- To contribute to the continuous exploration and sustainable exploitation of rock, mineral, hydrocarbon, and underground water resources.
- To establish and maintain a national geological information system consisting of reports, maps and other data in an easily accessible manner for end-users. This should include all bore-hole information such as reports, logs and cores.
- To continously publish its new geological findings nationally and internationally.

- To be pro-active in promoting the public understanding of the relevance of geosciences to key issues and the importance of the Survey for sustainable development.

The structure of the future Ghana Geological Survey was also discussed, and the organogram shown on p. 16 of this Progress Report was provisionally decided upon.

On Friday 28 June we had a meeting with Mr. Ben Aryee, Chief Executive of the Minerals Commission, to discuss progress and problems with the project. Mr. Aryee agreed that it is necessary for the GSD to become semi-autonomous because first then it would be possible for the Survey to follow a responsible policy with respect to personnel, income generation etc. We explained that, because of the financial constraints in our project there is relatively little we can do with respect to the reorganisation of the Survey.

In the afternoon of June 28th we had a meeting with Mr. Adade, Technical Director at the Ministry of Mines. He agreed that lack of funding made it difficult to reorganise the GSD. However, it is possible that money from the Mineral Fund may become available for this purpose. This will be a political decision.

At the end of my visit the rock saw used to cut samples broke down (it was used for cutting rocks for the preparation of thin sections in Denmark). Spare parts are not available in Ghana. This is an example of the difficulties of running modern laboratories in developing countries.

Attachment 1

Thin sections for self-study

Samples from the collections of F. Kalsbeek (GEUS). Numbers refer to the files of the former Geological Survey of Greenland (GGU), now incorporated in GEUS. Minerals in each thin section are listed below, together with a rock name and some explanatory notes. Note that the correct classification of a rock cannot always be done by studying a thin section alone. The field occurrence and the texture in hand sample are also important features to take into account. Therefore these thin sections are mainly intended to get familiar with the most common rock-forming minerals. Some of the minerals occur in small proportions (these are called accessory minerals); it may take some time to find them.

129105: K-feldspar (microcline), quartz, a little plagioclase, hornblende, epidote, titanite, carbonate, opaque minerals. The rock is a leucogranite; the prefix *leuco* is used for rocks that have less than the normal proportions of mafic minerals.

129131: Carbonate, diopside, epidote, plagioclase, some pale green amphibole, titanite, opaque minerals. This is a metamorphic carbonate rock (marble).

129131A: Carbonate, epidote, sometimes with a core of allanite, very little diopside, light-green amphibole, titanite, opaque minerals, small proportions of quartz, K-feldspar and plagioclase. Marble.

129134A: Diopside, surrounded by blue-green hornblende, plagioclase, quartz, K-feldspar (microcline), carbonate, epidote, opaque minerals. This is the metamorphic equivalent of a calcareous sediment (not a clean limestone).

149046B: Hornblende, plagioclase, diopside, hypersthene, some quartz, opaque minerals. Meta-diorite; *meta* means metamorphosed. The presence of hypersthene indicates a high grade of metamorphism: granulite facies.

149053A: Hornblende, hypersthene, diopside, opaque minerals, a little biotite, plagioclase. Meta-gabbro or meta-diorite.

149082A: Hornblende, diopside, plagioclase, opaque minerals. Amphibolite. Amphibolites are metamorphic rocks consisting mainly of hornblende and plagioclase. They are chemically equivalent to basaltic rocks, and in most cases they represent metamorphosed basalts. It is often not possible in thin section to differentiate between meta-diorite (or meta-gabbro) and amphibolite, because they consist of the same minerals. Field observations may help to make a proper determination of the rock.

149082B: Plagioclase, quartz, biotite, opaque minerals. Trondhjemite (= a leucocratic type of tonalite). *149092A:* similar to 149082A.

149104A: Hornblende, plagioclase, opaque minerals. Amphibolite.

149119B: Hornblende, biotite, epidote, plagioclase, quartz, apatite, zircon, opaque minerals. Meta-tonalite.

149148B: Same rock type. Contains also titanite.

254414: Olivine, augite, some hornblende, biotite, plagioclase, opaque minerals. Olivine gabbro. Note the clear igneous texture; the sample was taken from a > 100 m wide gabbroic dyke intruded into older granitoid rocks.

256858: Similar rock. Olivine gabbro.

256860: Similar rock, slightly more fine-grained.

256882: Olivine, hypersthene, augite, biotite, plagioclase, opaque minerals. Norite (a 'norite' is a hypersthene bearing gabbro). Note igneous texture.

256884: Olivine, hypersthene, biotite, opaque minerals, plagioclase. Norite.

263424: Hypersthene, clinopyroxene, biotite, opaque minerals, garnet, plagioclase. Meta-gabbro. Note clear equigranular metamorphic texture.

263427: Garnet, biotite, K-feldspar (with exsolution lamellae), plagioclase, cordierite, quartz, opaque minerals. This is a high-grade meta-sedimentary rock. Cordierite looks a bit like plagioclase, but has higher relief. It can be recognised by the presence of yellow pleochroitic halos around radioactive inclusions.

263429: Hypersthene, clinopyroxene, hornblende, biotite, opaque minerals, plagioclase, quartz. High-grade metamorphic rock.

263432: Garnet, biotite, cordierite, hypersthene, opaque minerals, spinel, plagioclase, quartz, zircon (with pleochroic halos in biotite). High-grade meta-sediment. Spinel occurs at one place in the thin section (near ink spot) as round inclusions in cordierite; it is optically isotropic (no interference colours), has high relief, and light blue-green colour.

267699: Biotite, hornblende, plagioclase, quartz, opaque minerals, apatite, zircon. Meta-tonalite.

269457: Hypersthene, hornblende, some diopside, opaque minerals, plagioclase, K-feldspar (inclusions in large plagioclase crystals), quartz. High grade meta-tonalite.

298604: Plagioclase, quartz, K-feldspar, biotite, opaque minerals, titanite. Granodiorite.

298616: Biotite, hornblende, titanite, opaque minerals, quartz, plagioclase, K-feldspar. Granodiorite or tonalite.

298625: Hypersthene, diopside, hornblende, biotite, opaque minerals, plagioclase, quartz, tremolite (alteration). Meta quartz-diorite.

298627: Hornblende, biotite, titanite, opaque minerals, plagioclase, some quartz, chlorite (alteration). (Quartz) diorite.

298630: Hornblende, biotite, opaque minerals, plagioclase, a little quartz. Diorite. Note porphyritic texture with large plagioclase phenocrysts.

298632: Hornblende, biotite, remnants of hypersthene being replaced by hornblende, opaque minerals, plagioclase, quartz. Quartz diorite. *298633* is a very similar rock but more altered.

298636: Hornblende, biotite (locally chloritized), opaque minerals, plagioclase, quartz. Quartz diorite.

298783: This is a fine grained sedimentary rock, a siltstone. Some larger grains of quartz and feldspar can be recognised. Note the wavy trains of black material. They are called 'stylolites'. Stylolites are caused by dissolution processes within the sediment.

311813: Biotite, diopside, some hypersthene. The interstitial light minerals are mainly K-feldspar and nepheline (a mineral taking the place of feldspar in rocks of very low SiO_2 content). Nepheline syenite.

311814: Diopside, biotite, carbonate, garnet (with reaction rims at the contact with carbonates), K-feldspar (with exsolution lamellae), nepheline. Nepheline syenite.

311816: Fine grained porphyritic gabbro. Olivine, pyroxene, biotite, opaque minerals, plagioclase. Note the occurrence of plagioclase as phenocrysts in a finer grained matrix.

311819: Olivine, augite, biotite, actinolite, chlorite, opaque minerals, plagioclase. Olivine gabbro. This sample represents the central part of a > 100 m wide basic dyke. Sample 311816 was collected from the 'chilled margin' of the same dyke.

311852: Hornblende (brownish), hypersthene, diopside, biotite, opaque minerals, plagioclase. High-grade metamorphic rock of basic (SiO_2-poor) composition (no quartz): Meta-gabbro.

311880: Hypersthene, diopside, brownish hornblende, opaque minerals, plagioclase. Much like 311852, but minerals occur in different proportions. Absence of biotite indicates low K content in the rock. Meta-gabbro.

311881: Hypersthene, garnet, opaque mineral, quartz. High-grade metamorphic rock, probably of meta-sedimentary origin (this can better be judged from the field relationships).

337028: Garnet, biotite, hypersthene, kyanite, opaque minerals, zircon, plagioclase, quartz. High-grade (granulite facies) meta-sedimentary rock.

337030: Garnet, biotite, opaque minerals, zircon, plagioclase, quartz. Chlorite and muscovite occur as secondary minerals (alteration). Meta-sedimentary rock.

337046: Hypersthene, diopside, hornblende, biotite, opaque minerals, titanite, plagioclase + various indeterminate alteration minerals. Meta-gabbro.

337070: Garnet, biotite, opaque minerals, quartz, plagioclase. Garnet-biotite gneiss; a meta-sedimentary rock.

337071: Garnet, biotite, muscovite, sillimanite, quartz, K-feldspar, plagioclase. Zircon is seen as inclusions in biotite; it gives rise to clear pleochroic halos. Sillimanite occurs as thin needles in felty masses. Garnet-micaschist. A meta-sedimentary rock.

337136: Garnet, kyanite, biotite, muscovite, titanite, opaque minerals, quartz, plagioclase. Garnet-kyanite schist. A meta-sedimentary rock. The presence of kyanite indicates metamorphism at high pressure.

337138: Garnet, muscovite, some kyanite, opaque minerals, titanite, quartz. Garnet-muscovite schist.

337142: Garnet, kyanite, biotite, muscovite, opaque minerals, quartz, plagioclase. Garnet-kyanite micaschist.

337166: Hornblende, garnet, biotite (partly chloritized), opaque minerals, titanite, plagioclase. Garnet-amphibolite.

337173: Biotite, hornblende, opaque minerals, quartz, plagioclase. Biotite-hornblende gneiss (or schist).

348648: Biotite, opaque minerals, a little muscovite, plagioclase, quartz. Biotite schist.

Attachment 2

Report on participation in the 2002 fieldwork of GEUS in West Greenland from 18th June to 31st July 2002

Geoffrey Loh
Solomon Anum

Introduction

Upon the recommendation of Dr. Feiko Kalsbeek, the Adviser to the Director of the Geological Survey Department (GSD), we were invited by the Geological Survey of Denmark and Greenland (GEUS) to participate in its fieldwork to be undertaken this year in West Greenland. This arrangement was made within the scope of the cooperation agreement currently existing between the Minerals Commission (MC) of Ghana and GEUS.
Under this agreement, GEUS is assisting to restructure the GSD with the view to make it more functional and capable of fulfilling its mission and vision as a government institution.

Our participation in the fieldwork in West Greenland was therefore considered a very useful means of exposing us to an ideal geologic environment and also give us the opportunity of gaining some experience from the perspective of effective mapping project implementation.

