An Affordable Exploration and Mining Licence Administration System for Developing Countries: Summary Report

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1. INTRODUCTION

The purpose of the project was to develop a simple, adaptable PC-based mineral exploration and mining licence management system, which can generate up-to-date hard copy maps and data, supporting effective mineral sector management and development. Developing countries need to promote and utilise their natural resources for the benefit of their population and 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.

The results of the project are reported in two volumes, a Summary Report and a more detailed Technical Report. This summary report contains an overview of the administration of mining rights, a review of the available software, the design of a generalised database and GIS after study of the systems installed in Malaysia, Botswana and Guyana, and details of the system implemented in Guyana. A summary of feedback and future prospects for implementation of the administration system in other developing countries is included.

The Technical Report covers similar areas but in more detail and includes a technical description of the database and GIS. It is intended for a more specialised readership with detailed technical knowledge of database and GIS design.

1.1 Project Requirement

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.

1.2 Overview of the nature and administration of mining law

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. Angola is an example where such a manual system is possible, because of the lack of exploration during the civil war and the subsequent licences are nearly all active. 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 active and 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 may be overplotted 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.
1.2.1 Computerised Mining Cadastres

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 code for each mineral
- printing current licence maps on demand

The problems of using a computerised cadastre are the higher levels of information technology skills needed to use and manage the system and the lack of a simple paper back-up. A computerised mining cadastre is in two parts; the database and the Geographic Information System (GIS) front-end.

1.3 Review of Software

A review of the most suitable database and GIS software products was undertaken at the project initiation stage, and specific requirements of developing countries were assessed. The main factors considered in choosing a software product for this application are:

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

A general specification for computer hardware and software has been 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. It is sufficient to say that 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 used was changed from Access 2 to Access 97 during the project because of doubts about the date handling ability of Access 2 at and after the millennium.

Geographical Information Systems (GIS) have developed greatly over the last few years and there are now a wide range of packages available from vendors. The same principles were used in choosing GIS software. In terms of wide market acceptance two products, MapInfo and ArcView were the main contenders. ArcView was selected for the implementation in Guyana because of its compatibility with Arc/Info, which was already in use in Guyana, and the familiarity of both BGS and local staff with it.
1.4 Detailed Studies of National Mining Laws

Three countries were visited during the data collection phase, Malaysia, Botswana and Guyana, and these were chosen to give a wide geographical spread and hence variety of administrative systems. It was 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 (available on a CD-ROM from the Multilateral Investment Guarantee Agency (MIGA, 1995)) has been consulted, together with data from other parts of the world, to see if significant differences exist in other countries. The desk studies of mining law showed that despite it reflecting the local mining history in its provisions, there are common patterns in the data. These patterns were analysed, and used to construct a generalised logical data model, the entity relationship diagram of which is shown in Figure 1. A full description of the data model is contained in the Technical Report. In addition, an outline of the functions commonly performed and articles of enquiry for establishing the provisions of the various classes of licence found in mining laws was prepared as aids to the design of the data output facilities of the system for a specific country.

2. PHYSICAL DESIGN OF DATABASE SYSTEM AND GIS FOR GUYANA

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. A checklist has been prepared of the main parameters in mining law which vary between classes of licence and local laws. Both the generalised logical data model and the checklist will minimise the time taken in the design and implementation of new licence management systems as required by developing countries (and for which funding is available) and make it more robust.

With the agreement of the Commissioner of the Guyana Geology and Mines Commission (GGMC) a trial installation of the system was made in Guyana. Guyana was chosen for the trial implementation because of the vigour of the mining industry there, and the complexity of the legal provisions. The legal requirements and administrative procedures were examined in detail. It was agreed that the small-scale mining permits would not be included in the trial for various reasons, including that no locational co-ordinates are 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.

2.1 Implementation Plan

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 worked in practice.

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
Figure 1. Summary Entity Relationship Diagram of the General Logical Model
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 the need for long-term support of the system was discussed.

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 licencing 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 be achieved in a timescale which would be acceptable to the public. 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 systematic approach, which was tried first, involved working through filing cabinets file by file. This method might be appropriate where the bulk of transactions during the transition period are renewals, with very few cancellations and some new applications. Unfortunately a period of civil disorder ensued shortly after the initiation of the data transfer process, which disrupted work, so that 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. The incremental approach, only computerising the paper records when they require some action (renewal, payments recorded or amendment) prolongs the transition period, but does seem more robust. When one licence fee payment cycle (usually 1 year) has been completed a systematic review of the paper files can be undertaken to see which files have not been loaded, the reason for this, and what action should be taken.

