An Affordable Exploration and Mining Licence Administration System for Developing Countries

J. S. Coats, R. C. Jones and B. J. Davies
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Front cover illustration:
Summary Entity Relationship Diagram of the General Logical Model of Mining Law Administration

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1. SUMMARY

The purpose of the project was to develop a simple, adaptable PC-based system for the management of mineral exploration and mining licences, able to generate up-to-date hard copy maps and data, supporting effective management and development of the mineral sector.

Desk studies of mining law in about twenty countries showed that despite local variations in legal provisions reflecting the local mining history, there are common patterns in the data. These patterns were analysed, and used to construct a generalised logical data model. A checklist was prepared to summarise the most significant provisions in the different mining laws. The generalised logical data model and the checklist will make the design and implementation of new licence management systems for developing countries faster and more robust.

A general specification for computer hardware and software was drawn up, but because of the rapid development of computer products this list can only be taken as a guide to the required functionality. The market should be surveyed for the best options at the time of equipping a new mining licence system. It is likely that the cost of equipment will fall rather than rise, so the estimated costs given will be useful for budgeting. The project found that there are low-cost commercial products currently available which fully meet the needs of the system. Most, if not all of these products are likely to be available and supported in developing countries. The database package chosen was Access 2, later updated to Access 97. The GIS software chosen was ArcView because of compatibility with existing systems in Guyana.

With the agreement of the Commissioner of the Guyana Geology and Mines Commission a trial installation of the system was made in Guyana. The legal requirements and administrative procedures were examined in detail. A physical database model was designed, and the experience of doing so led to some improvements in the general logical model. It was agreed that the small-scale mining permits would not be included in the trial, partly because no locational co-ordinates were held for the areas granted. Much more documentation is available for medium- and large-scale permit / licence areas, of which there are more than 3 000, making it a very good test of the system. A strategy was devised for loading the data held on paper records onto the database in file number order, but because of various unforeseen external circumstances this was changed to a slower system of loading files when they require attention in the normal order of events, which is a more robust procedure. The data-loading procedure was operational, but data retrieval cannot be fully tested until a larger volume of data is available. The use of mail-merge to produce official documents directly from the database produced significant efficiency benefits.

The concept of an integrated database and GIS system to form a licence management system has been seen as necessary and beneficial by all the administrations visited during the scoping study. Discussions with mining companies have also produced favourable comments on what the project has to offer. Limited publicity has been given to the system, which has produced two further serious enquiries about adopting the system for national mining licence administration. There is likely to be a need for external funding for future applications of the products of this project, since the countries which have enquired so far are unlikely to be able to fund the work from their own budgets.
2. INTRODUCTION

The British Geological Survey has, in recent years, undertaken several projects to provide databases of mining rights for developing countries. It was observed that, with the opening of many countries to private sector investment, the existing manual systems for awarding and administering exploration and mining rights were under stress. Long delays in issuing licences were reported in some countries due to problems in record-keeping. It was believed that the recording of area boundaries on maps, and distinguishing currently-licensed areas from formerly licensed areas presented particular problems.

Developing countries need to promote and utilise their natural resources for the benefit of their population. Efficient and beneficial exploitation of natural mineral resources provides an important part of the economies of many countries, both in the developing and in the developed world. The ability to exploit mineral resources can be an important factor in the growth and a driving force for the national economy, increasing wealth and general infrastructure.

Enquiries showed that there was no computer program available commercially designed to address the problem of the administration of exploration and mining licences. Some products were identified which contained part of the functionality required, but the most promising was designed to run on an UNIX Workstation. Workstations and workstation software are more expensive to buy and maintain than PCs and have a small support base in developing countries. A few countries had commissioned consultants to build systems for them, but besides the very high cost of each installation they were not designed to be flexible in their use.

This project responded to the needs described above by designing and testing a computer-based generalised national mining licence administration system, addressing both geographic and database areas, which could be customised to meet each country’s requirements. The criteria adopted in the design of the project were as follows:

- **The system should be affordable.** Low-cost widely-available computer hardware and software should be used, and the initial set-up costs should be minimised.
- **The system should be sustainable.** The equipment for which the system was designed should be supported locally in most countries. It also implied that the installed systems should be capable of being modified to accommodate changes in the law and regulations without significant rewriting.
- **The system should be adaptable.** The structure of the database should be capable of meeting the requirements of almost all legal systems without major revision. This would save most of the design work for individual installations, and hence expense. The structure should also accommodate extra types of data as required without rewriting.
- **The system should be efficient.** The structure of the database should accommodate as many types of data retrieval as possible. The user should not be frustrated by being unable to extract data from the database.
The system should be secure. Fraud and malpractice are unfortunately present as an undercurrent in mining because of the potential to make large profits. The design of the system should make it difficult to tamper with the data contained in it, and should contain an audit trail of all amendments.

2.1 Project Requirement

The main project goal was to develop methods and systems for defining and maintaining geoscience information infrastructure in developing countries. Geological surveys and mines departments have a wide range of responsibilities and one of the most important of these is the administration of mining rights. The departments should have in place efficient mineral exploration and mining licensing management procedures, in order to encourage investment in the mining sector. The major project requirement and purpose are highlighted by the following statements:

Goal statement: To develop methods and systems for defining and maintaining geosciences information infrastructure.

Purpose statement: To promote efficient mineral exploration and mining licensing management procedures, thereby encouraging investment in the mining sector.

2.2 Mining Law and Regulations

The purpose of mining law is to regulate and manage mining in a country in order to have a secure and long-term mining industry. Many countries encourage the development of a mining industry as a method of increasing Gross Domestic Product and foreign exchange earnings, and raising the skills of the population. Mining Law therefore regulates an industry that is seen as beneficial to the country but also has the potential for creating environmental problems. Good mining laws should allow for the efficient working of a deposit, give a return on investment for the mining company (state or privately owned) and benefit the country as a whole. The purpose of mining law is not to stop or prevent development but to regulate its activities, so that disputes over ownership are minimised, mining can proceed in an orderly and efficient manner and deleterious effects such as pollution and accidents are reduced to a low level. Mining law also attempts to provide a balance between the interests of the surface land holder or occupants and the mining company. In the past this has caused few problems in developing countries, but where the mining interferes with existing water supplies, agricultural practices etc. the rights of the surface owner and the mineral owner can be in conflict. A clear definition of these rights in a well drafted Mining Law will avoid such conflicts.

Countries where mining law has broken down and ‘unofficial’ mining is taking place suffer from many problems:

- large number of small, unregulated workings
- selective mining of deposits to the detriment of overall mineral recovery (‘high grading’)
- inefficient recovery of sought after mineral (gold, gems etc.)
• destruction of local habitats
• dangerous and unsafe workings
• pollution from toxic elements such as mercury
• criminal activity
• smuggling of production

Regulations for small-scale or artisanal mining have been developed in an attempt to control and regulate these unofficial activities, rather than drive them further into illegality. Small-scale mining has a very long history in many countries and provides a welcome addition to the incomes of many subsistence farmers, so that complete prohibition is not a sensible option. A few countries, such as Botswana, appear not to suffer from this problem and no regulations covering artisanal mining are in place.

2.3 Law, regulations and practice

Whilst every country’s mining law is different there are many similarities and a typical law, taken from the Ghana Minerals and Mining Law, 1986 (MIGA 1995), is divided into the following parts:

1. Ownership of minerals and government right of pre-emption
2. Administration
3. Mineral rights and other licences
4. Taxes, incentives and benefits
5. Reconnaissance and prospecting
6. Mining lease
7. Radio-active minerals
8. Surrender, suspension and cancellation of mineral rights
9. Surface rights
10. Building and industrial minerals and small-scale mineral operations
11. Miscellaneous provisions

This study addresses Parts 2, 3, 5, 6, 8 and 10 of this mining law and is basically concerned with the issuing of mining rights (the term is taken to include all licences related to mineral development - reconnaissance, prospecting and mining) and management of the information relating to the licence. It is therefore concerned with the implementation of the law and the administration of the licence system. Whilst each country’s legal system is different, the techniques of mineral exploration vary little from country to country, so that administration of the law is generally similar because it regulates the same or closely related activities. Administrative procedures, however, develop and mutate so that common procedures, which may have been inherited from a former colonial administration, may now be very different in independent nations.
Legislation for hydrocarbons and other fuel minerals is generally separate from that for industrial or metallic minerals, mainly because of their higher value and different mining and extraction techniques. The petroleum industry is, or until recently has been, distinct from the mining industry; the regulation procedures are often different and hydrocarbons are generally excluded from the scope of minerals legislation and are not considered in this study.

2.4 Factors affecting Mineral Development

Several factors influence the decisions made by multi-national companies to invest in a particular country and Otto (1992) has produced a ranking scheme for their decision-making criteria (Table 1). From this table it can be seen that security of tenure is one of the most important features which increases from rank 2 at the exploration stage to rank 1 at the mining stage. Granting of a secure mining licence after the exploration stage is therefore the most important factor in converting an expensive exploration stage into a profitable mining stage.

This study aims to improve the administrative procedures applying to mining rights and therefore addresses this critical issue of security of tenure along with stability of exploration and mining terms, and consistency and constancy of mineral policies.

Table 1: Ranking of Trans-national Mining Company Decision-Making Criteria

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Exploration stage</th>
<th>Mining stage</th>
<th>Decision criteria based on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>n.a.</td>
<td>3</td>
<td>geological potential for target mineral</td>
</tr>
<tr>
<td>n.a.</td>
<td>1</td>
<td>2</td>
<td>measure of profitability</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>security of tenure</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>2</td>
<td>ability to repatriate profits</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>7</td>
<td>consistency and constancy of mineral policies</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>11</td>
<td>company has management control</td>
</tr>
<tr>
<td>6</td>
<td>11</td>
<td>6</td>
<td>mineral ownership</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>4</td>
<td>realistic foreign exchange regulations</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>5</td>
<td>stability of exploration/mining terms</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>8</td>
<td>ability to pre-determine tax liability</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>10</td>
<td>ability to pre-determine environmental obligations</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
<td>14</td>
<td>stability of fiscal regime</td>
</tr>
<tr>
<td>12</td>
<td>14</td>
<td></td>
<td>ability to raise external financing</td>
</tr>
</tbody>
</table>

Derived from Otto, J (1992)
2.7 Advantages of a Computerised Mining Cadastre

A manual system for recording the areas of mining rights is normally carried out by drawing the outlines of the assigned area on a suitable scaled, topographic map. The availability of maps limits the choice of scales with many countries plotting on a 1:250 000 or 1:100 000 base map. The areas are plotted by hand, usually coloured by pencil, on a standard set of base maps using information received from the applicant. The areas are then checked for overlap with adjacent licences and the application may be refused if such overlap exists. This system works when the licences are all current and they are widely spaced. However, in countries with a lot of exploration interest over a long period of time, this system breaks down. Surrendered or lapsed areas are still marked on the base map and it is unclear which are still active or which have lapsed. The situation in Northern Ireland is an example of the latter case and in the most gold-prospective area up to 10 licences, dating back 20 years, may be over-plotted on the base map. One solution to this problem is to use multiple copies of the base map, which separates the licence areas but the problem of showing only active licences remains. A normal requirement of the licensing administration is to publish maps showing the areas of mining rights at regular intervals, normally every 6 months or annually, and in a manual system these have to be completely redrawn.

A computerised mining cadastre can help to solve these problems by:

- showing active licences
- checking for overlap
- interrogating lapsed licences
- easily distinguishing licences by colour coding for particular minerals
- printing current licence maps on demand

Solving such problems with a computerised cadastre also brings its problems. An increase in information technology skills is required to manage the system when moving away from simple paper-based systems. A computerised mining cadastre is in two parts; the database and the GIS front-end, and both need to be fully operational for the cadastre to work.
3. REVIEW OF EXISTING COMPUTERISED SYSTEMS

3.1 General

Very little information has been published on the computer systems installed to manage mining rights, mainly because this is seen as an administrative system which does not need documenting or description in the technical press. The authors have experience of existing systems in Northern Ireland, Zambia, Vanuatu and Angola and these are described briefly with a description of the database and GIS where present.

3.2 Northern Ireland

Northern Ireland, although it is a province of the United Kingdom and Northern Ireland, has a legal system which developed from that in place in Ireland before partition and the formation of the separate state of the Republic of Ireland. One particular and important difference to the legal system of the rest of the U.K. is that the ownership of all minerals is vested in the State, except for gold which is owned by the Crown. Separate licences are issued for hydrocarbons and these do not form part of the minerals licensing system. The Department of Economic Development is responsible for issuing exploration and mining licences, but the licensing system is administered on their behalf by the Geological Survey of Northern Ireland (GSNI). A simple database and GIS was set up in 1995 by BGS to manage the mining rights information (Collins, 1995), and recently this has been fully implemented.

At the end of 1997 about 160 exploration licences had been issued since the start of the licensing system. The size of the database is therefore not large but the accompanying GIS is very complex with many overlapping licences in one area of intense exploration interest. Copies of the company activity reports are lodged with the GSNI and one of the purposes of the database system is to manage the information in these reports. The database is therefore partly an information management system with a related GIS. No data on fees or company ownership, besides the company name, are recorded by the GSNI.

The GSNI is a small organisation with 10 staff and the licence information system is managed by only one member of staff on a part-time basis. The number of licences is relatively small but there are a large number of reports and related maps. The database structure was kept simple in order to make it readily understandable to a non-specialist in information science.