Copenhagen, Denmark: 14/6/02 – 17/6/02

We left Accra on the 13/6/02 by KLM and arrived in Copenhagen on 14/6/02. On Monday 17/6/02, a meeting was held for the geological mapping group made up of an international team of 13 geologists from GEUS and foreign institutions (from Sweden, Poland, Ghana, France, England, USA and Germany) under the leadership of Dr. Jeroen van Gool. Participants were briefed on the expedition in general and given background information on the geology of West Greenland through short presentations made by Drs. Jeroen van Gool, Sandra Piazolo, Adam Garde, and Henrik Stendal.
The legend to be used was discussed and emphasis placed on the colour code and structural symbols.

West Greenland: 18/6/02 – 31/7/02

The mapping team left Copenhagen for Qasigiannguit, West Greenland, by air on 18/6/02, and arrived there the same day after stop-overs in Kangerlussuaq and Ilulissat. The last leg of the journey was made by ship that passed through the Disko Bay dotted with large masses of beautifully carved icebergs.

An orientation field trip was organized the following day and members of the mapping team were introduced to the local geology along the coast south of Qasigiannguit. This was to ensure that the different rock-types were correctly named in the course of our independent mapping activities.

Between 20/6/02 and 30/7/02 we were paired with experienced geologists and undertook field mapping in various sectors of the 1:100 000 scale Kangersunneq map sheet located between 68°30' to 69°N and 49°41' to 51°45'W.
During this period, we and our partners were dropped by helicopter in fly-camps and spent 5 days in each camp carrying out geological mapping on a map scale of 1:50 000. We also worked at different times with rubber boats and larger ships.

Geological mapping was carried out with the aid of aerial photographs and aerogeophysical anomaly maps. Progress of field work was monitored from the base camp at Qasigiannguit by daily radio contacts at 8 a.m. and 8 p.m.

Field data was efficiently handled at the base camp by the project leader, Dr. van Gool. GPS recordings were regularly down-loaded onto the computer using ArcView 3.2 software. Additionally, field entries on the aerial photograph overlays were regularly transferred onto the master maps (on 1:50 000 and 1:100 000 scales) at the base camp. This strategy ensured that the draft geological map of the area was drawn progressively and enabled it to be almost completed by the end of the mapping exercise.

Besides the scientific knowledge acquired from the mapping exercise, we learned a lot from the planning stage to the successful execution of the project within its constrained time-frame.

We were impressed about the efforts put into the adequate supply of logistics to the mapping teams. Enough food and provisions were procured and delivered to the field camps on a weekly basis by helicopter and rubber boats.

The field teams were well equipped with light camping gear consisting of tents, sleeping bags, kerosene stoves, food boxes, cooking utensils, radio equipment and medical kit. As a precaution, each geologist was provided with colourful (red or orange) field attire and some safety equipment for use in case of any emergency.

Equally worth mentioning is the practice whereby field work is carried out without the support of technical officers and labourers. In this regard, we had to serve ourselves by carrying our own hammer and back-pack loaded with GPS, compass, camera, map case, safety equipment, samples, water-bottle, food etc.

Life in the field and base camps was indeed interesting. Team spirit was built on the bedrock of friendliness and equally shared responsibilities. All official and professional titles of the geologists were shelved and we all related to each other on first name basis. This made it possible for us to operate in a relaxed atmosphere that encouraged free interaction with each other. All the geologists were zealous about their work and none showed laziness or dissatisfaction.

Food preparation and washing of plates, cutlery and cooking utensils were done on a rotational basis. It was noteworthy that even the Director of GEUS who paid a brief visit to us in the field from Copenhagen was very happy to participate in the cleaning up of the table after meals at the base camp.

Participating geologists were not paid salaries, but GEUS took care of all our expenses and also provided us with moderate daily allowances.

Return trip: 31/7/02 – 2/8/02

We returned to Copenhagen on the 31/7/02 and after a post-fieldwork briefing on the 1/8/02, we returned to Ghana on the 2/8/02.

Summary

Most important aspects of the project about we were greatly impressed were:

Adequate logistic supplies and their well coordinated distribution
Transportation and timely movement of field teams by helicopter and ship
Monitoring of field activities and time fixed radio contacts
Safety measures
Data handling in base camp
Friendliness and equally shared responsibilities among geologists

Recommendations

It is recommended that our Department adopts some of the strategies that GEUS follows in carrying out its time-constrained fieldwork successfully.

Appendix 5.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

Mission Report – January 2002

Prepared by Christian Knudsen
Geological Survey of Denmark and Greenland

Purpose of mission

The purpose of the mission was to make a review of the status of the project and to:
Discuss the programme and inception report with the teamleader, the GSD management, Minerals Commission, the Minister of Mines and the Danish Embassy.
Comment on the organisation and programme of GSD.
Coach the new group of Heads of Departments in GSD.

Findings

It was found, that the new group of Heads of Departments are well educated and very devoted to make the organisation move ahead.
It was found that the weekly meetings among the Heads of Departments were beneficial to the work at the GSD. Agendas for the meetings as well as minutes from the meetings should be available to the Heads of Departments as well as the adviser before and after the meetings respectively.

The G*eophysical Department* is well functioning, as well as the Database Unit is moving ahead. They need more computers.

The C*hemical lab*. is very old fashioned and not productive.

The C*lay/ceramic laboratory* is producing results. An accesible database on the results is needed. The kilns are in a bad shape.

There is drilling equipment at the GSD, but this has not been used for many years, and is probably not in an operational state.

There is at present no record of the contents in the *Library* and the periodicals and books are outdated. There is a need for modern textbooks.

The *Drawing Office* is using ink on mylar. There is a need to co-ordinate the work with the GIS unit and use GIS to a higher extent, when computers are available. There is a need for scanning and digitalizing of the old geological maps.

The main focus of the GSD has been / is on 'traditional' geological / geophysical mapping. There is a need for widening of the activities not only directed towards environmental geology, but also directed towards hydrogeology and energy resources.

The knowledge about the sedimentery basins in Ghana is very weak at GSD. This has to be increased because:

- The Voltaian Basin covers about 1/3 of Ghana.
- There may be significant water resources and possible energy and mineral resources.
- The area is the target for the coming EU funded "SYSMIN" geophysical programme.

To improve the contact to the stakeholders it would be a good idea to introduce an advisory board which apart from the Ministry of mines and Mining companies also include the water and energy sector as well as universities and the environmental sector and possibly also the donor system.
It was found that the ratio between academic staff and technical staff is way too low. It was further found that the level of funding for activities is way too low to support the work of staff employed at GSD.

Meeting with Mr. Ben Aryee, Minerals Commision (MC)

- The findings described in the inception report were presented. The MC received the report on January 2nd 2002.
- The MC support that:
- GSD should be a semiautonomous institution.
- GSD should have possibilities of generating its own revenue by contract services.
- There is a need for a more effective organisation of GSD, and a more precise mission for the GSD.
- That an advisory board consisting of the stakeholders is a good idea.
- The GEUS/GSD programme should be extended to meet the EU programme time wise.

Meeting with the Minister of Mines

- GEUS presented its organisation and the current project at GSD. Further, GEUS presented the major findings so far:
- Lack of funding for field projects.
- Too little to work with at GSD.
- Too little flexibility in the budget – to redistribute funds among salaries and running costs and investments.
- Loss of experienced staff due to lack of incentives and low salaries at GSD.
- Need for semiautonomous status and advisory board.
- Need for a new structure partly in place.
- Need for instruments in labs e.g. thin section machines and training of personnel.
- Need for making existing information available like publishing old maps in digital format.
- Need for a water well database.

Meeting with Kurt Klitten (KK), Danish Embassy, Accra

The different donors are conducting a large water well drilling programme.
During this, a number of geophysical logs are produced as well as surface geophysics are conducted. These results are not captured in the geological system in Ghana. Further knowledge is gained concerning e.g. depth to bedrock and character of bedrock. This information is not captured either. KK recognises the need for systematic capture and organisation of these data, and indicated that the Embassy may consider to support an effort e.g. at the GSD to capture this information. Further KK indicated that the sedimentary rocks in the Voltaian Basin may contain significant water resources not being used today.

Schedule:

Jan 11 Dept. Copenhagen
Jan 12 Arr. Accra. Delay due to fog in Heathrow
Jan 13 Meeting with Feiko Kalsbeek and Kurt Klitten, Danish Embassy Accra
Jan 14 Review of GSD, meeting with the director
Jan 15 Meeting with Heads of Department
Jan 16 Discussions with GSD management
Jan 17 Meeting with Minerals Commission
Jan 17 Meeting with Minister of Mines
Jan 18 Discussions with GSD Management
Jan 18 Dept. Accra
Jan 19 Arr. Copenhagen

Appendix 6.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

Mission Report – June 2002

Prepared by Christian Knudsen
Geological Survey of Denmark and Greenland

Purpose of mission

Finalise mission and vision statement as well as draft organogram for the GSD.
Discuss the programme with GSD management, MC, Ministry of Mines, The EU representation and the Danish Ambassador.

Mission and vision statement

This was discussed at length with the GSD management and the outcome as well as the process was very satisfactory. The result of this is described in the June-July Mission Report by Feiko Kalsbeek as well as in the Progress Report.

New structure for GSD

The new structure was discussed and agreed with the GSD management. The organogram is presented in the June July 2002 Mission Report by Feiko Kalsbeek as well as in the Progress Report.
Compared to the present temporarily structure several modifications are suggested.

Strengthening of the secretarial functions

In a future semiautonomous institution there will be a need for a stronger secretarial office headed by a Head of Division with the following responsibilities:

- Policy and planning
- Budget
- Human affairs / personnel / salaries
- Legal affairs
- Secretarial support for the director
- General services such as security, cleaning
- Estate and vehicle fleet

A division of *General Geology* is suggested.
This should develop from the current mapping branch but should be expanded with responsibility for the Regional Offices (if they are sustained), the thin section lab (when in place), remote sensing as they are the main users of aerial photographs and satellite images. Further capabilities in stratigraphy and sedimentology should be in this division.

The *Geochemistry Division* will have the responsibility of conducting geochemical mapping as well as the chemical lab.

The *Geophysical Division* will have the responsibility for Airborne and Ground geophysical surveys as well as the seismology.

The *Environmental Geology Division* will have the responsibility for Environmental Geochemistry, Hydrogeology, Engineering Geology and Ground Investigations.

Finally a new Division dealing with *Economical Geology* is suggested. The reason for this is that there is a need for synthesising the information gained during geological mapping in an economic geological context, better service for the mining companies and the Ghana Government and together with the MC promotion of Ghana mineral resources to the International community.
This Division will also have the responsibility for promoting industrial minerals potential of Ghana. This based on the Country's strategy of diversification of its mining industry.

Meeting with Head of Minerals Commision (MC) Mr. Ben Aryee 28-06-02

- GEUS presented its findings.
- MC recognised a severe lack of funding for GSD.
- MC confirmed that it supports a semiautonomous status for GSD, that GSD should be able to generate revenue from consulting and that GSD should have an Advisory Board consisting of the stakeholders.
- The GEUS project should be extended to end 2003.
- MC stressed that GSD should be better to serve clients such as mining companies.

Meeting with Mr. Adade Ministry of Mines 28-06-02

- GEUS presented its findings and noted that there is progress at GSD.
- The Ministry of Mines support that GSD should be semiautonomous.
- The future EU contract will be between the Ministry of Mines and EU and not through MC.
- The Ministry of Mines support that GSD should house a future water well database.

Meeting with Danish Ambassador Ole Blicher 28-06-02

GEUS told about its findings and Mission and Vision statement for GSD. New management structures, weekly management meetings etc.
Discussed possibilities of erecting a water well database and prospecting for deep seated water in the Volta Basin. This may be of interest for future Danida programs in Ghana.
OB would like to be informed about developments through Mr. Kurt Klitten.

Schedule for the visit:

June 24 Dept. Copenhagen
June 24 Arr. Accra
June 25 Meeting with GSD Management
June 25 Meeting with Wim Olthof and Robert de Raeve, EU, Accra
June 26 Meeting with GSD Management
June 26 Meeting with GSD Management
June 28 Meeting with the Danish Ambassador
June 28 Meeting with Mr. Ben Aryee, Minerals Commission
June 28 Meeting with Mr. Adade, Ministry of Mines

Appendix 7.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

Producing Digital Maps and Associated Databases

Mission Report – February 2002

Prepared by Bjørn Hermansen
Geological Survey of Denmark and Greenland

This report relates mainly to the chapter 8 in the Inception Report to this project: ”Geological Maps, Records office and Library”. 8.1.1. quotes: ”*Geological maps.* About 90 geological maps of various ages are present at the Survey. Some of them are in poor state of preservation, and few are readily available to the mining community and other potential users. The Cartography Section of GSD works with rehabilitation of torn and defaced maps and has started digitising some of the maps (Annual Report of the Director for the year 2000, p.69)”.

1. Preproject status

The situation concerning the geological maps occured as expected to be characterised by many deficiencies: No index map or register of the paper maps produced at GSD in the past years. But a newly overview map existed. In the Inception Report the number of existing maps were estimated to 90, but it showed up to be 133 separate geological paper maps.

The old maps – many of which only existed in one or very few copies - were stored in the Drawing Office at GSD under poor conditions. Eleven maps produced in co-operation with the German Geological Survey BGR in the years 1991-99 were of a more recent quality. These maps were still only in paper formats.

The software in the Department of Data Management that could be used for this task of producing digital maps etc. were 3 licenses of ArcView 3.2 and an older version of PC Arc/Info. The Airborne Geophysics Lab. In the Department of Geological Mapping had some MapInfo licenses as well.

The available hardware was 4 older stand-alone PCs (Windows-98), a 5-10 years old Calcomp digitising table, a digitising tablet, an A4-scanner and a large HP750-plotter.

No personnel in the Department of Data Management were educated in GIS or digital mapping. Three persons (and Kwame Boamah) were assigned to the project.

Trainees making GIS-exercises in the Department of Data Management

Activities during my first visit 28th of January – 10th of February

- A new PC (Windows2000) borrowed from Feiko Kalsbeek was moved to the Department of Data Management and used for GIS purposes because GIS is quite demanding in terms of processing power.
- An indexmap (on paper) was made and the associated data was typed into Excel.
- Several trials were made to connect the digitisingtable to the PCs but fatal errors occurred.
- Different kinds of GIS and imagehandling software (extensions to ArcView and Paint Shop Pro) were installed at the PCs and tested successfully.
- A proposal for the working process of digitising maps at GSD was made.
- A working plan for the period February to April was suggested and accepted by the head of department K.O. Boamah.
- After some trials to convert data to lat-long degrees we decided to maintain the mapdata in the special Ghana projection. The PC Arc/Info should easily be able to do the conversion but we had too little time to get the parameters right. This task can be done later but it might as well be fine to use the same projection as the Ghana Landsurvey.
- Five persons at GSD got some basic education in GIS and were taught how to digitise maps using ArcView. This training must be followed by more education in GIS and related topics.
- Kwame Boamah got some basic instructions in how to merge scanned images and georeference the resulting image.
- We scanned, merged and georeferenced two paper maps. One for training purposes only and the other one as the beginning of the actual production of digital maps.

Kwame O. Boamah and Dr. Mauer participating in the set up of the GIS-environment

- I got in contact with BGR in Germany concerning the 11 maps from the 1990's. Only one map was in some digital form. The other maps could presumably easily be scanned and vectorized. GSD has given permission to scan these maps. It might be done at the BGR.

Conclusions and remarks

The situation concerning the geological maps at GSD seems quite troublesome but far from hopeless. The challenge is to get the maps and the associated information into a GIS-database. This is not a trivial digitising task while the process involves standardisation and reprojection of the maps – and even more important a review of the geological map content.

GSD lacks GIS-educated personnel but the necessary expertise can be build up along the first year or two of the digitising process which is estimated to last about 5 years employing 3-4 persons fulltime.

The hardware in the Department of Data Management is insufficient but if the digitising table is brought to work and the borrowed new PC can be used for GIS it is possible to keep the process going for a while.

The available GIS-software is acceptable for now. The PC Arc/Info should however soon be upgraded to a new version or even better replaced with an ArcGIS license. This would undoubtedly lead to higher production speed and better map quality.

A way to speed up the process and to ensure the preservation of the complete map content would be to scan all the old maps at some bureau in Accra capable of scanning in large formats.

To follow up the plan for the period February to April I have arranged to continue my work at GSD in late April.

Bjørn Hermansen

Attachment 1

Plans for the period February to April 2002

- GSD tries to get the digitizing table working – either with ArcView or Arc/Info. If they succeed further step should be taken to digitize from the table.
- If the converting routine PROJECT (in Arc/Info) still doesn't work with the Ghana projection in mid-February. Help should be obtained from the Land Survey or the university.
- A nationwide digital indexmap should be made as soon as possible from coordinates from the Land Survey (or Airborne Geophysics dept). This map should provide the fix points for the other map themes.
- Information about the maps that don't fit into the new mapsheets and which mapsheet that are geologically mapped – should be obtained from the manually drawn indexmap from the Drawing Office.
- The meta-data about the maps (in Excel format) must be completed (one record for each paper map) and updated along the digitizing process.
- The 11 maps printed in Germany in the 1990th will presumably be scanned at BGR and vectorized at GEUS.
- The resulting data should be edited and added to the geological information at GSD. GEUS or a Ghanaian expert will have to help teaching the staff geometric editing and building topology.
- In the meanwhile GSD should make progress by scanning 2-3 maps on the A4-scanner and merge them to whole mapsheets either with Paint Shop Pro or MapInfo.
- The geological information (sample points, faults, areas with described geology etc.) on these 2-3 maps should be digitized on-screen with ArcView.
- GSD should make decisions about the general layout of the future printed maps – including the legends and color tables.
- Contact between the Danish and the Ghanaian partners should be maintained via email in this period. Some on-line support to the GIS-trainees will be possible.

Suggested by Bjørn Hermansen
Accepted by Kwame O. Boamah
February 8, 2002

Comments and Explanation of the Diagram Showing the Proposed Processes of the Digitizing of Maps at the GSD

1. All paper maps can be used – but with varying difficulties.
2. Before digitizing an overview of the task must be possible. Thus a spreadsheet containing information about all the printed maps must be made. This spread sheet (Excel) will be a preliminary meta-database and should along the digitizing process be updated each time a map has passed one of the processes shown in the diagram.

Suggested content of the preliminary “meta-database”:

Map No.	Name	Scale	Year	Digitized	Scanned	Edited geometric	Reviewed	Edited geological	Stored in database	comments

3. Until an A1- or A0-scanner is available the best way to digitize the maps is to do it using the digitizing table. This can be done either by using ArcView or Arc/Info. Because GSD has only one license for PC ArcInfo but several licenses for ArcView this would at this moment be the best choice. –
4. While the table is not currently working (8/2-02) maps can be scanned in A4-format and merged in MapInfo or Paint Shop Pro. The resulting images can be geo-referenced and used for on-screen digitizing. If a large scanner becomes available the digitizing process could be speeded up.
5. Some few maps from the 1990th (printed by BGR) might be scanned from the print layer. This could result in rastermaps, which would be possible to process further by automatic vectorizing and topology building.
6. The first digitizing task could be to do the indexmap. This would be an easy way to maintain the overview of the progress in mapping and digitizing – moreover most of the mapsheet borders can be obtained from the digital maps made by the Land Survey.
7. After the initial digitizing next step is the geometric editing to avoid “dangles” and “unclosed polygons” in the map. Arc/Info would be the best tool for this process.
8. Adding geological information can be done with ArcView or ArcInfo by selecting the features (points, lines or polygons) and typing in the associated information.
9. Many errors will be evident when the digital map is printed out. These should be corrected, but the review by relevant geologists should also include a critical look at the information in the originally paper map. If the map is going to be part of the nationwide digital geological mapping the geological content should be updated when new knowledge of the area occur. These changes must be described briefly in the “comment” field of the “meta-database”.
10. When the content of a digital map is accepted be the responsible geologist it is stored in the map-database. Only one person should be responsible for the maintenance and frequent backup of the database.

Appendix 8.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

Producing Digital Maps and Associated Databases

Mission Report – May 2002

Prepared by Bjørn Hermansen
Geological Survey of Denmark and Greenland

This is the second mission report that relates to the chapter 8 in the Inception Report to this project: ”Geological Maps, Records office and Library”. The first report was made after the visit from 28/1 to 11/2 2002. This report describes the project in connection with my second visit at GSD from 23/4 to 7/5 2002.

Status at the 23/4 2002

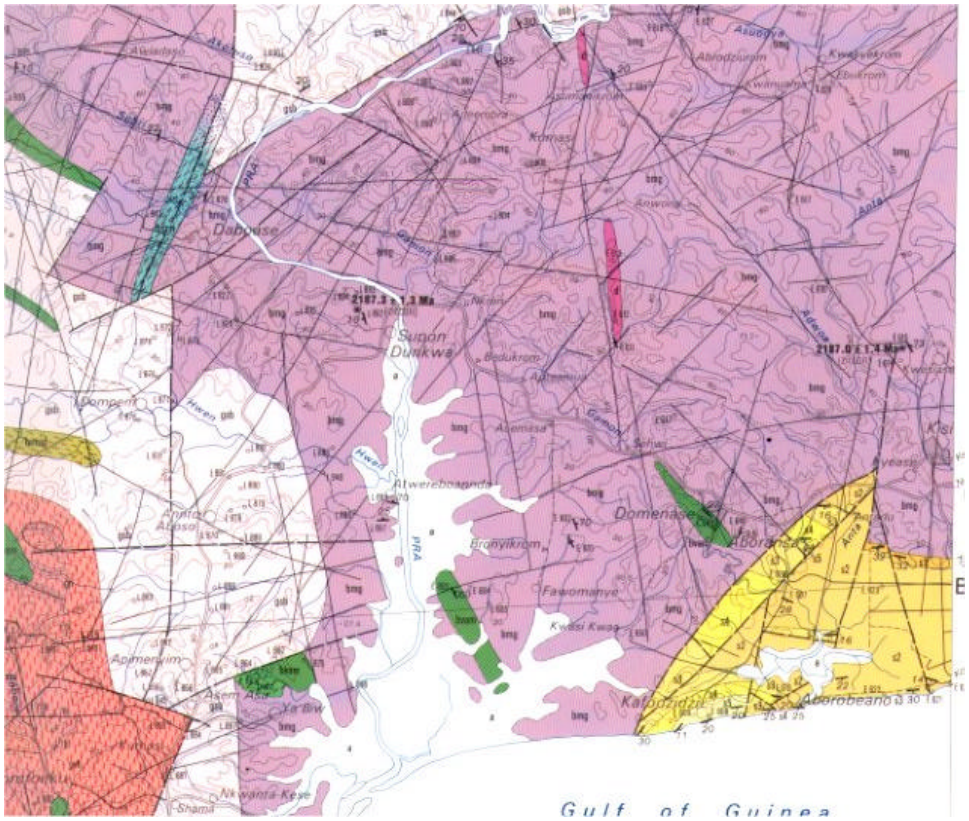
The hardware situation had not changed since my first visit two month before at GSD. The new PC (bought for Feiko Kalsbeek) worked perfectly. The 4 other PCs were slow but usable and the digitising table did still not work. I was told that a new PC would arrive very soon.