The logical structure of the database is illustrated in Figure 1. The central entity is the tblLicence, which contains attributes of Company code, DED licence number, start, finish, renewal, amendment and release dates, renewal length and licence area name. An additional table (tblRenewAmend) was added to the database to cater for multiple amendments and renewals and, as will be discussed later. This is a common feature of licence databases, particularly where mandatory reductions in licence area are included in the regulations. Each licence is held for a number of different commodities and these are held in the tblLicence_Commodity table. Linked to the tblLicence table are the tblCompany table, which contains details of the company holding the licence, and the tblReport table. Because a single licence can generate several reports and the company...
can report the results of their work on several licence blocks in a single report, this is a many-to-many relationship, which is broken down using an intermediate table called tblLicence_Report. Company reports can contain a variety of information which needs cataloguing and indexing to be useful. Each Report is indexed and its containing maps, Surveys, Traverses, Samples and Boreholes and other data.

Figure 1. Entity - relationship diagram for the Northern Ireland Exploration Licences Database

The GIS holds outlines of the licence blocks and each polygon is attributed with the information from the licence table. The database and GIS are implemented on a single PC and the system is managed by one senior member of staff. New licence areas are input by a cartographer and added to the GIS. Procedures for updating the database are in place and thus the information accessible via the GIS is constantly updated.

3.3 Zambia

3.3.1 Background

BGS completed in 1995 a database design for the Zambian Ministry of Mines and Mineral Development (MMMD) under a World Bank contract. The database was designed to assist in processing the large number of exploration licences issued by the Ministry, following the opening up of the country to foreign mining companies and moves to privatise the state-run firm ZCCM Ltd. Numerically, however, the largest number of applicants were Zambian nationals. Three categories of mining right exist: a prospecting licence (giving non-exclusive rights to an area and now largely defunct), an exploration licence, and a mining licence. Other categories exist for building materials
and for long term mining leases but these were outside the remit of the World Bank project. A new Mining Law was in preparation but had not been passed by the parliament.

3.3.2 Database Design

The core entity in the design (Figure 2) is called tblApp106, named after Application Form 106 which is completed by the applicant applying for a licence. The attributes of this entity are the application number, licence type; area, district and province of the requested exploration area; period of licence; and details of the financial status of the applicant. The primary key of this entity (AppNum) is the number which is allocated on receipt of the application form. There are three categories of applicant: single person, company or co-operative and these are stored in three entities linked by the relevant registration number of the person, company or co-op. The latter two entities have linked tables recording the shareholder or co-operative members. Applications can be for a range of mineral commodities and these are stored in a table, tblApp_Commodity. When the application has been approved, a mining right is issued and data is transferred to the tblLicence entity. The mining right can be amended and details are held in the linked table tblAmend. The fees due on the mining right are recorded in the table, tblFees_due, which also records the amount paid. Tracking the fees paid is important as local applicants can pay by instalments and may be in arrears.

Figure 2. Entity - Relationship diagram for the MMMD cadastre

The database design is different to the general logical model discussed in the following sections because it was designed to handle applications and record the details of these, even if they were not approved. Most mineral rights administrations only record information if the application is approved as a mineral licence. The ability to pay fees in
instalments is also unusual and reflects on the relatively large number of poorly
capitalised individuals applying for licences. Administration of this small mines sector
is always difficult in developing countries, because of the need to make the application
process as easy as possible and avoid a totally unregulated and illegal small mining
industry.

The Zambian system did not address the links between the licence database and the
licence area because sufficiently advanced PC GIS software was not available in 1993,
when the system was specified. It is believed that the Ministry has implemented such a
link with more modern software in the period since 1995.

3.4 Angola

3.4.1 Background

The BGS worked in Angola in 1996 advising the Ministry of Geology and Mines and
completed a brief investigation of the Mining Rights system. A simple database
structure was implemented and is described in the following section. The initial design
was kept to a minimum in order to be achievable in the limited time available and to be
simple enough for the relatively inexperienced staff to understand. When the staff have
gained greater experience, the database can be updated to include fees, amendments and
reports.

The number of Mining and Prospecting Licences that have been issued since the current
Mining Law was passed in 1992 is not large and the amount of information gathered
about each licence is relatively small when compared to countries which have a longer
tradition of mining and a more advanced regulatory framework. Whereas the Mining
Law is in place, several of the procedures in the Ministry are still in a formative stage
and this question was addressed by another part of the BGS team. It was therefore
premature to place a very detailed and, perhaps, over complex system in place when it
will need to be modified in the light of decisions yet to be taken by the Ministry. The
level of computing expertise is also lower in Angola when compared to some of its
neighbours, and an over-complex system for recording the licences is not warranted.

The country is also unusual in that Mining and Prospecting Licences are issued by
different parts of the Ministry of Mines. The information recorded in a Prospecting and
Mining Licence is essentially similar and to set up two separate databases or separate
tables is unnecessary and would cause unnecessary duplication. The two kinds of
licences cannot overlap, therefore they must both be displayed in the GIS on the same
screen. A relatively simple unified database design has therefore been set up, which
should be:

- Designed according to fully relational principles
- Easy to use and maintain
- Capable of holding the current data and answering common enquiries
- Capable of expansion as the level of sophistication and knowledge improves
- Compatible with developments in other SADC countries
One part of the database design is not fully normalised. The entity tblLicença contains an attribute Min_type, which is related to a grouping of mineral commodities as follows:

<table>
<thead>
<tr>
<th>Mineral type</th>
<th>Commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base and Ferrous Metals</td>
<td>Cu, Pb, Zn, Fe, Mn, Co, Ni, Ti, V, REE</td>
</tr>
<tr>
<td>Precious Metals</td>
<td>Au, Ag, Pt Group Metals</td>
</tr>
<tr>
<td>Industrial Minerals</td>
<td>Sand, gravel, limestone, clay etc.</td>
</tr>
<tr>
<td>Dimension Stones</td>
<td>Granite, Anorthosite, Marble</td>
</tr>
<tr>
<td>Gemstones</td>
<td>Diamonds and other gemstones</td>
</tr>
<tr>
<td>Water</td>
<td>Mineral and Medicinal water</td>
</tr>
<tr>
<td>Other</td>
<td>Miscellaneous</td>
</tr>
</tbody>
</table>

Licences are issued for specific minerals and this is modelled by the links between tblLicença and tblCommodity. However, in the GIS it is only possible to show on one digital map (or coverage) outlines of licences (as polygons) that do not overlap for the same mineral. Some simplification is therefore required, otherwise a separate coverage would be needed for every mineral (over 30 coverages) and, as most licences can be grouped into one of the above six or seven categories with little overlap, it was decided to group the licences into these categories. This is a common practice in mining regulations and just simplifies the current situation, where licences for different minerals can overlap. This is not a problem in Mining Licences, where the same ground cannot be mined by two different companies, but can occur in Prospecting Licences where the same area can be explored, for example, for both gold and dimension stones by different companies.

### 3.4.3 GIS

The design of the GIS cadastre was influenced by the following factors:

- ease of use
- must work in a PC environment
- can be linked to the mining title database
- compatible with other leading GIS products
- availability of suitable digital topographic bases

Cadastre coverages were set up for each of the six basic categories of minerals and overlaps between Mining and Prospecting Licences should not occur on each coverage. Overlaps for different coverages may be possible but attention should be paid to excessive overlaps, which may indicate incorrect data entry. The coverages should be displayed in different colours on the screen and on printed maps.
During the implementation it became apparent that the size of Mining Licences, typically about 50-100 hectares, was too small to show on a large map of Angola. At a scale of 1:1 million, a 100 hectare area is shown as a square of 1 mm side and is too small to be recognisable as an area. It was therefore decided that Mining Licences should be shown on country wide maps as point locations, which would be coloured by mineral type. Prospecting Licences are much larger, in the range 1-33 000 km² in area and are easily visible except for the smallest ones.

While the Cadastre was being implemented it was found that the co-ordinates of the Prospecting Licences were inaccurate in over 50% of cases. A revised list was supplied but even this contains serious discrepancies between the calculated area bounded by the geographical co-ordinates given and the area on the Licence. Over 40% of Licences had differences of greater than 10% between the area calculated from the co-ordinates and the area granted on the Licence. Most of this problem relates to the non-rectangular nature of the Licence blocks, and whilst the existing Mining Law states in Article 5 that they should be ‘a simple geometric shape’ this has not been strictly enforced. Some areas are thin triangles or rectangular strips following river valleys. Simple mistakes can easily arise in calculating by hand the areas of such irregular polygons and is probably the cause of the discrepancies noted above. GIS programs have a standard function to calculate accurately the area of closed polygons if the co-ordinates are correctly entered. Experience from countries that do not enforce rectangular blocks shows that this can cause disputes and difficulties as the number of licences increases. A minimum size for these blocks is also standard practice and this can range from 1-100 km² or it can be a geographic unit such as a square with sides of 5 minutes by 5 minutes (about 84 sq km), which are the grid lines marked on the Angolan 1:100 000 maps. Mining Licences, which are confined by the known geology need not be restricted in this manner, but it is good practice to make the blocks regular rectangles.
4. REVIEW OF SOFTWARE

A review of software for database and GIS applications was initiated at an early stage in the project in order to identify the products most suited to the needs of developing countries and yet still be capable of meeting the database and GIS requirements. The principal factors taken into consideration when choosing such a software product were:

1. Ease of use
2. Wide market acceptance
3. Capable of handling the tasks
4. From a well established software company
5. Work on an industry standard PC
6. Compatible with existing systems and regional organisations
7. Reasonable cost and value-for-money

4.1 Database software

Databases were traditionally set up on mainframe or mini-computers and personal computer products were markedly inferior until the launch of dBASE III in 1985. This was a DOS-based database that was partly relational and could handle a simple database structure. It lacked a graphical front-end and requires some considerable programming effort to make data entry user friendly. Its file format .dbf is still a common interchange format between later database programs, which shows that it was a de facto standard in the period 1985-1993. When the project was initiated in 1996 Microsoft Windows had become the dominant operating system for PCs and the Microsoft Office suite of programs had taken a dominant position in the PC software market. At the time of its launch in 1992-3 Microsoft Access competed with a number of very similar products, Superbase, Approach, Paradox and Windows versions of dBASE and its clones. The technical merits of these products may have been similar but the dominant position of Microsoft products led to general industry acceptance that Access, particularly Version 2.0, was the new standard for PC relational databases. This standard has been reinforced by the large numbers of books on Access, articles in the computing press and existence of training courses.

Microsoft Access has been updated twice since version 2.0, to Access 7.0 (or 95) and to Access 97. The file formats of these products differ, because of the change from the 16-bit environment of Windows 3.1 to the 32-bit environment of Windows 95 and 98. These are upwards compatible but not downwards, for example Access 97 files cannot be read by earlier versions of the software. Also, the memory requirements of the later versions are greater and need a faster machine to run. They are slightly ‘friendlier’ to use but the advantages of the later versions are small. The one difference between the versions of Access which makes the adoption of Access 97 essential is the millennium-proof four digit date handling which has been introduced with that version. Dates are a critical part of a licence database, and the two digit date storage used in earlier versions of Access may cause long-term problems, irrespective of certain ‘work arounds’, such as treating the date as being in the 21st Century up to the year 2030. It is to be hoped that the database and its successors will be operational for more than another 30 years.
4.2 GIS software

Geographical Information Systems (GIS) have developed greatly over the last 15 years, such that there are now a wide range of excellent packages available "off the shelf". The increase in desktop personal computer performance, and the decrease in memory, processor and storage costs, have meant that software applications that once required workstation or mainframe platforms can now run on the desktop.

Recently, GIS software vendors have started to produce packages specifically designed to suit the PC platform, with easy to use graphical user interfaces (GUIs), and the ability to exchange data with other PC applications such as word processors, spreadsheets, and databases. In the early 1990s, these PC based products typically held less functionality when compared to their UNIX-based counterparts. More recently, the functionality they provide has expanded, as the capability gap between high end desktop PC’s and UNIX workstations / mainframes decreases.

There are a number of software products that meet the requirements mentioned above, and whilst they each have different strengths and weaknesses, the price / functionality is similar for each. In 1996, two products stood out as being suitable, and these were MapInfo Professional (produced by MapInfo Corporation) and ArcView (produced by Environmental Systems Research Institute [ESRI]).

Both MapInfo and ArcView provide a powerful GIS that can be run on a standard PC, at relatively low cost. They both interface well with Microsoft Access, can provide links to legacy data, and provide developers with a flexible environment within which to work. They are also both capable of running on the 16-bit environment of Windows 3.1x, and the 32-bit environment of Windows 95, 98 and NT, although it should be stressed that both products are more stable running on a 32-bit operating system.

ArcView has been selected as the software of choice, and can be seen to integrate well with the current strategies of many developing countries where they do already have some investment in GIS. ArcView is a sister product to Arc/Info, a fully featured and extremely powerful GIS which excels in complex analysis and the handling of large volumes of data. Arc/Info, and its derivatives such as PC Arc/Info, have been, and still are, very popular tools and, as such, there are already many data sets that exist in a format which can be read by ArcView.

The current release of ArcView (version 3.0a) introduces the use of extensions, which provides the capability to enhance the core functionality, by incorporating, for example, an image processing extension.
5. DETAILED STUDIES OF THE NATURE AND ADMINISTRATION OF NATIONAL MINING LAWS

5.1 Introduction

Three countries were visited during the data collection phase, Malaysia, Botswana and Guyana, chosen to give a wide geographical spread and a variety of administrative systems. It had been intended that at least one country would be visited with a legal framework not derived from the United Kingdom, but for reasons of time and the good contacts that had been built up previously or presently by BGS staff this was not possible. Data on the Mining law of many African countries is available on a CD-ROM from the Multilateral Investment Guarantee Agency (MIGA, 1995) and this has been consulted to see if significant differences exist in other countries. Data on the mining law and regulations from Lao PDR., Peru, Saudi Arabia, Sri Lanka and Thailand were studied to improve the overview of the scope and structure of mining law.