The meta-data about the geological maps (in Excel format) had been completed as agreed. It will have to be updated along the digitising process.

The frame for a digital index map was made by merging map sheet borders from the Ghana Survey Department. The index map was finish during my stay.

12 maps produced by the German Geological Survey (BGR) in co-operation with GSD in the years 1991-99 were - according to an agreement I made with BGR and GSD - scanned in black and white and delivered to Kwame Boamah. Unfortunately not only the geological information was scanned so the process of semi-automatic vectorising could not be applied.

Part of the scanned version of the Tarkwa South map sheet



The software in the Information Technology Division seems to be upgraded soon with the ArcView extensions Spatial Analyst and 3-D analyst. They might be useful later in the process. Moreover BGR is expected to deliver a new PC and ArcView 8.x as a part of a new project

The personnel in the Information Technology Division that were slightly educated in GIS at my first visit had improved their skills and had made a nice looking digital map of Tarkwa South.

Activities during my second visit 23rd of April – 7th of May

- Kwame Boamah and the GIS-group had a list of problems they had encountered since last visit. We went through these GIS-problems and found a good solution to most of them. Some of the problems were due to lack of understanding of the nature of digital maps or ArcView. This led to a minor course in these subjects.
- A digital index map (polygons) was made and the associated data in Excel-format was joined to the dbase-table.
- More extensions to ArcView were downloaded from the Internet and installed on the PCs at the Information Technology Division.
- The proposed working process of digitising maps at GSD was changed according to realities (no working digitising table).
- A draft working plan for the period May to October was suggested and will be finalised through emails between Mr. K.O. Boamah and me.
- We found a provisional method to put degrees on the printed maps while still using the special Ghana projection as the Ghana Survey Department.
- Some more basic education in GIS – with emphasis on digitising, error-correction and joining tables - were given. The training in GIS should be disseminated to a somewhat larger group at GSD to make the GIS-resource at GSD less dependent on individuals.
- Some (two?) of the scanned maps from BGR where georeferenced with a satisfying result.
- I gave a lecture on GIS applied in geology for 25 persons at GSD. Those especially interested in GIS and data got a more technical lecture on data quality afterwards.
- I ensured that maps could be printed out in right scale. The reported problems must be due to wrong procedure.
- I got in contact with some local GIS-experts (Richard Kofie and Timothy Ayamga) who seem to be willing to co-operate and act as a kind of GIS-expertise backup if it becomes necessary.

Conclusions and remarks

The situation concerning the geological maps and the GIS-expertise at GSD evolves positively. A digital index map has now been made and joined with information on the existing paper maps. This should form the foundation for the coming digital geological maps. The first of them seems to be ready soon.

The GSD-staff needs generally more understanding of the new possibilities in digital maps. This process is now started. The group of personnel that is expected to make digital maps using GIS has to be increased to build a more robust professional network less dependent on the single individual.

Method discussions in the GIS-room

The digitising process is estimated to last about 5 years employing 3-4 persons fulltime, but it will be an advantage to spread out the work on 6-7 persons part-time.
If the hardware in the Information Technology Division is supplied with one or two new PCs (as expected) it will make the GIS-environment work in a satisfying manner. It would however be preferable if the digitising table were brought to work.

The available GIS-software is acceptable and will even be improved with more ArcView extensions. But to increase the production speed and enhance the data quality GSD should seek to get an ArcGIS license within a year or two.
At the moment (May 2002) I have not arranged when to continue this task at GSD.

Bjørn Hermansen

Attachment 1.

Plans for the period May to October 2002

- The 11 maps printed in Germany in the 1990th and scanned at BGR in April 2002 have been reduced in file size in May. These simplified map-versions will be geo-referenced by GSD using the ImageGeoRef-extension. (Two maps were done in May).
- GEUS tries to get approximately 20 maps scanned from copies received in July.
- The nationwide digital index map made in May 2002 is used as frames and fix points for all the other map themes.
- The meta-data about the maps (in Excel format) will be updated along the digitizing process by GSD. New records and fields will be added when necessary to optimize the linkage to the index map.
- The geological information (sample points, faults, areas with described geology etc.) on 4 of the scanned and geo-referenced maps should be digitized on-screen by GSD using ArcView. GEUS will try to help via email if problems occur.
- The new digital geological maps are send one by one to GEUS while they are assumed to be finished.
- GSD should make decisions about the content and general layout of the future digital and printed maps.

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Suggested by Bjørn Hermansen
Accepted by Kwame O. Boamah
July 2002

Appendix 9.

Republic of Ghana

Ministry of Mines

Minerals Commission

Mining Sector Development and Environment Project

NDF Credit 156-14

Adviser to the Director of the Geological Survey Department

Start of GSD institutional database analysis and development

Mission Report – 3 to 11 May 2002

Prepared by Leif Thorning
Geological Survey of Denmark and Greenland

Mission Report

Mining sector Development and Environment Project, NDF - Credit 156-14: Adviser to the Director of the Geological Survey Department (GSD)

3 – 11 May 2002: Start of GSD institutional database analysis and development

Leif Thorning
Head, Department of Economic Geology, GEUS

Final, 17 May 2002

Tabel of Contents

The information contained in this Mission Report is to a large extent dependant on the information I have received from managers and other staff at many talks and meetings during the week. However, the choice of subjects to treat in the report, as well as the wording of facts and opinions, represent my personal perceptions and recommendations. Though I feel it is a faithful representation of what at this time characterises the GSD with respect to development of databases, the statements in this report are of course in no way binding for the other parties to the various meetings. I apologise for any inaccuracies, errors or omissions that may be present in the text; please let me know so that they can be corrected.

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Mission Objective

The main objective of this brief mission to GSD was to carry out observations, participate in discussions and give recommendations concerning institutional database issues at the Geological Survey Department of Ghana.

Timing and programme

The mission took place 3rd to 11th of May 2002.

3 May 2002	Copenhagen – Accra with British Airways over London. Hotel: Byblos, 11th avenue, Accra
4 - 5 May 2002	Consultations with Bjørn Hermansen, GEUS, in Ghana on a similar mission directed at GIS related issues. Contact to Kurt Klitten, Royal Danish Embassy
6 – 10 May 2002	Meetings and discussions at the Geological Survey Department with a number of key people, including the Director, Heads of Divisions and other representatives for the Divisions.
7 May 2002	First Workshop on database issues
10 May 2002	Second Workshop on database issues
11 – 12 May 2002	Return to Copenhagen.

This Draft Mission Report was delivered to Feiko Kalsbeek in Copenhagen and Kwame Boamah by e-mail on 15 May 2002 with a request for comments; the final Mission Report was delivered to Phillip Amoako, Feiko Kalsbeek, and Kwame Boamah on 17 May, also by e-mail. In the author's opinion, this report can be freely distributed within GSD, but the final decision concerning this is left to the Director.

Workdays used for this mission: Two travel days counting as workdays (3/5 and 11-12/5), five workdays in Accra (6/5 – 10/5) and two home days in Copenhagen finishing the report, i.e. **a total of nine workdays.**

Summary of activities

I had an introduction meeting with Director Phillip Amoako and Kwame Boamah Monday the 6th of May. During the week available, Kvame Boamah and I had many conversations and discussions in between the other meetings. These were used for more complex and

technically detailed insights into database issues, but we were also looking for ways to co-ordinate views, strategies and actions with respect to the involvement of all divisions in the database building process. Kwame Boamah and I also held separate meetings with all heads of Divisions, where the agenda included both basic discussions in general terms and a specific discussion of the various types of data relevant for each of the Divisions. On Tuesday 7 May 2002, I gave a 1:30 hour general lecture on database issues relevant for GSD at this stage, for the Director, Heads of Divisions and some project scientist (about 12 persons). A concluding meeting involving all heads of Divisions and open for all scientific personnel was held on Friday the 11th of May 2002 (some 20 persons were present).

Main observations

In the following two sub-sections of this report, some main observations are listed in no particular order. In the subsequent Discussion, selected issues of some importance are treated.

General

- Everybody I talked with during the week expressed great interest in the issues related to the construction of databases in GSD. Without exception, most indicated with various degrees of conviction how important they considered this to be for the improvement of the scientific as well as the general functions of their respective Divisions. The degree of motivation is very high among employees and managers alike.

- Everybody also emphasised the problems caused by the virtual lack of access to computers in GSD. This means that the actual general knowledge of computer use is unfortunately very limited. There are exceptions and some employees have access to a PC and perhaps Internet at home or elsewhere. Some have experiences using Windows and MS Office products, mostly Excel and Word, but nothing advanced.

- Presently, knowledge about databases, the principles and practicalities concerning their definition, construction and use, is minimal to non-existing in GSD as an organisation. Few individuals know of some of the concepts, but no one has actually tried to make a database and whatever personal experiences exist, these have not yet resulted in the presence of institutional capacity.

- The overall effect of this is that any desired development in IT based methods must be proceeded by training at all organisational levels, in general as well as specifically. Again, this is something everybody agreed to.

- The start of the activities in the GIS group in the Data Management Division has gone well and means that the group now can produced digital geological maps. This

capability is important for further development and should be allowed to continue uninterrupted and with maximum support.

- This also means that similarly, a database group should be established in Data Management Division without interfering with the ongoing work in the GIS group. There will be much need in other divisions for the help and assistance such a group of database experts can give.

- The Geophysics Division is obviously an exception in all this. The geophysical projects that the group has been involved in have given lots of opportunity for learning, and the result of that is very visible now. It is perhaps a problem, for the Geophysics Division and the rest of GSD, that such a gap in knowledge and practical, hands-on experience exists.

- The use of IT that actually takes place in GSD is often based on individuals and it is not very systematic. In a few cases, Excel spreadsheets are used for tabulation or listing of information, and although Excel has a few limited database functions, it cannot be recommended to use a spreadsheet as database. However, the spreadsheet can be used as a tool for data entry.

- GSD is already involved in various national activities, which has relevance for database development. An example is NAFGIM (National Framework for Geo-spatial Information Management), a steering committee for a national spatial data initiative. The aim is a national electronically networked interdisciplinary, inter-agency and cross-sectoral organisation. This will place strong constraint on the participating agencies and offices, and will influence the choice of software for GSD. It will also result in demands to GSD to produce databases of the data under its responsibility.