5.2 Botswana

5.2.1 Mining Legislation

The current Mines and Minerals Act (1977) has six categories of mineral concession: Reconnaissance Permit (RP), Prospecting Licence (PL), Mining Lease (ML), Restricted Mining Lease (RML), Restricted Prospecting Licence (RPL), Restricted Mining Lease (RML) and Building and Industrial Minerals Permit (BIMP). Issuing of mining concessions is mainly handled by the Geological Survey with only Mining Leases being issued by the Department of Mines. A valid PL is needed before a ML is issued, so that all checking of area and mineral overlap is handled by the Survey. A map showing the current licences is published bi-annually, and indicates some of the ground that may be free. This map is drawn up by the cartography staff of the Survey from plots prepared by the Economic Geology Section.

No provision is made in the Mining Legislation for artisanal mining which is believed not to exist or be insignificant. In the dry conditions covering the majority of the country this may be true.

5.2.2 Databases and GIS

The Economic Geology Section of the Botswana Geological Survey has three 486 or Pentium computers running Access and MapInfo GIS software. Licence details are held are held in an Access table with details of Name, Licence number, Company, Licence type, Commodity, Quarter degree sheet, Districts, Area, Issue date, Expiry date. A separate GIS has the same details in an Info table. The databases and the GIS are not linked, so that the information on the database is not all accessible from the GIS. The GIS also exists on all three machines and it is not clear which is the master version. Other tables on the computers hold data on company reports and maps, but these are not linked, so there is duplication of information, some data redundancy and several inconsistencies. There are only a few queries on the database, because of this lack of links, and there is scope for further queries to be written to assist its management. The GIS is operated effectively but there are problems with areas that have been relinquished and still visible on the map. New licences have not yet been added. There
is no topographic base map to the licences and this prevents its use to print the licence map directly from the GIS. Addition of a simple digital base showing the country's borders, main towns, roads and district boundaries would make it more usable. A suitable base at a scale of 1:1 Million is available from the Digital Chart of the World and this would be sufficiently accurate for plotting the 1:2 Million map produced at six monthly intervals.

These are essentially problems of quality control and it is recommended that formal procedures for checking and verifying data on both the database and the GIS are set up. This could be achieved by listing all current licences, which could be checked and each verified on the GIS. Once an error free database and GIS are achieved, new licences can be added. Because the GIS and Access hold duplicate copies of the licence data, there is always scope for discrepancies to occur. The two can be linked more closely using a technique called ODBC which enables MapInfo to query the data directly from Access rather than storing its own copy in an INFO database.

The printing of a monthly list of new and relinquished licences from the database would enable the checking and verification of all additions to the GIS. It is important that formal procedures like this are set up and approval is given by a senior officer.

Collection of licence fees is a problem but again a monthly list of fees-due could be printed and passed to the Accounts Department to check that they have received the money. A standard reminder letter can also be generated from the database of those companies in default of payment.

The Economic Geology staff have designed an effective database and GIS, which is working well, despite some of the problems mentioned above. However, it is not being used to its full potential. The tables need to be normalised (removing redundant information) and linked so that better queries can be run against the database. Linking the database and the GIS will also simplify the work of keeping the system compatible.

Considering that the staff are largely self taught they have achieved a great deal but further training in Access and database design would be of benefit. This training can probably be obtained locally or in the Republic of South Africa.

Feedback on the licensing system was obtained from two companies and was generally favourable. The main problem identified by them was the lack of recent information on new licences or relinquishments.

5.3 Guyana

5.3.1 Review of Legislative Regime

The mining industry in Guyana is regulated by the Mining Act, 1989 and regulations made under it. This act subsumes various previous acts and repeals others wholly or in part. Much of the structure of the legislation, and in particular the regulations made under it, are derived from previous acts, going back for many years. As a result of this agglomeration of provisions, there is some confusion on the operation of the act. The responsibility for administering the mining law is vested in the Guyana Geology and Mines Commission. Executive responsibility is divided between the Mines Division, which handles the small mines sector and some other functions (e.g. recording
declarations of gold and diamond production), and the Geological Services Division, which handles the medium and large scale prospecting and mining licences.

The categories of licence are numerous, and are shown in Figure 4.

![Diagram of licence categories under Guyanese legislation]

Figure 4. Schema for licence categories under Guyanese legislation

It is notable that Guyanese legislation does not limit the number of claims, permits or licences that can be held by one individual or company. As a result, there are numerous cases of operators having large numbers of adjacent claims or river locations in the small scale sector and mining permits in the medium scale sector, forming extensive blocks of greater combined area than permitted in the Regulations. This was discussed with GGMC staff. It emerged that this practice is tolerated in order to facilitate rapid growth of the mining industry by expansion of the small and medium mines sectors, which are only open to Guyanese citizens. In the case of the small scale sector the administrative, financial and technological prerequisites are much less demanding than for the large scale sector, enabling 'adventurers' to have a go. It was pointed out that the annual payment per acre for claim licences was greater than for mining permits and mining licences, and there was a legal obligation to do work on each claim held each year in order to retain a claim licence.

5.3.2 Observations on the administration of the Mining Act in Guyana

The expansion of the mining industry in Guyana over the last six years has been the result of a deliberate policy, and has been targeted at the small scale sector. There are now approaching 15 000 small-scale operations in production. In contrast, currently
around 50 large scale prospecting areas are licensed, mainly for exploration for gold and diamonds. Interest in base metals exploration is low.

The issue of a Prospecting Permit at the small scale seems to be a formality: the main qualification for issuance is possessing Guyanese citizenship. The main function served seems to be that one has to be held in order to obtain a claim licence or a river location. Section 57 of the act indicates that the requirements for prospecting permits for both medium and small-scale operations are the same, but no register of small-scale prospecting permits was discovered. Section 60(2) states that 'the holder of a prospecting permit for small scale operations may locate a claim or claims in accordance with the regulations'. On application for a Claim Licence (or River Location) a fee is paid, and the Licence has effect from that time until it is cancelled, subject to an annual fee being paid. The details of the application are published on three successive Saturdays in the Official Gazette, and if no objections are received the Licence details are moved from a holding file to the main database. The licence requires verification by the local mines officer in the presence of two witnesses to check that the size and location of the claim is as applied for. When this has been done the Licence is formally issued, but in practice few Claims have been verified. The regulations provide for unlimited annual renewal of unverified licences, and the official list of small claims, which is published annually, makes no distinction between verified and unverified holdings.

The small scale sector data is held on a PC database in three files: new claims, claims and dredges. These files contain all the 'core' information about an operation, and the claims file is used to produce the annual statutory listing of all current claim licences and river sections (licences for dredging existing watercourses). These files are held on a PC in dBASE format. At the time of inspection there were 643 entries in the new claims file and circa 13 900 in the main database. Currently, a local computer consultant has been retained to upgrade the database. This investment has been made without considering future links to a GIS, because doubt about the accuracy of much of the locational data has lead to the feeling that computers can do nothing to help.

The medium and large scale sectors involve many fewer licensed areas than the small scale sector, and are currently administered manually. A computer system has been used to store some data for these sectors, but it is currently out of action and due to be replaced. In addition, a separate computer system is used to produce licence documents. The text of most of the public notices published in the Official Gazette are available on disk in WordPerfect format.

A German technical assistance project (GTZ National Resources Management Project), covering several government departments, has introduced computer equipment and the ArcInfo GIS software into GGMC. The project aims to train GGMC personnel in the use of ArcInfo, and then to digitise various maps, including licence / permit area boundaries (but not claims), for incorporation in a national land management database.

The pressures on the administrative system are considerable. It is widely recognised that there is a need for a system to provide up-to-date information on licence and permit area boundaries. In particular, small scale claim licences give exclusive right to work the land from the moment of application (unless later shown to be invalid), whereas medium and large scale prospecting and mining licences / permits do not give exclusive rights until they have been validated, which may take many months. This can result in conflicting claims to areas between applicants in different sectors.
The data on the location of claim licence areas is received as latitude and longitude values, with bearings and lengths for each linear segment of the area boundary. There are inaccuracies inherent in the plotting of this data on the index maps by measuring an angle and then measuring a distance. The paper maps are not dimensionally stable. The large scale sector tends to use UTM co-ordinates, which can be plotted directly by Knox Protractor. The standardisation on UTM co-ordinates for the reporting of corner points of all licence and permit areas would allow the numeric checking of lengths and areas as the co-ordinates are in metres (± 0.4%). Overlaps with neighbouring areas, particularly in the small-scale sector, could be identified by plotting the polygons by computer or on graph paper. As this may involve a change in the Regulations, a computer program could be used as a temporary measure to convert geographic co-ordinates to UTM. This would go a long way to overcoming the problem of dimensional stability of the index maps. This does not overcome the problem of the location of areas being inaccurately reported, but would help to reveal cases of mislocation.

The main problem, which was identified by several of those interviewed, is how to handle small, poorly located claims that need to be known about before the issue of large scale prospecting licences. Guyana is not the only country to have an artisanal mining sector, but the size and vigour of it does emphasize the attendant administrative problems. The small claims, which measure up to 800' by 1500', are often located in remote, forested areas, and have been sited by people with little expertise in land surveying. It is not possible to locate these claims on the master 1:50 000 scale maps with sufficient accuracy to detect overlaps where there are a number of claims in close proximity to one another, or to be certain of their absolute location. As noted above, there is a backlog of field verification of claims by mines officers.

The topographic maps used date from 1972 and were produced from a photogrammetric survey carried out through Canadian aid. It is understood that these maps are generally reliable, and the positional accuracy of major features is good.

If a GIS is to be used to record claims, some way of locating them will be needed. The ideal solution would be to establish exact co-ordinates of the corners or each claim. The size of the problem would seem to rule out conventional surveying of each one, and the potential for the use of GPS equipment is inhibited by the hilly, forested terrain in which signal strength is frequently inadequate. It is assumed that the forest has been cleared around the actual workings, so GPS locations might be established for one point within each claim, which could then be related to the cut boundary lines by tape and compass. Another quicker and cheaper approach might be to obtain aerial photography of the most intensively worked areas, from which workings could be plotted. If combined with a 'best guess' map of claims (current and recently abandoned) from the declared locations this would offer the advantage of identifying suspect unlicensed, or grossly mis-located workings. Though this would not locate the claim boundaries, it would localise them to within known limits.

It is probable that small claims will have to be represented on a GIS system by points of most likely location on the map. Prospecting licence area boundaries usually follow topographic features, and consequently are more accurately located on the topographic map than claim licence areas. Proximity searching, which is available on GIS systems, may be used to identify the claims that are likely to be within or near a given area. Once
potential conflicts between existing licence areas and areas being applied for have been identified further information from the paper records can be taken into account.

The overview obtained of the mining law of Guyana and its administration raised several important points that will serve to make the design of the computer system more robust. The need for a computerised system to assist in the administration of mining law was amply demonstrated in Guyana, and the response from the Commissioner and staff of the GGMC was very positive towards the project.

5.4 Malaysia

During a one week visit in January 1997 an overview of the federal and state mining laws was obtained. Thanks to the good offices of the former Director of the Geological Survey of Malaysia, Mr Fateh Chand, a visit was arranged to Kuantan, the capital of the State of Pahang Darul Makmur, where a detailed view of the role of the State was obtained.

5.4.1 Review of Legislative Regime

The mining laws in Malaysia are relatively unusual in that they divide responsibility between the federal and state authorities. Each state has responsibility for economic development and land allocation within its boundaries. Permissions for mineral-related activities (Mineral Tenements) are issued by each state in accordance with state legislation. Historically, the mining industry has been based on small-scale alluvial tin working in Peninsula Malaysia, and the law reflects this by treating mining as one form of land use, alongside and equal with forestry and agriculture. This approach has lead to the administration of mining tenements by local District Land Offices. Of the 13 states Selangor, Negeri Sembilan, Perak, Pahang, Melaka and Pulau Pinang have similar mining legislation, but there is considerable variation between the rest. The principal categories of licence are shown in Figure 5.

The federal government has oversight of the process of mining, and federal legislation concentrates on health and safety in mines and its enforcement, and environmental concerns. The Mining Enactment, Cap 147 of 1929 as revised (1962 revision seen) provides a framework for state legislation, for instance in Section 14 by stating that a mining lease conveys the right to win and get all metals and minerals. Some administrative detail is laid down, such as Section 51, which decrees that the time and date of the submission of any application for a mineral tenement must be recorded. Section 138 provides for an exemption from the mining licensing process for ‘Ancestral Mining Land’ in the state of Perak, which has been worked continuously (with breaks of no more than 2 years) by one family since before 1899. It is believed that few or no operations of this type remain. The Geological Survey Department has an advisory role in the administration of mining law, and by law is notified of every grant of a mineral tenement.
5.4.2 Current roles of the various ministries involved in the licensing process

5.4.2.1 District Land Offices.

District Land Offices (DLO) are state bodies, which seem to function as a land registry. There are 10 or 11 DLOs in Pahang alone. They have the legal duty to maintain a register of all mining and quarrying-related permits and licences except Dulang and Individual Mining Licences. They hold large scale topographic maps (1"=8 chains / 1:6336) on which boundaries of land titles are marked where they have been granted (alienated land), the status of land still in state ownership (state land / forest reserve etc.) and the boundaries of any leases which may have been granted on it for logging, mining etc.. These maps are confidential, so applicants cannot be absolutely sure of the availability of land before applying for it.

Applications for Quarrying, Prospecting Permits, Prospecting Licences, Mining Certificates and Mining Leases are processed by the DLO, who determine whether the land is available for mineral exploration from the maps which they hold. The boundary of the area applied for is amended to excise the areas not available. The amended application is sent out for comment to the State Lands & Mines Department (L&M), Mines Department, Forestry Department and the Geological Survey. The responses are collated before being sent via L&M to the State Council for determination. However, Mining Leases can only be issued by the Sultan.