- The future development of databases and GIS is not only a question of hardware, software and training. Attitudes and habits must also be looked at and very often changed. The institutional sharing of all data is not something that just automatically will happen at GSD; management must very actively encourage it.

- It is very encouraging that there seem to be a general consent to a strategy implying that GSD must be very responsive to the needs of Ghana society. Databases and GIS are very important elements to support such a strategy.

Interviews with Divisions

During the meetings with Heads of Divisions and/or other representatives from the Divisions, I tried to encourage discussion of the following issues as suitable or required, and always with a special view to databases:

- reactions to Tuesday's seminar and the issues discussed there

- state of affairs of division – main work now and in the near future
- main responsibilities – scientific and otherwise
- number of employees with knowledge of computing - expectations
- what are the training needs – heads and their employees'
- do a division have one or two employees that can participate in the Database Forum (see later) together with themselves?
- number of computers and programs – version and age
- desired number of computers and programs – ideas?
- how would the division like to organise the use of computers?
- types of key data and the way they are produced – priorities?
- users – internal and external
- need for databases – which ones would the division like to see started?
- can the division participate in the 'definition and analysis' of attributes?
- what type of outputs are the division interested in? Which are absolutely needed?
- how is the co-operation with other divisions perceived when it is concerned with databases,
- especially with Data Management Division
- can a representative for the division attend first meeting of GSD Database Working Group on Friday at 10:00 am?

The following summaries of observations based on the meetings with heads of Divisions or their representatives, is **not a complete record of the discussions, but an extract of those issues that are of direct importance for database development at GSD**. All meetings were open, interesting and very fruitful for me; they certainly demonstrated that though there generally is a lack of precise knowledge and skills, there are a great deal of motivation already present in the organisation, when the subject is development of databases in GSD.

Geochemistry Division

Wednesday 8 May 2002 10:00 – 11:15; Present: Head Dr. Daniel Boamah (DB) and Forsen Karikari (FK), recently returned from doing a M.Sc. in Mineral Exploration in Holland. LTH & KB.

- Presently staff comprised by Head and two lab technicians; DB wish for attachment of FK as assistant and one chemist plus one to two geologists.

- DB is familiar with some database concepts, has used databases, but has not been involved in development of databases. Has good working knowledge of general use of IT.

- Present programs being used: MS Office, mostly Excel. Agrees with policy of 'two to one', LAN and Internet hook-up. At present time one PC.

- Main responsibility and activity at present is the preparation for the XRF apparatus, expected to have been delivered and be ready for operation by July 2002. The instrument is of course highly computerised, and comes with a modern PC (Windows 98, MS Office Professional) with all necessary programs for running the XRF. Results are delivered in Excel spreadsheets, and will be easy to enter into a database automatically. Contacts should be made to the supplier of the instrument concerning their knowledge of any special databases fitted to the instrument? There will be training in the use of the instrument. This instrument will upgrade the computer knowledge of the Division considerably and will increase the demand for a GSD database of results/data related to samples. However, if the production of analyses is to be kept at the number hoped for (thousands per year), the computer will not be available for anything else. The system will – if successful – probably generate a need for additional computers, to be used for all the data administrative procedures that become necessary in a production environment.

- Division expects to be doing analyses for in-house clients (i.e. Geological Mapping Division, Clay Mineralogy & Ceramics Division, etc.) and at a price also for external customers, e.g. mining companies. Hope to be able to do some thousand of analyses per year. The urgent need for databases are clear to everybody.

- Close co-operation with Geological Mapping Division concerning mapping programmes. Need to also co-ordinate the database to hold both the field descriptions and sample analysis results.

- Urgent need for unique numbering system for samples used by **all** Divisions.

- Plans for involvement in regional geochemical sampling programme based on stream sediments and perhaps also heavy minerals. Wish also to be involved in the development of products such as geochemical maps based on these data. LTH mentioned the Geosoft product Chimerae, for the handling and interpretation of geochemical data – this product works well with other Geosoft products such as Oasis

Montaj, already being used in Geophysics Division. The database system, which is a part of these programs, may also be a suitable candidate for a database system to be used by the Geochemistry Division. Contact is being established to senior researcher Agnete Steenfelt, GEUS.

- The Division also produces thin-sections (but not polished sections); databasing probably also needed here.

Clay Mineralogy and Ceramics Division

Wednesday 8 May 2002 11:15 – 12:05. Present: Lawrence Asare (LA), KB and LTH.

- Five in division; two 'know something' about computers and their use. The Division is in agreement with the GSD policy of getting many more computers, LAN and Internet.

- Main responsibilities presently include collection of clays from selected locations and subsequent analysis and suggestions for use. This means that there is clear need for GIS.

- Attempts to work in one or two regions of the country every year. Establishes sites (localities) where certain observations are made and samples are taken. Depending on funding, there will be some 10 – 40 sites per region and at each site 1 – 2 samples of clay. This means a total of 40 – 160 samples per year and many laboratory determinations of physical parameters for each of them, perhaps later supplemented by chemical analyses. Clearly a database would be a great help.

- Data are now in spreadsheets. On maps, only a site is plotted without further quantification. Scope for improvement here. Also, it would be desirable to actually map the extent of promising clay formations. Development into GIS required.

- Analysis presently encompasses physical properties at various temperatures, but it is a wish in the future to include chemical analysis and mineralogy. Co-ordination with database for chemical analysis is required. This has implications for numbering of localities and samples, which should be homogenised with Geological Mapping (and Environmental Geology).

- The Division test-produce certain ceramic products and has a need to present these together with good presentations of the required parameters. Database and good lay-out/reporting required. Only a subset of the data is presented in a formalised form.

- The Division must be able to communicate with many local businesses and the informational material they produce must be designed accordingly.

Environmental Geology Division

Wednesday 8 May 14 – 15. Present were E. Efa, KB and LTH.

- Head, two full-time assistant geologists and three national service geologists presently in Division.

- No computers in Division, limited experience. Have urgent need for computers and training.

- Presently work in two sheets (15 by 15 minutes – same sheet division and topographic base as Geological Mapping Division), nearly 80 % done.

- Make observations - based on a number of sources – of certain environmentally critical features, such as sites with risk for flood, landslides or other natural hazards, mine sites including old ones, mine tailings, sand deposits and quarries, borehole data (from other agencies?). Use different symbols on map to represent these but would like to add more details, with different additional attributes. It may be a problem that similar symbols are used in other Divisions, but with other meanings. Databases for site attributes, including characterisation etc, and GIS production of maps urgently needed. Database for borehole data probably also required.

- Make use of same definitions as Geological Mapping Division concerning geology. Would like more chemical analyses, for instance of tailings.

- Work together with other agencies/organisations concerned with environmental issues, such as Mines Department in Environmental Protection Agency and another department concerned with environment in this Ministry of Mines. Participates in Technical Review Committee, where Environmental Impact Assessments must be evaluated. GSD do not participate in monitoring.

- Main products from the Division are maps and reports.

- Strong focus and attention, because environment is high exposure subject. Urgently need development and training in IT generally and certainly also in both databasing and GIS.

- Upcoming co-operation with German institute BGR on environmental project for Accra area and one other town. Three years. Very good opportunity for development of GIS and db – important to influence project to agree with Ghana standards as to software and databasing.

Geophysics Division

Thursday 9 May 2002 10 – 12. Present: Head Sam K. Amedofu and Edward Otori-Asabere and Dr. John Asabir.

- This Division has benefited from considerable support during a number of Airborne Geophysics projects financed by World Bank and NDF credits. This means that the geophysicists are much ahead in the development. The latest NDF funded project is still active in 2002. There are new airborne surveys included as a component in the coming EU program, so there will be focus on geophysics for some years to come.

- The Division has four PCs (Windows NT 4.0 or 95, 200 – 500 MHz) and a local network connects them. Also large plotter and various bits and pieces. Though the Division thus is well equipped compared with other divisions, the geophysicists nevertheless increasingly run into trouble with capacity, so they also need new computers. However, their existing computers can do much good elsewhere in GSD.

- There are presently five geophysicists including the Head, and they are all proficient in the use of computers, including specialist software like Geosoft Oasis Montaj. The primary geophysical data – the actual measurement of a number of parameters are already in databases and need not be transferred to a new database. They all have a fairly good understanding of some aspects of databasing.

- Amedofu has also been involved in the PANGIS project, phase one, on bibliographic data (French/Belgian funding – I have as a consultant to Unesco/IUGS been involved in attempts to transfer the concept to South East Asia – SANGIS). It is now being considered if Ghana should also join the second phase concerned with 'factual data', basically meta-data describing the existing data in all the African countries which have joined the project. Amedofu now feels that decision should await the present development in GSD.

- The Division produces many types of geophysical maps including interpretational maps based on combinations of geophysical parameters. These maps and the technique used are fully up to modern international standards. The Division is considering how to produce a meta-data system to describe the available maps for potential users.

- Division also does follow-up on ground using various techniques. The measurements can be stored in the same type of database as the airborne data.

- The Division uses MapInfo, but as the agreed standard in Ghana is/will be ArcView and ArcInfo, it may be necessary to change to ArcView, or alternatively, test out how well ArcView can read MapInfo files. Decisions must be taken here, certainly before the next airborne project. It cannot be recommended to change GIS program in the ongoing project.

- Co-operation with Geological Mapping Division mainly by delivering maps on paper. The Division often lacks access to digital geology and sometimes has to prepare alternatives. Tried some ten years ago to interest the then mapping group in digital methods, but without success.

- Division is considering Adobe Illustrator as a layout tool. This is a good program, but it must be made clear that once a map has been imported into such a program it is no longer data, but has become a picture. Maybe an alternative should be considered: to use Oasis Montaj and ArcView for layout of maps. If the purpose is to produce posters with many graphical elements, it may of course be advantageous to us a graphics program like Adobe Illustrator.

- In terms of new GSD databases, the most beneficial one that the Division could produce would undoubtedly be a meta-database with all relevant information on the maps produced in the Division, supplemented by a database giving the relevant details of the projects which have produced all these wonderful data.

- It is also important that the divisions of Geophysics and Geological mapping co-ordinate the meaning of the various structures, polygons, etc that they both use to represent data (~ geology) on a map, e.g. in GIS.

- Two of the geophysicists, supplemented by a group of technical officers take care of the seismometer network of Ghana. There are nine stations (observation points for shock-waves from earthquakes), of these four are working, while various malfunctions make the remaining five inoperative. The sensors send the analogue information via radio links to the recording facility here at GSD. Any seismic events are later read of the drum-paper and distance to epicentre, force of the earthquake etc. are tabulated and once a year delivered to the international organisation. These tabulated results could easily be arranged in a database and supplemented with additional data, so that seismicity maps can be produced. The group would very much like to do this.

- There are attempts to find ways to make the recording digital, e.g. by AD converter; some sites may have to be moved. This modernisation of the network (or would not a replacement by a completely modern, IT-based system be a better choice?) also including the digitisation, must be considered a special project outside the scope of any ongoing contracts. However, the databasing of the results can be considered a part of the present development.