The DLO appears to collect royalties and most other dues. It also issues Temporary Occupation Licences and State Leases, which appear to be required for quarrying but not for mining.
5.4.2.2 State Lands & Mines Departments.

These are state bodies. The L&M departments are mainly concerned with land use planning, though not with the administration of forest reserves. They monitor the observance of permit and licence area boundaries, and deal with illegal panning. They collect Quit Rent (similar to business rates) on all licensed areas and a charge of RM50 for each application granted. They act as an intermediary in passing applications to the State Council (a political body) for determination.

5.4.2.3 Ministry of Primary Industries

The Ministry of Primary Industries is a federal body. Two of its component departments are concerned with minerals.

5.4.2.4 Ministry of Primary Industries (Mines Department)

The main function of the Mines Department is to see that mines are worked in a safe and competent manner. After the granting of a Mining Certificate (by the DLO), the grantee has to prepare a detailed account of how the mineral deposit is to be worked. This is then reviewed by the Mines Department, who issue a Letter of Authority to Mine, a Licence to Work Underground, a Hydraulic Licence, Explosives Licence etc.. These licences have conditions attached specific to the circumstances of the working, and are for one year to ensure compliance and to allow for any variation of the conditions which may be necessary from time to time. Quarries also require licences from the Mines Department to perform certain functions, but also require a permit to remove material from the site from the DLO.

The Mines Department receives monthly reports from dredging operations, but smaller operations are only required to report when there is a change in mining plan. No information was given for large operations, as there are few of these, and none were operational in Pahang at the time of inquiry. The Department also receives copies of all exploration and mining licences issued.

The Inspector of Mines in each state office of the Department (who has dual capacity as a state and a federal officer) also issues Dulang Passes and Individual Mining Permits, which do not relate to a specific place. Notice of the issuance of these permits is published in the state Gazette.

5.4.2.5 Ministry of Primary Industries (Geological Survey Department)

The main function of the GSM is to advise on the prospectivity of land. It also collates mineral statistics for government. In the former role it issues Mineral Land Clearance Certificates on land prior to development only if it appears to be unmineralised. Mineral potential has priority over other land uses. The Survey receives copies of all prospecting and mining grants from all states.
5.4.2.6 State of Pahang (PASDEC)

PASDEC is a state-owned company that is charged with stimulating economic development. On advice from the GSM it has identified 12 areas of gold potential, for which it has taken out Prospecting Licences. It has sub-let these licences to mining companies, some of which, as a consequence of their exploration results, have applied for Mining Certificates (as sub-lessees from PASDEC). Though the normal policy is to limit prospecting permits to 1000 acres in forest reserves, and permit areas may not cross DLO district boundaries, these restrictions do not apply to PASDEC. Constraints on access to alienated land still apply, and can only be overcome by buying out the holder of the land certificate or by reaching some form of agreement. This is causing some very prospective land in Pahang to be unavailable because the level of compensation for the value of the overlying oil palm plantations would make all but the richest deposits uneconomic. Existing exploration and mining licences within these 12 areas are not being renewed on expiry to enable the large companies to have unhindered access to any mineral deposits. This arrangement is probably peculiar to Pahang. It provides companies with an 'off the shelf' prospecting area without the necessity of going through the licensing process. Companies which surrender their sub-lease are being replaced.

5.4.3 Revision of the Mining Law

In 1989 the Mineral Development Policy and Planning Project was set up between the Government of Malaysia and UNTCD. The principal objective was to formulate recommendations for improvement in legislation, capabilities and procedures.

A preliminary study made the following recommendations:

1. That better ways of promoting hard rock mining should be found.
2. That a ‘one-stop’ application point for mineral tenements should be set up in the Lands and Mines Department of each state.
3. That each state should set up a State Mineral Resources Committee to adjudicate on applications, and the committees should be formed of technocrats as well as politicians.
4. That a Central Mineral Resource Information Centre should be set up.
5. That there should be a new mining law which differentiates between small-scale and large-scale mining.

The possibility of computerisation was examined, and it was concluded that it was not practical at that time, but future developments should start with a pilot project in one state.

The development of new mining legislation was undertaken by Dr James Otto. This took the form of a federal act (subsequently passed as the Mineral Development Act, 1994 (Act 525)), which provides the framework for subsequent state legislation, and a Draft Mining Enactment as a model for state legislation. The latter has not yet been enacted by any state, though parts of it have been incorporated in recent revisions of the mining law of Sabah and Sarawak.

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The Mineral Development Act, 1994, is described in its preamble as ‘An act to provide for the inspection and regulation of the exploration and mining of minerals and mineral ores, and for other matters connected therewith’. The majority of the act sets out the duties and powers of the Mines Department, Ministry of Primary Industries, which, as mentioned above, is mainly concerned with health and safety and environmental matters. The provisions which relate to the Geological Survey Department (Sections 9, 11, 20 and 37) are mainly concerned with the submission of duplicate copies of documents to the Survey.

The major modernising feature of the act is to be found in section 3, Definitions. In the definition of ‘mineral tenement’ the categories of licence are fossicking, panning/dulang, individual mining, prospecting, exploration, proprietary mining licence and mining lease. This changes the structure of licensing, particularly for prospecting, which is split between a Prospecting Licence for small scale work and an Exploration Licence for large scale work.

The Draft Mining Enactment (Draft 7, 26/6/91) defines the rights attached to the various categories of licence and some of the duties imposed upon the licence holders. It provides enabling legislation for the promulgation of regulations (Section 215) on administrative details. It requires the Directors of State Lands and Mines Departments to hold registers of all licences issued. This provision represents a major change in the administration of mining, which is currently undertaken at the District level, but is to be moved to the State level. The legislation will create State Mineral Resources Committees to approve or reject any application for a licence (with the exception of fossicking, dulang and individual mining licences, which will be issued by the State Director).

5.4.4 National Land Information System

The National Land Information System (NALIS) is a recent initiative by the Federal Government to use GIS technology for land use planning in its broadest sense. Each department has been charged with contributing a layer to the system - the Geological Survey Department are digitising the geological map at 1:50 000 / 1:63,360 scale. Within the next few years NALIS will contain topographic and geological maps, details of land use and several other spatial datasets. A pilot scheme is being run by the Ministry of Lands in the Kuala Lumpur area before the system is launched throughout the country. ArcInfo v7 is being used as the GIS system.

5.4.5 Potential for the use of computerised data management

The way in which the administration of mining law is structured in Malaysia rules out the adoption of a single computerised administration system.

A GIS system can help with several specific problems, the first of which was evident when a map of mineral tenement boundaries was examined in the District Land Office. As the maps held by the DLO contain all boundaries of alienated land as well as all kinds of occupation under licence, the number of lines and accompanying labels make the maps very difficult to read. A GIS can hold each class of boundary as a different layer, from which a clear picture can be obtained of the availability of land for a particular class of exclusive use, and potential conflicts in land use or tenure can be
identified by comparison between layers. It is noted that as the Draft Mining Enactment comes into force, the responsibility for holding the maps of mining tenement boundaries and associated records will pass from the DLO to the L&MD. It is suggested that the L&MD could capture the past data from the DLO in digital form (as the data on the maps will have to be divided up), and thereafter run a digital system. It may be advisable for the L&MD to capture the boundaries from the individual plans which accompany each licence, as the legibility of some boundaries on the DLO maps is poor.

Historical information on exploration work and mineral production is very valuable when the mineral potential of an area of land is reassessed. Details of dumps, slimes dams and underground workings are essential if former mining land is to be used for other purposes safely. A GIS can operate as a spatial index to past reports, maps and abandonment plans. As the GSM and the Mines Department between them hold a substantial body of data, the creation of such a spatial index to serve those two departments would allow comprehensive answers to be given to enquiries on old workings.

The exploration and mining licence areas, gathered together on a GIS system with the prospectivity data (or geophysics, geochemistry and mineral occurrences) and land zoning information on a topographic base, will stimulate interest in mineral exploration in Malaysia by making the information accessible. Much of the data needed for such a system is either currently available within the GSM or will become available through NALIS. Capturing comprehensive mineral tenement holdings and boundary information in digital form represents the biggest challenge to implementing such a GIS system.

5.4.6 Observations on future developments in mining law in Malaysia

The overview obtained of the mining law of Malaysia, its administration and its future form was most enlightening, and of considerable benefit to the project. The view that mining law of a country is largely determined by its economic history is born out by Malaysia, where the law has provided for small scale alluvial tin operations to a greater extent than hard rock mining. The revised mining law will provide a more favourable climate for hard rock mining and for large-scale operations.

The need for computerised support for the administration of mining law was recognised by the Mineral Development Policy and Planning Project in 1989. Because of the spatial and departmental division of responsibility for administration, as well as the state of computer technology, this was deemed to be impractical at that time.

The revision of state mining law will reduce the number of administrative centres and simplify the administrative process. The coming together of this legal change and NALIS presents an opportunity to provide each state with a computerised mining law administration and information system.

The need for a Central Mineral Resource Information Centre (CMRIC) was recognised in 1989. The technology to operate such a centre is available at the GSM. A user-friendly front end to the GIS and database software will be required to allow real-time data retrieval for enquirers. The completeness of the information received from the DLOs has been questioned, and may have to be checked with the DLOs once the information held by the GSM has been input. The CMRIC should also provide a spatial
index to historic data held by various departments, as part of the service to potential investors. The establishment of a computerised CMRIC is not dependent on legal changes, and could be started in the near future.
Other solutions for recording amendments are possible but may make the building of applications to pick up the current situation more difficult.

Periodic removal of expired licences to an archive database may be necessary, as the database performance may suffer due to the volume of redundant data in it, but this function must be carefully controlled.

Some licence amendments may depend on public notice being given before they are accepted and can be entered into the main part of the database. An AMENDMENT APPLICATION entity is provided to store all such applications and to record the actions taken in accordance with the law. This entity is linked to the Licence Holders entity to provide details of the applicant, which is needed for the generation of the statutory notices. AMENDMENT TYPE is a domain table which is used to standardise the description of the types of amendment permitted by law.

Particular properties of the various licence categories are stored in the CATEGORY PROPERTIES domain and is used as a look-up table for categories of licence to guarantee uniform entry of this parameter. The data stored in this entity is used chiefly for validation purposes, and to permit modification of Mining Regulations on matters such as the maximum permitted area for a particular class of licence to be amended without the need to change the validation software. New categories of licence can be added as required.

Licences relate to areas of land, but in some legal systems one licence can cover more than one tract of land, so AREA becomes an entity with a one-to-many relationship with Licence. The Area entity contains text information about individual parcels of land, of which there may be several covered by one Licence. The digital co-ordinates of the parcels are stored in a linked table in the GIS system. In some legal systems the location and identifier displayed on each boundary marker or beacon has to be registered. This information is recorded in the BOUNDARY MARKER entity, which has a many-to-one relationship with the Area entity. The MINING DISTRICT domain table is used as necessary to provide a list of mining districts into which a licensed area may fall.

The statutory reporting frequently required of licence holders relates to the area of land covered by the licence in the period of time in question. As it is common for areas to be amendable, either by statutory reductions in the area held, or by additions, the REPORTING entity is linked to the Area entity on a many-to-one basis using the Category, Licence No. and Amendment No. as a compound keyfield so it is clear which area of land is being reported on. Provision is made for various types of report to be submitted by the use of a REPORT TYPE domain table to show the permissible categories.

The PRODUCTION entity similarly relates to the area of land licensed during the reporting period which is held in the Area entity. Production figures will have to be manually abstracted from the reports provided unless separately available from a Mining Statistics Section, but the Licensed Commodities table can be used to confirm the commodities which should be reported on. There is the potential for adding tables and processes which will enable the revenue gathering side of the licence management system (e.g. land rents and royalties) to be automated.

Licences are for a commodity or a group of commodities, dependent on local regulations. LICENCED_COMMODITY is an entity to record the commodities for which
each licence is valid, usually with a one-to-many relationship with the Licence entity. A coding system is used for storing commodities, and the COMMODITIES domain table is used to contain a list of commodities or classes of commodities as text to prevent the use of synonyms which would prevent efficient data retrieval. It may be useful to add royalty rate information to the Commodities domain table to enable royalties appropriate to each commodity to be calculated automatically.

Licences are issued to LICENCE_HOLDER. Generally this is a sole trader or a legal entity (partnership, co-operative, company, state organisation), but in one country (there may be others) it is known that licences may be held ‘jointly and severally’ by two or more people not forming a legal entity. Because of this, the general logical model identifies Licence_Holder as a distinct entity with a many-to-one relationship with Licence. In most implementations where there is a one-to-one relationship it would be preferable to subsume the contained fields into the Licence entity. The information on licence holders relates either to a person or a legal entity. As the ways in which these two categories are identified differ, there are one-to-one links both to the PEOPLE entity and to the ENTERPRISE entity. The BUSINESS CLASS domain table provides a list of the types of enterprises which are legally recognised.

It is likely that many participants in the mining industry have interests in more than one Licence; consequently the PEOPLE entity is used for all information on individuals in the database to remove possible duplication.

The ENTERPRISE entity records information on any form of registered enterprise - state or private. If a business is registered in another country, the code for that country, taken from the Country domain entity, forms part of the identifier. In many countries any foreign company taking out a Licence must have a local address. Two addresses are allowed for in the database; the first is for the local address (the registered address if a local company), the second is to be used for the registered address if the enterprise is registered in another country. If an enterprise holds more than one licence, the same entry in the Enterprise entity is used for all licences it holds. An enterprise has shareholders, and directors if it is a company. One-to-many links are provided to the Shareholders and Directors entities. The COUNTRY domain entity provides a standard list of countries which are used for recording the country of business registration, for nationality and for postal addresses.

SHAREHOLDER attributes vary from country to country. Information may only be required on large shareholdings. Shareholders can either be people or enterprises; both are provided for in the model. There is one-to-one relationship between the Shareholders and the People entities using the unique personal identifier as the keyfield. There is also a one-to-one relationship with the Enterprise entity, using Nationality and Registered Number as the keyfield. This is a recursive link in the data structure, but it should not cause problems.

The DIRECTORS entity is linked to the People entity on a one-to-one basis using the unique personal identifier, and records the position held on the board of the company or other office of the company and their appointment and resignation dates. This is to provide an audit trail to the responsible officers at any time in the past, if this facility is required.

Consideration has been given to providing an entity to record individuals and enterprises which are under a legal disability consequent upon prosecution. It is thought
that the numbers of entries would be too small to warrant the effort. It is possible to
obtain a list of the involvements of an individual or enterprise in the mining industry by
retrieving on unique personal identifier from the Directors, Shareholders and Licence
Holders entities.

The **COUNTRY** domain is used as a look-up table wherever a country name is required in
the database to enforce standard forms of entry. It is possible that there might be
problems with using a single domain entity for postal addresses, nationalities and
legislative entities - the USA issues passports at the federal level, but companies are
registered under State legislation (e.g. many of the major U.S. companies are
incorporated in the State of Delaware for tax reasons). At the moment the argument for
simplicity is given most weight. The Country domain entity for Guyana was populated
from countries listed in the overseas dialling codes section of the Guyana phone book,
with a few additions such as the Isle of Man, States of Jersey, Bailiwick of Guernsey
etc. which are known to issue their own passports. There are other possible sources of
this information such as the ISO standard country list.

New applications for any category of licence should be kept separate from the rest of
the database, as they only have validity after the approvals procedure has been
completed and the necessary fees paid. A proportion of applications will be rejected,
and it is considered undesirable to mix these with the valid licences. An exception is
made with respect to the data on corporate and personal applicants, who it is considered
may already be on the database, and the number of ‘orphaned’ entries should not be
large. Under many legislations it is the usual practice to give an application its
application number on receipt, and then on approval to award a licence number. The
**APPLICATIONS** entity is designed to contain the basic details of applications, and to be
linked on a one-to-one basis to the Licence entity through the Category / Previous
Category and Application No / Previous Licence No. keyfields. The commodities or
classes of commodities applied for are in a many-to-one relationship with Applications,
and are stored in the **APP.COMMODITY** entity. Applications can be in a one-to many
relationship with applicants, consequently **APPLICANTS** are stored as a separate entity.
The Applicants entity has the same relationship with the People and Enterprise entities
as Licence Holder.

### 6.3 Attributes

It is essential that a computerised licence management system should accommodate
most of the information which is legally required for issuing a licence. For some types
of information it may be preferable to store a pointer to paper records, but the system
should aim to provide for the administration of the law completely, including legal
provisions that have not been used. The generalised logical model attempts to
incorporate and describe all types of data which have been encountered in the study of
mining law in many countries, but it is inevitable that some logical flaws may be found
in future years. A working version of the list of attributes with provisional definitions
has been prepared as part of the project. The objective of setting up a generalised
logical model is to provide a superset of the information known to exist, but individual
implementations will require the removal of some domains and attributes, and careful
checking, to see that what remains is appropriate for the licence management system
being computerised.
6.4 GIS Design

6.4.1 Introduction

In parallel with the design process which was undertaken for the database component of this project, an analysis of the users' needs was carried out in order to determine what tasks the users of the GIS part of the system would be required to perform.

The purpose of the GIS within the system is to manage the spatial aspect (the physical shape, and boundaries) of the licences, and to provide a simple means of viewing and querying the attribute information stored in the databases. At its simplest level, this provides users with a 'point and click' method of retrieving data relating to licences, and licence applications, and also the ability to create maps utilising the information stored in the database.

For complex enquiries, and for routine attribute data entry and updating tasks, the database interface should be used, as the GIS has been designed to permit users read only access to information.

6.4.2 Data Organisation and Storage

As discussed in previous sections, the attribute data relating to a licence (the holder, data, licence type etc.) is stored in a relational database (Access). The licence boundaries are stored in the GIS, using a file format specific to ArcView known as a shapefile. Other data sets, including national borders, roads, rivers and geological information (where available) are also stored in the GIS, and thus maps of mining licences can be created on top of a topographical background.

The two primary data sets (or themes to use ArcView's terminology) are Licences, and Licence Applications, and it is these two themes that are linked to the database. Ideally this link is performed using the licence number, which will be a common file between both the database, and the GIS. However, due to the complex nature of the licence numbers, often constructed of text characters, numeric characters, dashes, dots and so forth, the use of a unique code, a 'GISLink' is required to provide a more robust and reliable method of joining attribute and spatial data. This can either be a number generated automatically by Microsoft Access, or a field produced by concatenating other suitable fields in the database. Microsoft's Open Database Connectivity (ODBC) interface is used to facilitate the link between Access and ArcView.

6.4.3 Security

The issue of security is very important when dealing with the physical boundaries of mining licences, particularly when an economically valuable deposit is found. The best form of security with computerised systems is to not allow any unauthorised access to the computer(s) which hold this information by locating them in a secure room. If the computer in question has an external link (such as a modem and phone line), then adequate 'firewall' procedures need to be implemented in order to prevent unwanted log-ins.

At the system level, various password and permission systems can be implemented to maximise security. Entry to the GIS is controlled by a password system, and the
operator is given the choice of logging in as either a ‘user’ or an ‘administrator’. These
two levels of access offer the operator different levels of functionality within the
system, and in most cases, administrator privileges are only given to those that require
to perform modifications to the software.

When the user has entered the system, additional security is implemented on the
Licence Application, and Licence themes themselves. This is performed by ArcView’s
own ‘theme locking’ functionality, with the effect that a password must be entered for a
theme’s shape or attributes to be edited. If this password is not entered, the theme can
only be viewed.

6.4.4 Functionality

As mentioned above, the purpose of the system is to manage the spatial aspect of
mining licences, and to provide ‘point and click’ entry to a selection of the attribute
data stored elsewhere. In the context of the proposed installations of the system, and its
intended market, complex functionality has been kept to a minimum, and robustness,
and ease of use prioritised. Development time available also constrained development
of the functionality available.

For example, automated methods of checking whether Licence Applications overlapped
existing Applications were considered, but it was felt that visual checking methods
were best suited. Likewise, more time was spent on ensuring that the data input
operations were reliable, as in most installations, this is the area in which initially, the
most time will be invested, during the transition from analogue to digital workflows.
Screen dialogues guide the user inputting geographical data through a number of stages,
ensuring that a repeatable methodology is followed as far as possible.

The identification of co-ordinates (in projected metres or latitude / longitude) of a point
clicked at on screen was seen as an important function, as this would allow easy
checking of boundary co-ordinates. This has been implemented such that when a
location is clicked on the screen, a graphic point is created, and a information box pops
up displaying the co-ordinate as an x and y value.

The calculation of the mathematical area for Licence and Licence Applications areas
was also implemented as a simple menu choice that can be run every time a new area is
added. The area can be calculated in a variety of units (e.g. acres\(^2\), metres\(^2\), km\(^2\)) to suit
the particular standards of the organisation operating the system. This utilises a
standard ArcView tool, but makes it much easier for the user to perform the operation.

Functions to help locate the user within a large geographic area were also developed,
allowing, for example, a grid co-ordinate to be typed in, and then having the map
display automatically zoom and pan to that location. This also allows a region to be
entered, and the map zoomed to the boundaries of the region in question, although this
function requires a data set representing such areas.
7. PHYSICAL DESIGN OF DATABASE SYSTEM AND GIS FOR GUYANA

7.1 Introduction

A logical design addresses the question of what items of data are recorded, and how they relate to one another. The physical design is concerned with how they are recorded, and what legislative and other constraints apply to this process. The experience of setting up a working Licence Management System has been very instructive on the practicalities of this task. The following sections of the report contain some 'check lists' which have been devised to assist in the analysis of legal provisions and administrative practices, prior to the development of the physical design of a database.

7.2 Areas for Enquiry into the Provisions of Mining Legislation

The scope of the basic mining law and amendments of general applicability needs to be established to identify areas which are subject to individual negotiation, the question of which provisions are mandatory, and which are discretionary? The list of questions in Table 2 was drawn up to assist in defining the mode of operation of the Mining Law and regulations.

Whilst this is a reasonably comprehensive list of the functions or user requirements to be supplied by the physical implementation of the database and GIS, some of the requirements (e.g. definition of licence areas on the ground) cannot be answered by the database. Where large numbers of categories of licence are involved, it may help to tabulate some of the information on each class of licence as shown in Figure 7.

<table>
<thead>
<tr>
<th>Guyanese Mining Law (Mining Act, 1989)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Small Scale</strong></td>
</tr>
<tr>
<td>1500' x 800' (27.5 acres) or sides or 1 mile along river, 300' from each bank, including small islands as river. Exclusive.</td>
</tr>
<tr>
<td><strong>Medium Scale</strong></td>
</tr>
<tr>
<td>Only open to Guyanese nationals and companies. Area to be defined by natural features or parallel boundaries</td>
</tr>
<tr>
<td><strong>Large Scale</strong></td>
</tr>
<tr>
<td>Limited to corporate bodies. 500' x 1200'</td>
</tr>
<tr>
<td><strong>Bauxite</strong></td>
</tr>
<tr>
<td>Right to convert to Mining Licence. Right to convert to Mining Licence, except for minerals covered by another licence. Right to convert to Mining Licence, except for minerals covered by another licence.</td>
</tr>
</tbody>
</table>
| [Table continued...]

Figure 7. Specimen Licence Category Properties table
Table 2. Questionnaire on the provisions of a Mining Act and related regulations, and their administration.

1. What is the legal definition of mineral or commodities covered by the legislation?
   - does it extend to bulk (e.g. bauxite) and industrial minerals (e.g. sand and gravel), coal, building stone, brick clay etc.?
   - are surface rights licensed as part of the same process (cf. planning permission)?
2. Does the legislation cover beaches and off-shore areas as well as land?
3. How are minerals categorised for licensing - by each commodity / by each type of commodity / otherwise?
4. What activities are licensed and what are leased?
5. Are there special arrangements for precious metals, gemstones, radioactive minerals?
6. Does the same government department have responsibility for all mineral licensing, or are certain categories of licence (e.g. for building material extraction) issued by another department (e.g. local administrations)?
7. Where more than one department is involved do they confer?
8. What functional categories of licence can be issued
   - reconnaissance, exploration, mining, small mines etc.?
9. Which categories of licence are exclusive? How exclusive (for commodity, category, everything?)
   - can a single licence be for more than one category?
10. Do licensees have the right to convert a licence from one type to another (e.g. prospecting to evaluation) at any time? If so, what categories of licence are convertible?
11. What is the maximum permitted duration of a licence - are other periods permitted?
12. Can licensees relinquish, let or assign part of their licensed area at any time? Can licences be inherited?
13. Are licences renewable
   - do any conditions apply such as the reduction of the area licensed on renewal?
   - how many times may a licence be renewed - does this depend on category?
14. How are licences identified - Do they have an unique serial number?
15. How are dues calculated (fixed / determined by negotiation)? Do they depend on category, area, production etc.
16. Does the licensing authority collect and/or record payment of dues?
17. What criteria are set for monitoring progress. What constitutes adequate progress?
18. What action is taken when licensees are deemed to be in default of their licence conditions (block on renewals?).
19. What eligibility criteria are set for licence applicants? Can some of the validation of this be done by interrogating past records?
20. Are there limits to the area which may be held under one licence?
21. Are there limits to the number of licences one person / company can hold at one time?
22. Do either of the above vary with category of licence?
23. Are any areas of the country closed to mineral development?
24. Are licences for one contiguous area or can they be for multiple areas?
25. How are licence areas defined on the licence and in official records?
   - What co-ordinate system is used, what map projection, what map series?
26. How are licence areas defined on the ground?
27. Has the use of GPS for location purposes been considered - is there any legal impediment to this?
7.2.1 Structure of Applications Menus

Applications generally use queries made of the database to extract information to be amended or reported upon. The ability of the database to be used in new ways will depend on the robustness of its design, which is why the design of the logical model has been a major feature of this project.

Below is a list of the basic functionality, which is likely to be required of the licence (permit) management system. The functionality implemented will depend on local legal requirements and administrative practices, which may change over time, but the list forms a useful basis for discussion with the licensing authority. In some cases it is useful to identify the sections of the Mining Act which apply to each requirement, and in some cases these may be usefully stored in the database for inclusion in any legal documents which may be generated as part of the licence management system.

- Process applications for new licences or permits
- Process applications for the amendment or change of category of current licences or permits - including:

  Register changes to a Mineral Agreement
  Change commodities for which a licence or permit is valid
  Suspend a licence or permit
  Record changes in personnel and controlling interests
  Extend a licence or permit area
  Surrender part of a licence or permit area
  Relinquish a licence or permit

- Renew licences or permits
- Convert a licence or permit to a new category
- Record receipt of annual payments and reports
- Record production details
- Terminate licences or permits in default
- Produce maps of the areas occupied by current licences
- Produce information on past licences for a given location or area
- Produce statistics on many aspects of mining activity

7.2.2 Licensed Commodity Categorisation

There is a wide variety of approaches, under different legislative regimes, on how licences authorise the exploration for and mining of specific commodities. In some cases licences may give exclusive rights for all minerals (though usually there are some exclusions, such as radio-active minerals), and in others each mineral must be named on the licence.
The law in Guyana appears to operate on the basis of licences and permits being for specific minerals, to enable different licence-holders to search the same area for different minerals. This is logically correct, as enterprises do tend to concentrate on producing one type of commodity - a diamond mining company may not have any interest in copper-lead-zinc mineralisation, and the way in which the law is phrased potentially prevents resources being sterilised as a result. In practice applications are being made for categories of minerals by the use of such terms as ‘gold, precious stones and other valuable minerals’. This causes some difficulty in implementing computerised validation of applications because of uncertainty in the scope of generic terms used. A list of minerals and acceptable terms should be used to clarify the situation and one is provided in the database.