Geological Mapping Division

Thursday 10 May 2002: Present: Head of Division Geoffrey Loh and Solomon Anum, KB and LTH.

- The Division has one PC (Loh's office), but they have no printer or plotter. Some limited use of MS Office products, mostly Word and Excel for report writing and tabulation, but basically most of the personnel of the mapping teams of the Division

are considered by the Head to be in need of much training. Thus there are a strong need for purchase of computers and programs, and for training.

- The Division can presently keep four mapping teams in the field. A mapping team usually consists of one senior geologist, two assistant geologists, one technical officer, four casual technicians, and one driver. Theoretically, it would be possible to aim at a situation where each team had a labtop at their 'base camp' and one person being able to handle it proficiently, so that field observations can be entered while in the field.

- The Mapping Manual that has been prepared recently can form a very good starting point for a database of field observations. LTH will get a copy from Feiko Kalsbeek and have a first look on the possibilities.

- Presently, four map sheets are being handled. The need for GIS based on observational and analytical data in a database is perceived as urgent by the Division.

- The Division uses no special programs for e.g. norm calculations or petrographical plots etc. Rockware, the company, was mentioned by LTH as a place where one could look for good, simple and well tested, but fairly inexpensive programs of this sort. Whether or not there is an urgent need or not depends really on the number of calculations that are needed.

- A unified way of numbering sites (localities) and samples have been agreed upon as part of the Field Manual. It was uncertain if all Divisions would use this, but they ought to.

- The Division is very aware of the fact that close operation with especially the Geochemistry and Geophysics Divisions is important. Therefore, it is also important to maintain similar definitions of map features and ensure ability to use the same database of analyses.

- The problem of definition of terms and schemes for lithological descriptions and rock type naming was also discussed. There are obviously a number of issues to analyse and decide. A good process around the definition of objects and attributes can help.

- Loh mentioned the special role of the Regional Offices, with a question on how they could be involved in this modernisation process. LTH advised that the situation seems so complex and difficult that ongoing efforts should be concentrated on the Headquarters in Accra. Once the Accra office has achieved a certain competent level in the use of modern, IT based methodologies, it can then be considered how next to involve the Regional Offices.

Brief discussion

In the previous section I have already hinted at some of the issues that need attention. In this discussion I would like to just emphasise some of the more important points. As an introduction to this discussion it must be said that there is very seldom only one correct solution to the type of problems GSD is facing. It will be necessary to pay constant attention to new possibilities, do re-evaluations and be very aware of the influence of attitudes of people. What is written in this report is based on the impressions I have received from GSD, compared with the knowledge and experiences I have accumulated as a leading participant in the development of many databases and IT based systems. I have attempted to use as few IT words as possible.

It is a good sign that there are several national initiatives concerned with the development of nationally based access to GIS and geo-information. GSD must seek to play its role in these and influence developments outside GSD, because these will in turn be determining for much of what can be done in GSD. GSD can fetch support and inspiration in this.

Similarly, I noted a very strong desire in all Divisions to use their expertise and data to the good of society. Many of the questions brought to my attention during the discussions were directly related to this aspect: How can we best make our results available for potential users? This attitude should be strengthened as much as possible.

Some years back, it would have been possible to believe that an organisation such as GSD had a choice whether or not to go the digital route with databases and what follows from that. That is no longer the case. It is in my opinion an absolute necessity to develop databases etc., if GSD is going to have any chance at all in honouring its obligations and fulfil the expectations, which its employees, managers and indeed society itself rightly have. It is in other words quite critical for GSD to get started now on the activities eventually leading to useful databases. Society taken in its broadest sense, including the international mining industry, today expect that a national geological survey can deliver relevant geoscience information in quality controlled, digital format, easy to receive and use for ‘the client’. So, the issues addressed in this report are definitely core issue for GSD’s ability to deliver the services and information required by society.

A word of warning must also be given here. It should be self evident, but it is nevertheless important to emphasise that the quality of the geoscience data of course still is of paramount importance. Nobody can use bad data, even if they are advertised and delivered in flashy packages. GSD therefore faces the difficult task to develop entirely new IT-based facilities and at the same time maintain and in some cases significantly improve the quality of data and information. It is a daunting challenge, probably best met by taken one step at a time while keeping the more distant goals firmly in view.

Looking ahead, there are some coming projects, which give even more emphasis to this. As an example, the up-coming EU funded project seems to operate with plans and goals for very advanced, inter-agency databasing. If GSD is to carry its part in all this, it is very urgent that GSD arrange for good order and capability in its own house. Or to express it directly: unless GSD has managed to get internal GSD databases in operation before the

demand for inter-agency joint databasing increases, GSD will be hard pressed to maintain its position in such future co-operation.

In general, experience has shown that one of the most important factors for the success or failure of an IT project, such as e.g. the development of an institutional database, is the attitude shown by and the support given by top management. In the case of GSD this means that the Director and the Heads of Divisions must be very aware of the signals they send out to the employees. If they do not clearly show that this development is desirable, necessary and important, the risk of failure is great.

It must certainly be admitted that the lack of hardware facilities, such as PC's, LAN, printers, access point to the Internet etc. are a severe impediment to progress. IT based facilities can only function effectively and satisfactory if such basic conditions are present. However, as I pointed out repeatedly during my talks and in the discussions with the various Divisions, it is not necessary to wait for all this to arrive, before the process of database development can be started. There is plenty to do now, basically using just pen and paper, brains and time! The first phase of any IT development involves a lot of analysis, aimed at finding the answer to questions such as: what are our key data? How precisely are they defined? - measured? - produced? Why must we put them in a database? Who will use the data and for what? How should we present the data to the potential client? Etc., etc. As a matter of fact, GSD must have good answers to these and many other questions, before any database should be defined.

During my stay at GSD, it quickly became clear that it would not be useful only to describe the distant goal of the desired development as a nice, put unattainable picture on the horizon. Based on this I tried to concentrate on the first step to take, on how to get started given the present, lacking situation. I suggested that each of the Divisions tried to describe their key-data and do it in such a way that it would actually become the first step in the definition of databases. In Annex A, the slides (talk on Tuesday) give some more detail on the process of defining data objects and the attributes describing the data objects. This is the process that can be started now, without waiting for new PC's. A few additional hints are given in Annex C.

All Divisions that participated in the open workshop Friday were asked beforehand to prepare a first list of objects that they envisage should be in their databases and to present this list for everybody at the Friday meeting. The suggestions for objects and attributes – for that is what it was - were then discussed and used to point out some problems and considerations relevant for all Divisions. Since that workshop I have received the list of suggestions electronically from two Divisions, and Kwame Boamah will forward those still missing as soon as he receives them. I will subsequently attempt a first analysis and return my comments, so that the Divisions can use them to continue the refinement of their choice of important key-data.

The rationale behind this approach also has to do with the need to involve everybody in the process. Such an analysis of key data is not dependent on knowledge of computers and databases but can be carried out relying only on good sense and geoscientific knowledge and training. Ideally, a person with a good understanding of databases should

lead the process, but even without that a very good start of the process can be achieved in each of the Divisions.

As another preparation, whenever possible all actual data should be recorded digitally in a spreadsheet, preferably using a structure that is comparable with the future attributes. These digital versions of data serve as back up in case of loss of the original notebooks etc, and they are excellent as input tools when a database has been constructed and existing data need to be entered into the database. There are a number of ways this can be done very efficiently from Excel to Access. Also, data in a spreadsheet are thereby available for plotting in GIS, e.g. in ArcView, because this program can read from an Excel spreadsheet.

As an aside, I would like to question if the assignment of personnel to the Divisions is optimal. Without having used any effort to get the facts, I did get the impression that some of the Divisions were fairly thinly manned and needed strengthening, in some cases I believe it to be a necessity in order to reach the stated goals. At this point where I have not been able to double-check my figures, I can only point to the need to allocate adequate personnel or revise the goals in some of the Divisions.

I have been using the new structure of GSD as the skeleton to hang my observations on. Also, I have suggested using the Divisions to create the necessary foci for the definition and subsequent development of required databases. However, it must also be emphasised that the development of databases must be an institutional task and that a maximum degree of co-operation and co-ordination between the Divisions is absolutely necessary, as the figures in Annex A also strongly implies. During my visit, I – perhaps unjustly – got the impression that knowledge of activities across divisional boundaries was fairly limited. I have already mentioned the need for strong management control and leadership in this process. Subjects such as in which order the databases should be build and the weighing of various associated considerations should be on the agenda for Management Meetings at regular intervals, because the decisions must be strategy/policy driven. The technical solutions need not be discussed in great detail at management level, only the goals that the solutions must serve.

There is, however, also need for a forum, where both managers and those employees directly involved in the development (and for the next months that means the analysis of data objects and attributes), can meet and discuss. Definitions must be homogenised; several databases I have discussed with GSD will probably have to serve several Divisions. If these issues are not discussed freely and openly, the risk of fragmented development of separate, incompatible databases is a real risk, and that should not be allowed to happen. The suggestion is therefore to form a GSD Database Forum to hold these co-ordinating functions and be a place where experiences can be shared on a technical level and where it is possible to learn from one another's successes and failures. There should be representatives from all Divisions in the Forum.

One of the Divisions, Data Management, will have to play a special role in this development. Apart from having to go through the necessary learning curve for database disciplines, this Division must be prepared to act as consultants for the other Divisions and eventually take on the responsibility for the data modelling and other technical

aspects of the development. Probably, a second group of professionals (the first is the group of employees now forming the GIS group) should be gathered and allowed to develop their skills in database issues. The composition and training of such a group could be a subject for future missions.

As the Head of this Division, Kwame Boamah must develop an even better understanding of all the phases of database development, as he indeed himself has expressed during our conversations. To achieve this, I would suggest that we try to arrange a stay for Kwame Boamah in Copenhagen. With access to GEUS experts, he can work actively with data modelling, build a database in Access and by doing, learn what he needs to know in order to be a good internal consultant for GSD. Probably the database given the highest priority by GSD management should be chosen for this purpose.

There are some projects to start in the near future with financial support from abroad. It is very important that these projects are anchored in the GSD structure and not allowed to create budding of special groups, which absorb all the funds and all the development. A project such as the co-operation with BGR to start later this year will bring into play disciplines that affect, and should affect, many Divisions, so they should all participate and have a role in the project. Any decisions taken by GSD as to standard programs to use should also be enforced in such projects. In other words, the interaction between on the one side externally funded and generated projects and on the other side GSD should be handle so that the many positive effects of the project are deposited throughout the GSD.

There are a number of issues that I need to analyse further and a second visit to GSD seems to be called for. During the discussions, I also registered a wish for visits by two other GEUS expert, namely Thorkild Rasmussen to assist the Geophysics Division with how to distribute geophysical data to e.g. mining companies and Agnete Steenfelt to assist the Geochemistry Division in the preparations for their geochemical stream sediment programme. I will leave it to the team leader Feiko Kalsbeek and the Director to make the decisions concerning these additional visits to GSD, but I have checked that they both are prepare to participate.

Future visits should include issues for databases not touched at this visit, such as reports and data received from the mining industry, co-ordination with external data centres, e.g. the Minerals Commission, and a closer look at resources needed, both hardware and software and personnel. Also, further analysis is necessary to define the databases and which Divisions should be involved in each of these, not the least in order to define clear responsibilities.