It is suggested that a more manageable approach may be to group the minerals into a few categories, which both reflects what the customer is applying for, and is not so broad in its scope as to sterilise mineral deposits. This would clarify the scope of each licence or permit, and usually would enable production of unexpected minerals to go ahead without further paperwork (e.g. for W if Mo is licensed) by the selection of groupings which reflect mineral associations and styles of working. There may be some minerals which appear in more than one category, some of which are detailed below (there may be more). It may be expected that there would be a need for licences to cover more than one category in many instances (e.g. Gold + placer + precious stones), which might encourage expansion of the recovery of by-products. This approach may also encourage the declaration of unlicensed production from licensed mines.

1. **Noble Metals**: Au, Ag (except Ag in Galena up to 100 oz/ton) and Platenoids (Ru, Rh, Pd, Re, Os, Ir, Pt) also As, Te by association.

2. **Valuable Metals** (in the Guyana law this term has a specific legal definition - perhaps Valuable Base Metals & Minerals would be more appropriate) not in placers. Ti, V, Cr, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Y, Zr, Nb, Mo, Cd, In, Sn, Sb, Ta, W, Hg, Tl, Pb, Bi, also Ca, Ba, Sr, Cs by-products - which also may be Industrial Minerals.

3. **Non-precious Placer Minerals**: Compounds of Ti, V, Cr, Y, Zr, Sn, La, Ce, Rare Earth elements, W.

4. **Bulk metals and minerals**: Mg, Fe, Mn, Ba, Sr, Cs, Be (not gem), Li, B, Phosphates (except placers), evaporite minerals, zeolites. Mined micas etc.?

5. **Radioactive minerals**: Compounds of Po, At, Fr, Ra, Ac, Th, Pa, U (except phosphates with minor U).

6. **Precious and Semi-precious Stones**: Diamond, Ruby, Emerald, gem Beryl, Amethyst etc. (except where there an official definition).

7. **Quarryable minerals**: Rock, laterite, sand, shell sand, gravel, kaolin, clays (brick, fullers earth, pottery etc.), barite, quartz(ite), guano, peat.

8. **Bauxite**

9. **Coal** and Lignite (not applicable to Guyana as they do not occur).
7.3 Validation Procedures

An abiding problem with any database is how to minimise the error rate in data input. There are numerous sources of error, for example the wrong information supplied, typographic errors, right information entered in the wrong place etc. A simple but effective technique to capture many errors is to constrain what may be entered into a field in the database. This is not effective for text fields, but numeric, logical and date fields are protected from receiving any data which is not of the right type. Screen forms can be used in various ways to constrain the input of parametric data. Several data fields (AmendmentType, BusinessClass, Country, Commodity, Licence Category, MiningDistrict, Nationality and ReportType) are limited to containing values selected from pre-loaded lists which are stored as domain tables. This measure standardises the form of text string used for various common parameters, and promotes accurate data retrievals.

7.3.1 Spatial Data Quality

It may be found that, in some cases, the areas covered by permits and licences which have been calculated manually are at variance with the more accurate calculations by the GIS. As these areas are related to the licence fee payable it is recommended that the existing figures are used for current licences and permits. Discrepancies between the published co-ordinates and the boundaries of areas shown on the stock maps will be ignored for existing licences, and the Stock Maps will be taken as authoritative (though in Guyana this may not be the legal case).

As paper maps are dimensionally unstable, a scale-correction procedure is used to compensate for paper stretch, using latitude/longitude intersections as fixed points for the process, recalculated to UTM grid co-ordinates with an accuracy of 1m on the ground, rather than assuming that the map scale is exactly 1:50 000. UTM co-ordinates of boundaries will be used to reflect current practice, as boundaries have been plotted as straight lines on the stock maps - lines expressed as bearings are actually slightly curved on UTM maps (but this is only measurable over long distances). The GIS can convert back to geographic co-ordinates if required.

Differences between the geographic co-ordinates supplied in future applications and the measured co-ordinates from the accompanying maps will be assessed for correspondence as part of the validation process.

The current analogue workflow involves all Licence Applications being drafted by hand onto the topographic stock maps. The areas are drawn either by interpreting co-ordinates supplied by the applicant, and constructing a closed polygon, or by transposing an area from a map supplied by the applicant. Many boundaries are described, for example as ‘following the south bank of the River x’, and thus accurate topographic base maps are needed to compile such areas. When a complete digital topographic base is available, this can be included in the GIS, making the above process much easier. At present, the Digital Chart of the World (DCW) 1:1 000 000 scale data set is used as a national topographic base within the GIS, and the accuracy of this cannot be recommended for tasks such as described above.
7.4 Production of the physical design

The physical design was derived from the logical model, using the data gathered using the questions listed above. As the legal structure for mineral exploration and mining in Guyana is complex, few excisions were made from the logical database model.

The main excision concerns the fiscal side of the operation of the mining law, which was not required, because the treasury, which operates the revenue gathering, is a separate section within the organisation.

The registration of boundary marker beacons is not required under Guyanese law, though this facility may be useful to store the corner point information in the DescriptiveLocation attribute in a structured manner.

The link to the LibraryCatalogue entity is not required for the database of active licences as all reports remain confidential while the licence to which they are related is current, and in certain circumstances where the same area is taken up by another licensee after the original licence was surrendered.

Several tables in the database contain 'lookup' information. Of these tblCountry and tblCommodity are common to any installation of the database. MiningDistrict, ReportType, AmendmentType and Category are specific to Guyana, and reflect legal and administrative procedures. The CategoryProperties table is populated from the information summarised in Figure 8 (above).

7.5 Construction of the database

The parent entity, name, type and size of each attribute in the database were listed in a Microsoft Excel spreadsheet. The appropriateness of the size of storage allocation for each attribute was checked by inspection of the original paper records, and changes were made as necessary. The use of a spreadsheet enabled attributes which occur in several entities to be grouped together before amendment by sorting on attribute name, to ensure uniformity of format of similar attributes. The spreadsheet was then re-sorted into entity - attribute order before the creation of the database tables in Microsoft Access.

The database was initially created in Access 2, but after the announcement by Microsoft that there were Year 2000 problems with Access 2 the database was converted to run under Access 97.

The screen forms through which data is loaded into various tables were customised to use the terminology found in the equivalent paper forms in the Guyanese system. Various standard notices were typed in to Microsoft Word and were edited to enable mail-merge fields to be filled from queries on the database.
8. IMPLEMENTATION PLAN

8.1 Introduction

Planning and executing the implementation of the conversion of a national exploration and mining licence management system to computerised operation is perhaps the most difficult part of the whole project. This step was included in the project to demonstrate that the ideas and methods evolved during the project work in practice. Guyana was chosen for the trial implementation because of the vigour of the mining industry there, and the complexity of the legal provisions. It was considered to be a good place to test the authors' work, as more of the logical model would be required than would be the case in other countries examined, and it would be subject to a high throughput of transactions. Any problems with the design or implementation would be likely to be revealed in such an environment. This was proved to be true.

The implementation plan fell into two parts. The first task was to establish how the system should be run, by whom, and with what equipment. The main consideration was to make any compromising of the integrity of the system as difficult as possible. This involved making recommendations to GGMC on what extra equipment would be necessary to protect the database from tampering, theft, fire and power supply problems. Staffing and staff training requirements were defined, and some thoughts were shared on the long-term support of the system.

The second task was to devise a way of capturing all the required information from the paper records and maps without interfering with the day-to-day running of the system. The suspension of operation of the licensing system for a period while the data was transferred was not an option, because the volume of records to be transferred was too great to do on a timescale which would be acceptable to the public.

8.2 Digital Capture of Paper Records

The conversion of the existing paper-based system for administering exploration and mining licences in Guyana to a computer-based system was found to be a major logistical problem, the magnitude of which was initially underestimated. The initial emphasis was on loading the information on the large and medium scale sectors. Because the level of activity on applications, permits and licences is so high it was suggested that separate databases were set up temporarily as follows:

8.2.1 Sequential loading strategy

8.2.1.1 Current licences and permits (large & medium)

A temporary database was set up with utilities for sequential keyboarding of the information from the paper records in file number order. It was discovered that many of the detailed descriptions of the licensed areas had been typed up for gazetting, using a word processing package, and had been saved on disk. The files on disk were catalogued, and were transferred to the data input forms as required using the Windows cut and paste facility. This was found to halve the time taken to load each file, and had the benefit of recording exactly what had been published in the Official Gazette (including any errors). GGMC staff were trained to do this with BGS assistance. It was
requested that this work should be completed by a set date. Any amendments to the files which had been added to the computer database during this period were to be marked by a sticker on the paper file, and the amendments were to be loaded after amalgamation with the main database.

8.2.1.2 Current applications (large & medium)

Applications being processed during the conversion process and those received from that time onwards were to be loaded into the main database in the order in which payment has been received. On the designated date the data detailed in the previous section was be added to this database, to become the full working system.

8.2.1.3 Spatial data (large & medium)

Licence Applications are composed of text format geographic descriptions which are plotted on ‘Stock Maps’. The digital workflow currently still involves this drafting of stock maps, as there is no suitable digital topographic base to capture these data points electronically, as explained above. The paper stock maps (not the maps supplied by the Licence Applicants) are then digitised using the procedure described in the Licence Management System (LMS) manual. This provides for special procedures when adding a licence which adjoins another, and for inputting licences which may run over the boundary of two or more stock maps. When this procedure is followed, licences that share a boundary in real space will also share a line that represents them on the GIS. This avoids ‘slivers’ that are often formed when the same line is digitised twice.

When an area has been digitised, the application file number (for example GS8:C-69/001) is entered into the theme attribute table, and also the GISLink number, which can be obtained from the database for each Licence and Licence Application. This field then provides the link between the spatial data and the attribute data.

8.2.1.4 All small-scale applications, permits and licences

The small-scale text information is already on computer, and can be incorporated at an agreed time. Some extra data may be needed from the paper records. As the small-scale sector is administered separately, procedures will be needed to ensure the harmonisation of the information in the two systems. The preparation of maps of approximate (point) locations for the small-scale sector has been discussed (there are no location maps or digital co-ordinates for small-scale Prospecting Permits, River Locations and Claims Licences at present), and hopefully this information will be available for digitising and incorporation in the database at some time in the future.

8.2.1.5 Quarries and Bauxite mines, Geology & Geophysical survey permits

It is assumed that the volume of this data is so small that the time required for its incorporation will not be more than a day or two.

8.2.1.6 Data on lapsed permits and licences

As data from lapsed permits and licences becomes publicly available from the date of termination, it is suggested that a separate GIS database is set up to provide information
on what paper records are available for any specified area. It is assumed that this will apply chiefly to the large and medium scales where full reporting takes place, and possibly only to the location of workings in the small-scale sector. On termination of a permit or licence the appropriate data fields should be moved from the Management System to this enquiry system. The addition of some reason for abandonment would be useful (sub-economic, worked out etc.).

For future terminations the entire prospect or licence records should also be moved to an archive database to provide an audit trail should one be needed, and to prevent the performance of the Management System being degraded by unused data. It is suggested that it is not practical to computerise full data for prospects and licences that have already lapsed.

Unfortunately a period of civil disorder ensued shortly after the initiation of the data transfer process, which disrupted work, and it was not possible to keep to the schedule. Staff changes caused further problems. The collapse in the gold price during this period caused the surrender of about 30% of the current licences. This lead to a revision of the strategy for implementing the database.

8.2.2 Incremental loading strategy

A new start was made, loading both new and current files onto the computer database on the first or next occasion on which they required some attention. When most files seem to have been loaded onto the database (which takes one licence fee payment cycle – 1 year), a systematic review of the paper files can be undertaken to see which files have not been loaded, and why this might be, and what action should be taken.

The systematic loading of licence area boundaries onto the GIS system by stock sheet was found to be the most practical approach to the task, and was retained. Because of the time taken to complete the task, and the level of cancellations, the digital files will require revision before they can be linked to the paper records, particularly to take account of new licences issued after digitisation of a sheet has taken place.

Following discussions with senior GGMC staff, the stock maps are being digitised without reference to the digital co-ordinates of the various licence areas. This is a consequence of the legal problems implicit in making any change to locational data already gazetted. In order to capture errors in new applications, and to correct them before gazetting, some form of validation test needs to take place. A temporary solution, which may be used until the systematic digitising has been completed, is to plot the co-ordinates, provided in the area description, in Excel to see if they resemble the shape of the boundary delineated on the map which accompanies each application.

Once all the stock maps have been digitised, and new data added, and all paper records captured digitally, the two databases will be sorted and listed by file number. The checking for correspondence between these sorted lists is likely to involve a considerable amount of work. It is likely that discrepancies will be found, involving cancelled areas still being shown as current on the stock maps, areas not appearing on the stock maps – and other problems too. There will then be a phase of locating additional information, adding it to the database, deleting expired records, and bringing the two lists into complete correspondence. There will be the requirement to continue processing current applications and renewals during this reconciliation process, which will add the problem of keeping both databases in step with one another. The
manpower implications of sorting out these problems should be considered before they
are encountered.