Databases (and machines and programs) for purely administrative use or for accounting/budgeting should of course also be considered, but has not been a part of this mission.

In Annexes B and C a few additional comments can be found on equipment and the process of building ‘logical’ tables.

Recommendations to the Director

In the previous section, I have discussed some key issues and in doing so, both implicitly and directly given advice that can be acted upon as the process develops. Based on the observations and the conclusions reached during this first, brief visit to GSD, I would like to put forward the following recommendations for the immediate deliberation of the Director:

1. The commitment and need to engage in activities leading to the establishment of geoscience databases in GSD should be re-affirmed internally in the organisation and externally to potential clients and users of GSD data. Issues should be discussed regularly at management meetings. GSD should be very active in inter-agency co-operation on related issues.

2. The severe difficulties arising from insufficient funds, material and perhaps manpower must be faced and discussed with a view towards improving this situation soon. This means that it should repeatedly be pointed out to the Ministry that this is a prerequisite for delivery of the expected contribution to the Nation.

3. The in-house GSD database process must be started without waiting for additional hardware. The first phases of database development relies mostly on GSD's geoscience expertise combined with a good understanding of user needs. Elsewhere in this report some concrete actions to be taken now are suggested; a cautious start has already been achieved during my visit and the process should be nurtured and allowed to grow.

4. The need for training of personnel is urgent; many employees need basic IT training before they can contribute to the filling and running of databases. Employees should be encouraged to seek education and training whatever way they can. Some should be given special training to fulfil their role in the development, e.g. the Head of Data Management Division; part of this training should be carried out in Copenhagen with access to GEUS experts.

5. There are presently a few operational Excel spreadsheets in GSD. Whenever possible, all data should be recorded digitally in a spreadsheet. To ensure that this happens GSD-wide, the instruction to do so should come from the Director; an excellent subject to be taken up at a Management Meeting.

6. The Director should establish a GSD Database Forum with knowledgeable representatives from all Divisions.

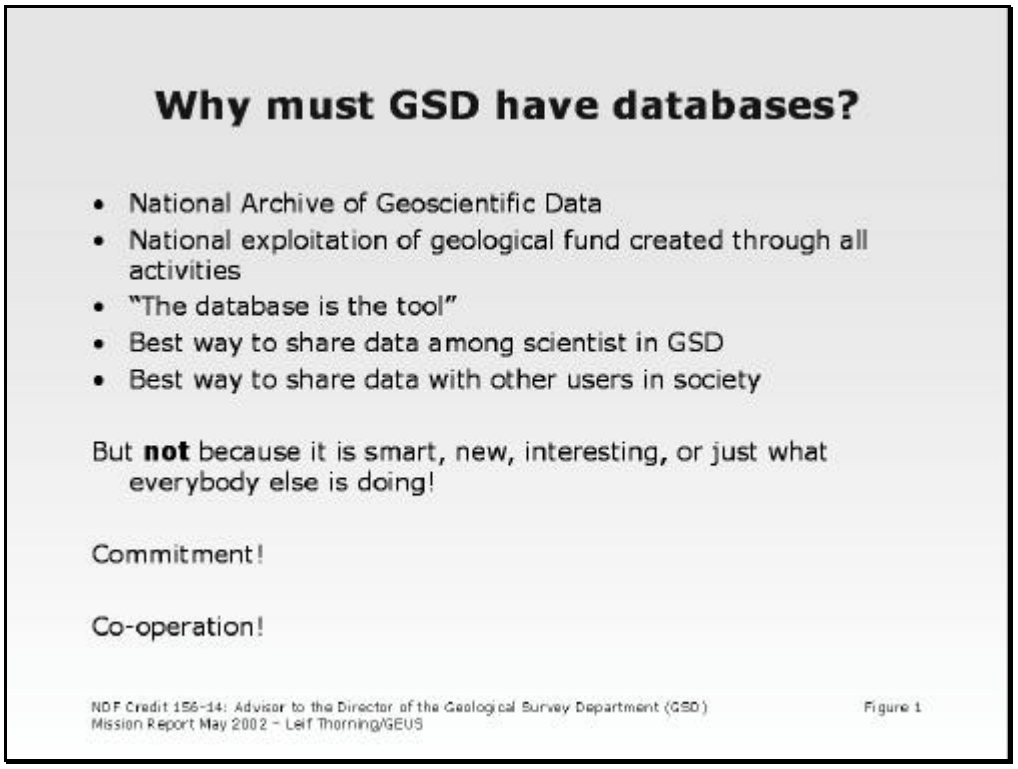
7. There are a number of special issues that need to be discussed in detail and to be co-ordinated between Divisions, such as numbering systems for localities and samples, format of co-ordinates on maps, conventions for naming etc. etc. The discussion should be started at management level, i.e. by the Director, to set the frame for subsequent discussions in the GSD Database Forum, which in turn will spell out the guidelines for the work.

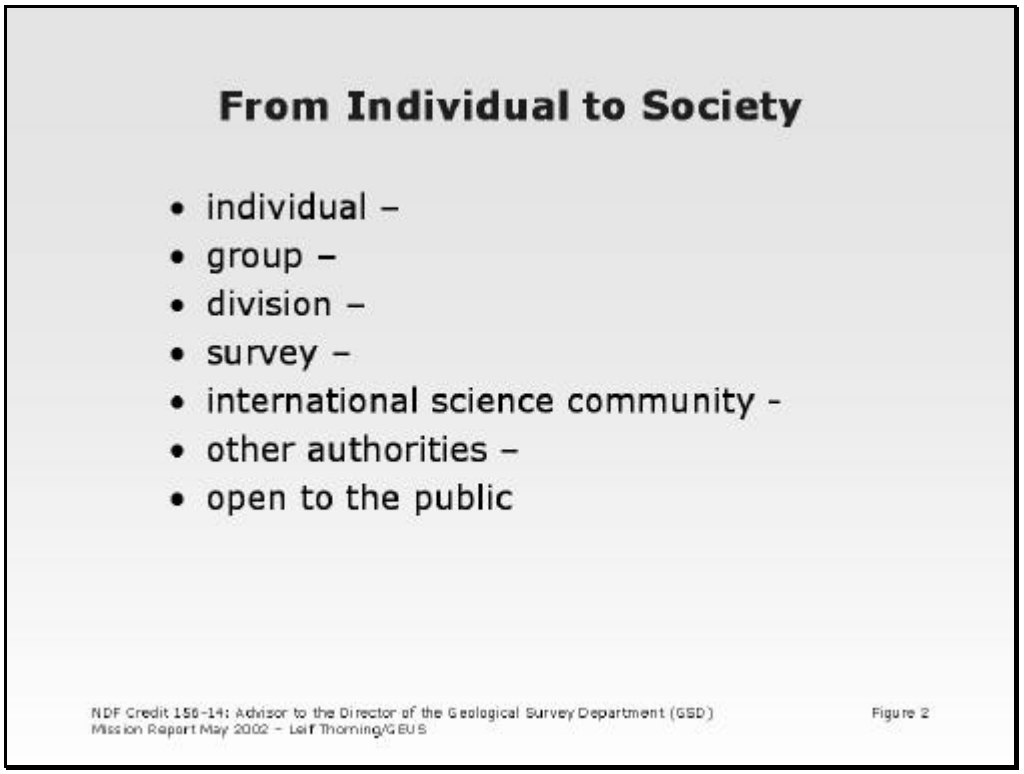
8. There are further issues and also a number of foreseeable processes needed to ensure a good development of the first phase of database development that would benefit from further contacts. A second visit of slightly longer duration is recommended and should be planned as soon as possible.

9. Those Divisions that have not yet delivered their suggestion for key data should be encouraged to do so. I hope that the Project management will accept that I spend approximately three workdays analysing the material I receive from GSD in order to give useful feedback. In any case, the material will become part of the more detailed discussions that will be possible during my next visit to GSD.

10. There may be subjects and questions which in the mind of the GSD reader of this report are important, but which I have not treated in the report. I strongly recommend that such be communicated to me so that they can become part of the future process. *Any* feedback on the content of this report will be appreciated and will become part of the process.

Annex A: Figures (overheads from Tuesday's talk)





Divisions and data responsibility

Geological Mapping:
Field Data
Formation data
Sample Registry

Geophysics:
Geophysical Maps
Petrophysics
Sample Registry
Seismology

Geochemistry:
Analyses

Examples shown - must be done for all Divisions!

Data Management:

Clay Mineralogy and Ceramics:

Environmental Geology:

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Figure 3

Responsibility of Divisions

- must be responsible for acquisition, QC, maintenance, and distribution of data
- must therefore handle input operations to the relevant databases
- must also be given access to other databases required for its functions
- subject matters on agenda at management meetings
- must be a consultant for other Divisions' use of institutional data under its control

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Figure 4

Steps in the creation of a database

- Identify key data - attributes - you!
- Identify key users - internal and external - you!
- Datamodelling - db professional!
- Database construction - db professional!
- Database implementation - db professional and you!
- Define responsibilities - you!
- Define input operation - you!
- Define standard searches - you!
- Define output products - you!
- Revise institutional procedures where necessary - all!
- Document and publish it!

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Figure 5

Definition of attributes

- Identify the 'objects' you want to describe with a number of properties or 'attributes'
- For each of these attributes, give name, define, explain, constrain, validate, give help, give db-technical definitions, etc.
- Do this (priorities) for all the data objects for which your Division is responsible

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Figure 6

Co-ordination of attributes between groups

- Use the same definitions in different Divisions!
- Decide who has responsibility for QC
- Let other users (Divisions) know how 'to get to' an attribute!
- Avoid different versions of content
- Basically, do this together in work groups

Construction of 'logical' tables

- meta- data or data?
- your collection of attributes describing an object is a 'logical table'
- all these 'logical tables' are the starting point for the data modelling
- other, technical attributes will be added - don't worry about it!
- your logical tables may be broken down and put together again in a manner suited for relational data base construction - don't worry about it!

From logical tables to divisional databases

- Basically a data modelling and db programming issue
- Priorities!
- Design Document must be prepared for the data modeller
- Be very aware of required/desired OUTPUTS!
- Define responsibilities - train personnel
- Stream-line the whole production line
- Set dead-lines - Fill the database!
- Use the database - it is a tool and an archive
- Safeguard the database - backup!

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Figure 9

Geological Survey Database – what should it be?

- Aggregate of the divisional databases
- An organised, systematic, approachable, verifiable, sustainable and trustworthy representation of data entrusted with or produced by GSD
- The basis for delivery of services and information to society, be it via individual scientist of via modern communication methods

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Figure 10

Databases and the web

- A good database in today's technology will almost automatically be a good basis for public, web-based access to GSD data
- The trend is very clear: Society expects this to happen soon
- If an organisation like GSD cannot deliver this in the near future, it may fail an important task
- If GSD does not do it, someone else will

The Next Step

- Put the subject on Management Level Meetings. Lead and organise.
- Form a GSD Database Forum (committee, work group). Start the process of attribute definition and analysis in all Divisions now (priority!)
- Start analysis of potential users and required outputs
- Co-ordinate between Divisions
- Let Data Management Division do the data modelling and database construction
- Decide how to equip and man DM Division for that purpose

Annex B: Hardware and software – present and future

As was pointed out to me by many at GSD, and clearly to be seen, the need for new hardware and programs is great. Some Divisions have no PC's, there are no LAN connection between PC's with the exception of internally in part of the Geophysics Division, and there are too few printers and plotters.

It may be difficult to get the funding necessary for the purchase of all the required equipment for an ideal solution. I have been informed that a "two to one" ratio of employees to PCs has been defined as the present target and can fully support that. However, the ideal would be a suitable PC to each professional in the survey and probably also to some technicians.

It is important to formulate a policy for which machines and programs GSD wishes to acquire. This should not be an entirely personal choice of individuals, but has to follow guidelines securing compatibility. As to software, some clear candidates are already defined (Windows 2000 and up, MS Office Professional, Oasis Montaj modules, ArcView, etc). The safest course to follow, especially if equipment is to be purchased piecemeal, is to rely on internationally based standard, and whether one like it not, Microsoft and ESRI provide that in their respective fields of expertise. There are many 'free' programs to be picked up on the Internet. Many of the can be very useful for personal tasks, but care must be taken not to base important institutional task on such software. It is too risky.

The section containing observations list approximately what is available in the Divisions I have been in contact with. Immediate purchase of about 10 ten good PC and redistribution of the present ones, would give good basis for an intensified and accelerated development, first focusing on training. If new projects give the opportunity to by PC's etc., it is important to follow the same guidelines: GSD must define the standards to be followed.

The lack of LAN facilities is a serious setback. I do not know how this can be funded, but the need for it must be stressed repeatedly anywhere there are chances of obtaining support. If a good standard is defined, it may even be recommended to do it for smaller groups at a time. No matter how the LAN facilities are acquired, I must strongly recommend that absolutely standard specifications are adhered to and that a contract with a knowledgeable **local** company for support is established. Keeping a LAN up and running is not always a simple affair. All users also have to learn, maybe the hard way, how to treat a LAN and the many components that make up a LAN.

Finally, reliable and fast Internet connections via the LAN must be established. Until that is possible, I believe every Division should be given access to the Internet via modems.
I know well that much of this may not be realistic now or in the near future though attempts will surely be made to make it so. However, management must establish a plan that can control and maximise benefits, even if GSD perhaps must accept a slow gradual growth rather than a hardware revolution.

Annex C: Identification of objects and key attributes

As mentioned in the main text of this Mission Report, one of the first steps necessary to perform in the construction of institutional databases, is the identification of the required attributes of the database. This must be done by each of the Divisions, so that the definitions, mode of data input and uses of the data can be clear from the outset. The list of required attributes would be one component needed for the data model, which must be made as the basis for the construction of any database. Data modelling is a very skilled process and will add new, technical attributes to the list prepared by the data producers (i.e. the Divisions), and will organise all the attributes in what is called normalised tables for professional database construction. However, for many simple, personal databases the 'logical tables' (see below) may often serve as a good first suggestion for the required geoscientific information in a database. For a Division, they may help significantly in achieving a good overview of key data and at the same time be a good start for the data modelling.

Without going into a description of data modelling and what it entails, it is the suggestion that each Division start this process simply by defining the data objects and the corresponding attributes for all key data that the Division is responsible for. For each of these data types, a number of issues must be resolved. It must also be tested that different groups in GSD uses the same definition for the same item. To help in the process I can recommend using a format that I have used in other, similar situations. I bring it here and it may be used as required by all in GSD.

Once the Divisions have produced this description of their data, these should all be compared to check for definitions, different names for the same thing, conventions to be observed, lists of legal values for a given attribute etc. etc. To help facilitate this process, I have offered (provided project management accept to use the workdays necessary for this) to have a first look at the suggestions prepared already and given to me. My feedback would follow the form shown below.

The following form can be defined in Word or Excel as a table. Each of the spaces in the table must be expandable (without destroying the structure of the table) as needed to contain all the information that is needed to make a description complete. This means that they are best used digitally, i.e. in Word or Excel. Again, it should be emphasised that these tables could be produced and used also by someone without any knowledge of databasing. Just rely on common sense and your professional knowledge of your field of expertise.

Data object:			
Attribute no:	Name	Definition	Comments

…Extended as needed for any number of attributes.

Guidelines:

Data object: (sometimes called Entity) is the object, phenomena, item that is to be descried by a number of properties or attributes. Examples: Samples, Maps, Analysis, etc. This will often become the name of the table.

Attribute no: is the no of the attributes. To distinguish them from one another, one can use two letters from the Data Object and then add a number. E.g. if the Data Object is a sample, the attributes would be numbered SA1, SA2, SA3,…..

Name: is the name one wishes to attach to the attribute; it should be meaningful and at this stage a full, easy to understand one is better that a complicated abbreviation. Examples could be: density, collector, date, colour, rock type, sample type, longitude, latitude, etc. Often this is what would be printed at the field on e.g. a screen-form for entry.

Comments: all information needed to fully understand the definition and how the attribute should be described. All known constraints can be noted her, e.g. if the table is only concerned with samples from Ghana, then there are certain limits to what the latitude and longitude (or corresponding co-ordinates) can be. Future help texts could be defined here. If the value of an attribute can only be certain exact words ('yes' or 'no' , one village, one of a list of rock names, one of a list of formation names etc.), a 'look-up-table' or 'a list-of-values' must be defined for this attributes. Words to that effect would be in this column.

Often, I would add another column defining the database field type, but in this case it is better to add this later. However, for those having a clear understanding of such issues, it is a good idea to do it from the start.

Also, there are some 'data administrative' attributes one would often attach (such as 'entered on date', 'by', 'confidential', etc); however, that can also be done at a later time, so forget about this for now.

Above all, be exact and thorough!

Appendix 10.

RECOMMENDATIONS REGARDING LEGAL ISSUES RELATED TO THE DRAFT ”GEOLOGICAL SURVEY ACT”

27.06.2002
MT

Introduction:

The management of GSD has ellaborated a lot furhter on the draft “Geological Survey Act” compared to the first draft submitted to GEUS in the spring 2002.

Upon thorough and constructive discussions with a number of geologists of the GSD, including the executive director of the survey Mr. Philip Amoako, during 25-26 June 2002 in Accra, it has been desided that GEUS makes its proposed recommendations by way of specific corrections in the draft “Geological Survey Act” supplemented by a number of general recommendations as stated below.

The numbering of the sections are not clear. The below references refer to the numbers in the latest draft received from GSD.

Recommendations:

Re § 1 OBJECT
The object of the Survey should correspond to the revised mission statement.

Re § 2 FUNCTIONS
The paragraph should be introduced by the following; ”The functions of the Survey are:”

The stated functions should be compared and should correspond to the mission statement and the vision statements.

Re §2 litra (f):
The Survey should not take on a responsibility to coordinate activities with all local and international bodies. The expression “collaborate” does cover the relevant relations with other bodies.

New function:
It would be relevant to add the following function and delete litra (i):
To continuosly work for the integration of geoscientific aspects in mineral ressources, environmental issues, groundwater management, land use planning and geohazards , including participation in networks together with other relevant authorities.

New function:
GEUS recommend that the Act specifically entitles the Survey to undertake consultancy services.

Re Qualification and registration of geologists:
GEUS has some doubts whether it is relevant and effective to institute a certification system for geologists operating in Ghana. However GSD still needs to consider this issue. Therefore it is recommended to make a paragraph giving the Minister the power to regulate this issue at a later stage.

Re Services to the Minister of Mines:
GEUS recommend to stipulate specifically the right for the Minister of Mines to require services from the Survey, however in respect of the Work Programmes made by the Survey and approved by the Board.

Re § 5? Governing Body of the Survey:
GEUS recommend that the functions of the Board are specified to clearify the general character of the responsibility of the Board.

Re composition of the Board:
GSD agree to compose the members of the board a little different to ensure a broad representation of the stakeholders of the Survey. GEUS further suggests to institute a nomination procedure of the different instituions and to require for at least one woman in the Board.

Re § 6 Tenure of office of the members:
GEUS recommend that the resignation of a board member should be subject to a 3 months written notice.

Re § 8 Meetings of the Board:
The Board should meet “4 times a year” in stead of once every three months.
Quorum should be 8. Decisions should be made by at least a simple majority of the total Board; meaning at least 7.

Re §9 Disclosure of interest:
The frase “directly or indirectly interested” seems very general. GEUS suggest to qualify the paragraph by specifying that the interest should be of a personal and/or commercial nature.

Re § 10 Regional offices:
It is the opinion of GEUS, that it should be considered very seriously to close down or at least decrease the regional offices significantly. Therefore GEUS recommend to delete the regulations in the Act regarding regional offices, so the Act will not be hindering for at close-down at a later stage. It it proposed to insert a paragraph which entitles the Board to establish regional offices along the line with other organisational issues, in § 14.

Part II – Enforcement and Control:

GEUS recommends that the Survey does not go into matters of regulating and controlling specific actions, permits and undertakings. Therefore it is recommended to delete Part II.

Part III Geological Survey Fund
It should be clearly stated, that the Fund is a fund of the Survey and that all income of the Fund is generated to or by the Survey, and that all use of means of the Fund shall be for the benefit of the Survey. A number of minor changes have been suggested.

The connection between the management of the Survey and the management of the Fund should also be more clear. GEUS is of the opinion, that budgets, work programmes and annual accounts of the Survey should integrate plans, budgets and accounts for the Fund. GEUS has suggested some specific changes hereto. However, GEUS is not in the position to give exhaustive advice on the appropriate way to establish and manage the proposed fund. Local governmental advice is recommended.

Re § 20 Appointment of staff:
It is the opinion of GEUS that employment of regular staff is not a matter of the Board. GEUS suggests that only heads of divisions and regional offices should be appointed by the Board. All other officers shall be appointed by the executive director.

Other issues:

Information and data to the Survey:
It is the clear intension of the GSD to build up a modern data-base for a large range of geo-data to be available for the political decisionmakers, the industry and the public in general. GSD should in deed be supported in that effort. In order for the Survey to be able to succeed in this, it is necessary to incorporate a duty for all relevant data collectors to report the data to the survey with duly enforcement and controlling regulations. These matters could be regulated in the “Geological Survey Act” or in the relevant sector legislation.

Admission to go to land:
In order for the Survey to be able to collect data, it is necessary that the officers of the Survey has the right to go to any land surface or underground. This right should be appropriately ensured in the Act. It is suggested that Part I, 1, (4) is moved to the clauses related to the above “information and data to the Survey” and further elaborated.

Rights to use, compile and sell data:
It should be ensured, that the Survey has the right to use, compile and sell data collected and received by the Survey and integrated in the data bases.

General reservation:

The above recommendations are made based on general legal considerations and without sufficient insight to Ghanian legislation. Therefore our recommendations shall be considered as to the best of our knowledge, made to enable GSD to submit a clear proposition for a “Geological Survey Act” clearly covering the wishes and needs of the GSD to operate efficiently within their field of work. It is recommended that Ghanian legal experts ensure the proper fitness of the Act into the Ghanian governmental legal framework.

27 June 2002
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GEUS