8.3 Security

As the data to be managed by the computerised Licence Management System is of
commercial significance, it was appreciated from the start that it should be constructed
to discourage misuse. Probably the best way of stopping unauthorised use is by
restricting access to the computer on which the Licence Management System is kept. If
the computer is not devoted to the one function, an alternative method of maintaining
security is to use a demountable large capacity disk on which to store the database (e.g.
Iomega Zip drive, $US 150). This provides the advantage of being able to use the
database on the most convenient computer. The disks could be locked in a safe when
not in use. In the long term, the provision of a secure room and a dedicated computer is
to be encouraged. In Guyana the GIS functionality is provided by a separate computer
which has access to the large-format plotter and digitiser in the digital cartography
section. In most authorities it is unlikely that the provision of dedicated digital
cartography equipment for the Mining Licence System will be warranted, consequently
the portability of the database will be necessary.

A regular backup procedure is required to safeguard the integrity of the data, whether
from mishap or wilful tampering. The demountable disk drive will provide this facility
conveniently for daily or weekly backups, but to supplement this the most secure form
of backup / archiving is periodically to write the database to a CD-ROM of the ‘write
once read many’ variety. As far as it is known, this form of storage is incorruptible.

Several security measures have been put in place to monitor and restrict authorised
usage, and are necessarily confidential. The database has been designed not permit
deletion of records. Any amendment will be as a new record with a new amendment
number. Access not involving amendment will be logged, though these security
measures will not be apparent to the casual user, and access to the logs will only be
available to staff with the appropriate permissions.

8.4 Training

Training has been given, and documentation has been provided, to ensure that the
GGMC staff who will be using the system are confident in its operation. Because of the
problems outlined above it has not been possible to operate the database fully as
originally envisaged, and further assistance and training may be necessary in the future.
The maintenance of a sufficient pool of staff trained in the use of the system will be
required to cover for absences and resignations, and for the long-term operation of the
system.

8.5 Sustainability

Consideration needs to be given to the financial implications of using the system in the
years ahead. The maintenance of the computer equipment and its eventual replacement
must be provided for as this is a ‘mission critical’ application. To cut running costs to a
minimum, the system has been designed to work on ordinary PCs with basic
commercially available software. A change to a network operating system, such as Windows NT, may involve some changes to the way the system is set up, as may migrating to future versions of Access and ArcView. For security reasons access to the application software and the database structure and information on it should be kept secret. Careful consideration should be given to the security implications of mounting the system on a networked computer.

8.6 Future Development

The structure of the database is such that extra functionality can be added easily, either to store more parameters or to generate more queries and reports. The full information on the database structure, queries, forms, reports and Visual Basic code is to be made available to a designated person at GGMC to enable modifications to be made without outside support. It is envisaged that the support of the authors will be required for perhaps two years while the system comes into full operation, but, as the system was installed under TDR (later KAR) funding, such continuing expenditure is not provided.
9. PUBLICITY AND FEEDBACK

The system was publicised through a poster display at the meeting of the Commonwealth heads of Geological Surveys, which was held at BGS Keyworth in May 1998. From a count of the descriptive leaflets accompanying the display it seems that many survey representatives took a copy.

During the meeting one survey Director expressed interest in the system, and was given a detailed presentation on its scope. It was found that the logical model covered his requirements, which included a system for managing the administration of current licences, including fiscal aspects, and a separate system to act as a spatial index to and database of former licences and related reports and information. Subsequently to the meeting, a letter has been received from another survey Director, saying "we have seen the need to have such a system in place. As such, we are very interested in obtaining this system and would like further information about whether this project is still available along with a possible estimate". Subsequently, two non-Commonwealth geological surveys have expressed interest in the system.

In the early stages of the project, the responses from Malaysia and Botswana were very positive towards the project, as they have a need to combine their data on licences with geographic information. The division in responsibility for the administration of the mining law in Malaysia, and the fact that the change in the federal law has yet to be reflected in the laws of all the States does present some problems, not least in sharing confidential information electronically between government departments.

An article on the project will appear in the issue of the DFID journal 'Earthworks' to be published in late 1998, which will spread the information about the system to every geological survey. The BGS Press Office will be distributing information on the project to relevant publications on publication of this report. It is hoped that the commercial sector may prompt struggling mining law administrations to modernise, using the results of this project to show what can be achieved at a reasonable cost.

Most of the organisations which may want to use the fruits of this project are dependant on donor organisations for funding innovation. The response from BGS to those expressing interest has been that the Mining Licence System is available for installation and customisation, but an external source of funding must be found first as BGS does not have its own funds for this work.

Because of the problems in computerising the data in Guyana, which is likely to take at least another year to complete, there is no ‘new’ system in place at the moment for the commercial sector to judge. Confidential discussions held with mining companies in Georgetown on their perception of the state of mining law administration in Guyana and what they would like to see showed a strong demand for the improved speed of transaction processing and improved access to historical data.
10. CONCLUSIONS AND RECOMMENDATIONS

It has proved possible to construct a broadly-based logical model of the data pertaining to mining law administration based on a study of the legislation and practice of many countries. Mining law often reflects in its provisions the mining history of a country, but many of the core areas of the legislation are similar in their requirements and operation.

The benefit of having the logical model and the articles of enquiry will be found when computerising further administration systems:

- The time taken to establish the relationships between attributes and entities will be reduced substantially.
- The framework provided will help to identify aspects of the legal and administrative process which otherwise might have been missed.
- The software and software tools which have been created as part of this project will further speed the creation of new systems.

The design of the mining licence system which has been developed through this project is likely to improve the access of the multi-national mining companies to the data they need concerning available land for exploration, though in the case of Guyana this will not take place as soon as was originally envisaged. The experience of setting up the system in Guyana suggests that the process of switching from a paper-based administration system to a computerised system (with legal documents still on paper) is perhaps the most difficult stage of the whole operation. Amongst the problems found was that paper-based records tend not to be completed with the rigour demanded by a computer form, where the built-in constraints force the entry of essential information before anything else can be done. Some relaxation of data standards is essential if the transfer of the database is to be accomplished. Generally, 'holes' in the data can be filled in when the licence is next renewed, and the applicant is in the office to supply the information.

For the above reason and also to avoid confusion in the data transfer process it is considered that the incremental approach to data transfer is preferable to others, unless the volume of data is so small that the job can be done systematically in two weeks of concerted effort. The adoption of the incremental approach does imply that the switch to a computerised system cannot take place in less than one year. The input of licence area boundaries from maps has to be undertaken systematically, and as the paper records, housed in 'physical' files are not tied to the maps which show the spatial distribution of licence areas, it is to be expected that these two sets of information will not correspond when the initial data loading process has been completed, involving investigation and resolution of mis-matches between the datasets.

The studies of the countries where computerised licence management systems have been installed show major benefits in the efficiency and speed of administration. The addition of an integral GIS facility to existing licence management systems would add further improvements to the efficiency gains already enjoyed.

It should be noted that in addition to Guyana, where the test implementation was set up, four other countries have expressed serious interest in obtaining the mining licence system even before the report is published. It is concluded this research and
development project shows considerable potential for meeting a clear need of developing countries.

10.1 Recommended computer specification

The system uses types of computer hardware and software which are known to be supported in almost every developing country to minimise the capital costs of the system and to maximise its sustainability.

The present recommended specification for a computer system to run the mining licence system is as follows:

- Pentium PC with 32Mb of memory,
- 2Gb SCSI Hard disk and controller,
- external CD-ROM writer,
- CD-ROM reader,
- internal 100Mb Zip demountable disk drive,
- Good quality A4-format printer (for producing statutory notices),
- A2-format (or larger) digitiser,
- A1 or A0-format plotter.

An uninterruptable power supply unit is also necessary, as the software is sensitive to sudden power failures, which can corrupt the database and GIS. It makes economic sense to use the plotter and probably the digitiser as a site facility for digital cartography and other purposes. The total cost as of September 1998 in the U.K. market is about £5 000.

10.2 Recommended software

The available software for databases and Geographic Information Systems (GIS) was reviewed in 1997, and it was concluded that Microsoft Access offered the best facilities for building the database. Since then it has been necessary to switch to Access 97 because of the millennium bug problem in earlier versions. The use of Access 97 implies the use of Windows 95, 98 or NT. A copy of Microsoft Word is also necessary to provide mail-merge facilities. Experience has shown that the automatic generation of documents from the mining licence system provides a major boost to administrative efficiency, though Microsoft Access will only provide data for a mail-merge if the mail-merge document is in Microsoft Word.

The current versions of Map Info and ArcView were found to provide adequate GIS facilities.

The current cost of software in the UK market is about £1,500. Additional costs may be incurred to provide anti-virus and data recovery utility programs, if these are not already available.
10.3 Take-up requirements and the cost of installation

The cost of installation will vary with the size and complexity of the paper-based system to be replaced, the quality of the existing data, and the extent to which computerised processes are to be used. The major costs are staff time, travel and subsistence, all of which vary from place to place. A recent costing for a country with a 'medium sized' mining industry indicated that the British Geological Survey could undertake the work for about £60 000. The assumption in this costing is that BGS would be involved in the process, using expertise and computer code which has been developed in the course of the present project. It is important to provide follow-up support for at least two years after the computerised system is commissioned, otherwise problems and misunderstandings may go unresolved and the system may cease to function. It is of primary importance to maintain the confidence of those using a major computerised system for the first time until knowledge and self-confidence have become firmly established.
10.4 Recommendations

1. The Mining Licence System should be brought to the attention of countries which need to computerise the administration of their systems. The data model and articles of enquiry remove the need for an extended period of investigation before the customisation of a system to meet the legal and administrative requirements of a country.

2. The data model should only be made public down to entity level. Details of the attributes and inner workings of the system should be distributed only on a need-to-know basis to make it difficult for anyone to gain enough knowledge of the system to use it for corrupt ends without being detected subsequently.

3. Revised mining laws and mining regulations (secondary legislation) should make provision for computerisation of data management and administration, in particular with respect to the storage and display of spatial information, using a GIS.

4. Further funding needs to be found for Guyana for continued support and development of their computerised mining licence system to follow the TDR funding which has now expired. Mining is central to Guyana's economic recovery, and the maximisation of the benefits of the work that has already taken place will lead to more inward investment. Long-term feedback from Guyana will be beneficial in highlighting and circumventing problems which may occur in future implementations.

5. A funding mechanism is required to enable further take-up. The Department for International Development may wish to consider ways in which such funding could be made available for the implementation of the system in developing countries as requested, both in order to protect their investment in the creation of the system and to promote more efficient and responsible development of the natural resources of developing countries.

6. It is important to provide follow-up support for at least two years after the computerised system is commissioned, otherwise problems and misunderstandings may go unresolved and the system may cease to function. The confidence of those using a major computerised system for the first time should be boosted until knowledge and self-confidence have become firmly established. This can be best addressed by long-term agreements between BGS and host geological surveys through twinning arrangements.
11. REFERENCES


12. ACKNOWLEDGEMENTS

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The authors also acknowledge with gratitude the help provided to the project team in granting facilities for detailed examination of their national mining licence systems by The Director-General, Mr Chen Shick Pei, Geological Survey Department Malaysia; and the Director General, Mr T P Machacha, Geological Survey Department, Botswana.
APPENDIX A

Short Visit Report to the Botswana Geological Survey Department

by Dr J S Coats
25th February - 1st March, 1997

Timetable

25.2.97 1100 hrs Arrive Gaberone and met by Dr Roger Key (BGS) and driven to Lobatse
        1400 hrs Discussions with James Chatupa, Principal Economic Geologist

26.2.97 0800 hrs Detailed discussions on Mineral Concessions legislation
        1400 hrs Demonstration of the Access database and MapInfo GIS

27.2.97 0800 hrs Visit to the Department of Mines in Gaberone for discussions on Mining Leases with Mr Thamage, Principal Mining Engineer
        1200 hrs Return to Lobatse for more details of the GIS

28.2.97 0800 hrs Examine Records Office and PANGEIS bibliographic database

Introduction

The Botswana Geological Survey is a well equipped and efficient organisation. The staff are well trained and motivated. The Economic geology Section is well run and managed and the staff take an active interest in mineral exploration. I was afforded a great deal of time, attention and co-operation by many members of the section. The exploration scene in Botswana is very active with many international companies exploring for diamonds, gold, nickel and base metals. Currently there are about 25 mining operations, ranging from small aggregate quarries to large underground Ni-Cu mines and open pit diamond mines.

Mining Legislation

The current Mines and Minerals Act (1977) has six categories of mineral concession: Reconnaissance Permit (RP), Prospecting Licence (PL), Mining Lease (ML), Restricted Mining Lease (RML), Restricted Prospecting Licence (RPL), Restricted Mining Lease (RML) and Building and Industrial Minerals Permit (BIMP). Issuing of mining concessions is mainly handled by the Geological Survey with only Mining Leases being issued by the Department of Mines. A valid PL is needed before a ML is issued, so that all checking of area and mineral overlap is handled by the Survey. A map showing the current licences is published bi-annually, and indicates some of the ground that may be free. This map is drawn up by the cartography staff of the Survey from plots prepared by the Economic Geology Section.

Databases and GIS

The Economic Geology Section has three 486 or Pentium computers running Access and MapInfo GIS software. Licence details are held are held in an Access table with
details of Name, Licence number, Company, Licence type, Commodity, Quarter degree sheet, Districts, Area, Issue date, Expiry date. A separate GIS has the same details in an Info table. The databases and the GIS are not linked, so that the information on the database is not all accessible from the GIS. The GIS also exists on all three machines and it is not clear which is the master version. Other tables on the computers hold data on company reports and maps, but these are not linked, so there is duplication of information (and some redundancy) and several inconsistencies. There are only a few queries on the database, because of this lack of links, and there is scope for further queries to be written to assist its management. The GIS is operated effectively but there are problems with areas that have been relinquished and still visible on the map. New licences have also not yet been added. There is no topographic base map to the licences and this prevents its use to print the licence map directly from the GIS. Addition of a simple digital base showing the country's borders, main towns, roads and district boundaries would make it more usable. A suitable base at a scale of 1:1 Million is available from the Digital Chart of the World and this would be sufficiently accurate for plotting the 1:2 Million map produced at six monthly intervals.

These are essentially problems of quality control and it is recommended that formal procedures for checking and verifying data on both the database and the GIS are set up. A list of all current licences should be printed, checked and each verified on the GIS. Once an error free database and GIS are achieved, new licences can be added. Because the GIS and Access hold duplicate copies of the licence data there is always scope for discrepancies to occur. The two can be linked more closely using a technique called ODBC which enables MapInfo to query the data directly from Access rather than storing its own copy in its INFO database.

A monthly list of new and relinquished licences should be printed from the database and this can be used to check and verify all additions to the GIS. It is important that formal procedures like this are set up and approval is given by a senior officer.

Collection of licence fees is a problem but again a monthly list of fees due should be printed and passed to the Accounts Department to check that they have received the money. A standard reminder letter should also be generated from the database of those companies in default of payment.

The Economic Geology staff have designed an effective database and GIS, which is working well, despite some of the problems mentioned above. However, it is not being used to its full potential. The tables need to be normalised (removing redundant information) and linked so that better queries can be run against the database. Linking the database and the GIS will also simplify the work of keeping the system compatible.

Considering that the staff are largely self taught they have achieved a great deal but further training in Access and database design would be of benefit. This training can probably be obtained locally or in the Republic of South Africa.

Feedback on the licensing system was obtained from two companies and was generally favourable. The main problem identified by them was the lack recent information on new licences or relinquishments.
Summary

1. The database and GIS are working effectively but there are some problems with quality control.

2. Further training in Access and links to the GIS would be of benefit to the staff.

3. Very good co-operation was obtained from all the staff and the Geological Survey is clearly one of the best in Africa.
APPENDIX B

Report on a visit to Guyana Geology and Mines Commission (GGMC)

by R C Jones
15th - 23rd November 1996

Introduction

The purpose of the visit was to obtain information on the nature and operation of the mining law in Guyana. This forms part of an DFID KAR-funded study entitled 'Geoscience Information System for Mineral Development' which aims to construct business models of the mining laws of a representative sample of developing countries. This information will be used to develop an inexpensive computer system for managing spatial and administrative data, which is adaptable to local requirements.

Diary

Friday 15th Nov.

By air from London to Port of Spain, Trinidad on Flight BW901, dept. 08.55 (10.15 actual) thence by Flight BW431 to Georgetown, arr. 22.20.

Met at Airport by Dr M Petterson of BGS. En route for Georgetown, Dr Petterson provided details of the current situation at GGMC. In particular a German-funded project to introduce GIS equipment to relevant government bodies was discussed. RCJ outlined the purposes of the DFID-funded Geoscience Information Systems for Mineral Development project, and the information being sought from the GGMC. It was agreed that any outcome of the project should build on existing facilities and projects, and should not be open to suspicion of encroaching on their territory.

Dr Petterson provided a copy of the current mining law and other related papers for study.

Arrived at the Pegasus Hotel, Georgetown at midnight.

Saturday 16th Nov.

Rest day.

Sunday 17th Nov.

pm. Started the analysis of the Mining Act, 1989. Dinner with Mr I Jackson of BGS. Mr Jackson reported that Dr Petterson had returned to the UK on compassionate leave due to the serious illness of his son. Mr Jackson briefed RCJ on the nature of his visit to GGMC, and the information which he had obtained.

Monday 18th Nov.

By taxi to the GGMC, Upper Brickdam, Georgetown. Mr Jackson introduced RCJ to some of the staff. The study of the Mining Acts of 1979 and 1989 was completed. The 1972 revision of the subsidiary legislation (Mining Regulations) (Laws of Guyana, Cap 65:01) together with some subsequent Gazetted amendments and the Bauxite
Regulations *(op cit. Cap 65:02)* were obtained from the library and analysed. RCJ attended Mr Jackson’s presentation to GGMC staff on digital mapping.

**Tuesday 19th Nov.**

At GGMC. The anticipated meeting (arranged by Dr Petterson) with the Commissioner, Mr Brian Sucré, did not take place, as the Commissioner was out of the office all day. The analysis of the subsidiary legislation was completed. A copy of the annual Gazetted list of current claim licences was acquired and examined. A report for the Guyana Government on land use planning was reviewed (Bishop A R, 1996).

**Wednesday 20th Nov.**

Mr R B Evans telephoned from BGS to Pegasus Hotel at 7.15am to discuss progress in the light of Dr Petterson’s departure. Mr G P Riddler also spoke concerning his contacts with Mrs Liván, Geological Services Manager, GGMC. Mr Evans telephoned again at 11am to GGMC. Mr Woolford, Deputy Commissioner, and Mrs Liván called to enquire on progress, and in response to concerns about access to staff Mr Woolford gave permission for interviews. Subsequently interviews took place with Mrs Liván, who outlined the functions of various members of staff in the licensing process, and with Mr S Edwards, Manager, Mines Division, from whom information was gained on various policy issues.

**Thursday 21st Nov.**

A meeting was held with the Commissioner at 8.30am, at which the mining licensing process and the ideas behind the TDR project were discussed. Mrs R Benjamin-Noble, Legal Officer, was interviewed. Clarification was obtained on some of the legal provisions. Mrs Silvia Johnson of the Cartographic Section outlined the procedure for recording licence or permit area boundaries on the master maps. Mr I Smith, Chief Mines Officer, provided information on the administration of the small-scale sector. At the invitation of the Commissioner RCJ joined him, Mr Woolford and Mrs Liván for lunch, at which conversation ranged widely, including a discussion of variations in gold grain chemistry in the light of recent work at BGS and elsewhere. After lunch a meeting was held with Mr K Persaud, Senior Geologist. Mr Persaud outlined the administrative procedures for the medium and large scale sector licensing, and gave his views on what he would expect of a computer system set up to assist in this function.

In the evening the information gained was re-examined, and a list of questions was prepared to fill any apparent gaps or to gain clarification where necessary.

**Friday 22nd Nov.**

A second meeting was held with Mr Persaud to discuss, *inter alia*, the numerical referencing of claims etc. and the requirement to produce statistics for government on licences/permits issued, revenue received and mineral production. Mr Semple, who runs the small-scale sector computer database in the Mines Division, was not available, however his assistants demonstrated the dBase system, and notes were taken of the structures of the component files. In a second meeting with Mrs Liván the computerisation of information held in the library was discussed. A previous Canadian proposal to do this had not received funding. A brief conversation was held with the
Deputy Commissioner, Mr Woolford, to bid farewell to the organisation, and to express thanks for their help. Mr Woolford reported that an enquiry had been received by GGMC concerning the operation of their mining law most probably from the Commonwealth Fund for Technical Co-operation, though he was not absolutely certain which Commonwealth body, as he did not have the relevant papers to hand. Mention was made of the current moves to revise the mining law.

By taxi to the Airport for a 13.15 check-in, then by Flight BW426 (scheduled departure 16.15, actual departure 17.45) scheduled to fly to Antigua, but diverted to Port of Spain, Trinidad, because of mechanical problems. Connection made there to Flight BW900 to London Heathrow, arriving at 10.40 GMT on Saturday 23rd November.

Acknowledgements

The author acknowledges with gratitude the help and access to information given by Mr Brian Sucré, Commissioner, Guyana Geology and Mines Commission, and his staff, which have enabled the project team to gain insight into the regulation and operation of the flourishing mining sector in Guyana. Dr M Petterson of the British Geological Survey is thanked for organising the visit and Mr I Jackson of the British Geological Survey for providing information.

Reference

APPENDIX C

Report on a visit to the Geological Survey Department of Malaysia

3rd - 11th January, 1997
by R C Jones

Purpose

The visit was to obtain information on the nature and administration of mining law in Malaysia as part of the Overseas Development Administration TDR project 'Geoscience information system for mineral development', project number R6635.

Diary

Friday 3rd January:
To Heathrow Airport by rail, because of snowy conditions, departing Loughborough at 15.45. Departed Heathrow on flight VS502 to Kuala Lumpur at 22.00.

Saturday 4th January:

Sunday 5th January:
I read through the recently-passed Mining Act (federal), the draft state mining enactment and the National Land Code, which had been left for me at the hotel by GSM staff at my request.

Monday 6th January:
Arrived at the Geological Survey of Malaysia, Tabung Haji Bldg, Jln Tun Razak, at 9am. Received by Mr Chu Ling Heng (Assistant Director) and Mr Zulkipli che Kasim (Mineral Information Group) who briefed me on the general structure of the mining licensing system in Malaysia. This is split between the Federal and State Governments. The Geological Survey Department's role in the process is largely advisory. The desire was expressed to use computer technology to improve the accessibility of the Survey's data. A brief meeting was held with Mr Chen Shick Pei, the Deputy Director General.

Mr Chu had arranged a visit to Kuantan, the State Capital of Pahang Darul Makmur, to visit the local GSM office and the various State bodies involved in the issue and administration of Mining Licences. Kuantan had been chosen because of the active gold exploration being carried out in the state. The GSM provided a car and driver, and I was accompanied by Mr Zulkipli. We left Kuala Lumpur at 12.30, arriving at Kuantan at 6pm, and stayed at the Grand Continental Hotel.
3.4.2 Database Design

Future entities that may need to be added to the database are:

1. Fees (in order to track the amount of licence fees due and paid)
2. Amendments (to record any amendments negotiated to the licence)
3. Reports (to record the receipt of reports relating to the work completed)

Specimen design structures for these tables are included in the database but as no data was available they have not been populated. The tables are not shown on the Entity - Relationship diagram (Figure 3) but are connected by one-to-many links to the tblLicença table. The reports from companies are at present kept in a records room in the Ministry and there is a typed list of all 5000 reports. This report list should be entered into a simple database table (tblReport_List), indexed on the existing report number. A link to the tblEmpresa table will enable the amount of typing to be reduced and eliminate redundancy.
Tuesday 7th January:

We were taken to the local office of GSM by car at 8am. Mr Sidi bin Daud, the officer-in-charge, outlined the licensing process and the role of his office in it. A meeting was held with Mr Ruslan of the local office of the Mines Department (federal) at which the role of the Mines Department was outlined. In the afternoon Mr Sidi and Mr Zulkipli took me to see Mr Ahmad Rosdi Abdul Razak, mining manager of PASDEC, a subsidiary of the Pahang State Development Corporation. Mr Rosdi explained how PASDEC had taken out exploration licences on twelve areas, selected on the advice of the Geological Survey as having gold potential. These areas had been sub-leased to local and overseas mining companies, and the first resultant mining venture was about to start operation.

In the evening I discussed what we had found out with Mr Zulkipli, and the prospects for a computerised data management system. We concluded that with the licensing process divided between so many federal and state bodies there was little prospect of establishing a single national system in the immediate future. The GSM seemed to be the only body with an overview of the national mining situation, and any computerisation should help it discharge that role, but would not perform any administrative function.

Wednesday 8th January:

We were taken by car to the local office of the GSM, and after further discussions with Mr Sidi visited the offices of the State Lands and Mines Department, where Mr Jamlus outlined the role of the Department in the issue and administration of licences. Principally this is concerned with matters of land use policy, but the Department also acts as an intermediary between the District Lands Office and the committee of the state legislature, which approves or rejects applications. Finally, a meeting was held with Mr Razak of the Kuantan District Land Office. The Office is the point of contact between the applicant for a licence and the administrative system. It maintains a register and map of all licences granted and files on all applications within its area, and it advises on the availability of land for licensing for exploration and mining. Examples of the documents held were examined, and the data structure noted.

We left Kuantan by car at 11.30am and arrived at the Crown Princess Hotel, Kuala Lumpur at 5.30pm.

Thursday 9th January:

The morning was spent at the hotel analysing the data collected to date. In the afternoon I visited the GSM offices. I was introduced to Mr Hamadi che Harun, Principal Geologist of the Corporate Unit. A meeting was held with the Director General, Mr Fateh Chand, at which the scope of the project and the GSM’s present and future roles in the mining field were discussed. The evening was spent in taking notes from various documents and secondary legislation which had been loaned to me. The possibility of setting up an appropriate data management system and the likely cost was discussed by telephone with Dr J S Coats at BGS.
Friday 10th January:

At the request of the Director General, a meeting was held with the Officer-in-charge of information technology, Mr Seet Chin Peng, to discuss the technical aspects of the proposed computer system. An attempt was made to obtain a copy of the current mining law from a local agent for the government printer, but they were out of stock. At 2.45pm a presentation on the project was made to the Director General. Mr Chen Shick Pei, Mr Chu Ling Heng and several others were also present. Discussion on the preliminary logical data model confirmed that the basic structure accommodated current and projected Malaysia legislation. The ability to link the mining database with their industrial minerals production database was demonstrated. The potential application of the project deliverables to GSM’s need for a computerised management system for their exploration and mining licence data was discussed.

I left the Crown Princess Hotel for Subang Airport at 19.30hr, departing from there on flight VS501 to London Heathrow at 23.55hr.

Saturday 11th January:

Arrived at Heathrow Airport at 05.50hr. By car to Upper Broughton, arriving at 09.15hr.

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Figure 6. Summary Entity Relationship Diagram of the General Logical Model