The digital capture of the licence area boundaries has to be done systematically to take account of the computing problems posed by shared boundaries. This is where small gaps or overlaps will occur if each area is digitised separately. Figure 2 shows the GIS screen used to validate boundaries which have been digitised. 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.

Once all the stock maps have been digitised and new data added and all paper records captured digitally, the two databases can be sorted and listed by file number. The checking for correspondence between these sorted lists will probably 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 and 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. During this reconciliation process there will be the requirement to continue processing current applications and renewals, which will add to 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.

The data loading procedure has been tested but data retrieval cannot be fully tested until the database loading has been completed. The use of mail-merge to produce official documents directly from the database promises significant efficiency benefits. It is envisaged that some support will be required for perhaps two years while the system comes into full operation, but as the system was installed under project funding such continuing expenditure is not available.
Figure 2. GIS Validation Screen for new Licence Areas
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.

2.2 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. A change to a network operating system, such as to Windows NT, and migrating to future versions of Access and ArcView may involve some changes to the way the system is configured. For security reasons access to the application software and the database structure and information on it should be kept confidential. Careful consideration should be given to the security implications of mounting the system on a networked computer.

3. PUBLICITY AND FEEDBACK

The concept of the integrated database and GIS system to form a licence management system has been seen as necessary and beneficial by all administrations visited during the scoping study. Presentations to mining companies have also produced responses which can be paraphrased as ‘they need to do something to improve their administration’, and favourable comments on what the project has to offer.

The system was publicised through a poster display at the meeting of the Commonwealth heads of Geological Surveys, held at BGS Keyworth in May 1998. Many representatives of these Surveys took descriptive leaflets of the system.

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 geological survey, 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.”

Recent contacts with two non-Commonwealth countries have also generated expressions of interest in the system. The likely limiting factor to take-up is funding, unless a donor organisation can be found to sponsor and fund future installations. The countries which have enquired so far are not likely to be able to fund the work from their own budgets.

A short article on the project has been published in the June 1998 edition of the BGS official magazine Earthwise and a further article 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 geological surveys in developing countries. The BGS Press Office will be distributing a press release on the project on publication of this report, to further publicise the project findings.
4. PROVISIONAL SYSTEM SPECIFICATION AND COSTING

The computer hardware required to run the licence management 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 removable disk drive,
- Good quality A4-format printer (for producing statutory notices),
- A2-format (or larger) digitiser,
- A1 or A0-format printer / plotter.

An uninterruptable power supply unit is also necessary, as sudden power failures can damage the database. The total cost as of September 1998 in the U.K. market is about £5,000. A review of database and GIS software in 1997 concluded that Microsoft Access offered the best facilities for building the database. The current version is Access 97, which is year 2000 compliant, unlike earlier versions. The use of Access 97 implies the use of Windows 95, 98 or NT. Experience has shown that the automatic generation of documents from the mining licence system provides a major boost to administrative efficiency, using Microsoft Access to provide data for mail-merge in Microsoft Word. The current versions of both Map Info and ArcView were found to provide adequate GIS facilities and ArcView was chosen because of compatibility with existing systems in Guyana. The current cost of this software in the UK market is about £1,500.

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 BGS could undertake the work for about £60,000, based on costs at early 1998 levels.

5. RESULTS

This study has demonstrated that it is possible to construct a broadly-based logical model of the data pertaining to mining law administration based on the legislation and practice of many countries. Differences in mining law often reflect the differences in mining history of countries. Where alluvial mining has been prevalent the law is usually weighted towards regulating that sector and not the underground mining sector, and vice versa. Notwithstanding this, many of the core areas of the legislation are similar in their requirements and operation.

Conversations with the staff of mining companies have confirmed the view that in many places the manual processing and recording of exploration and mining licence data leads to a slow service and poor access to historical data. The implementation of programmes of computerisation would seem to be generally timely in meeting a declared need. 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 the licence management system will complete the system.

By concentration on the types of computer hardware and software, which are known to be supported in almost every developing country, as the platform on which the mining licence
system functions, it has been possible to minimise the capital costs of the system and to maximise the sustainability.

The major benefit of the project to developing nations is that there is now a readily available system for the computerisation of mining law administration. The cost to countries and donors is likely to be significantly less than would be paid for a bespoke system. The general logical model which has been developed can be customised to meet local needs by the elimination of attributes and the amalgamation of entities. The framework provided will help to identify aspects of the legal and administrative process which otherwise might have been missed, substantially reducing the time taken to establish the relationships between attributes and entities. Finally 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 will improve the access of small mining enterprises and multi-national mining companies to information on land available for exploration.

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. Some relaxation of formal data integrity may be essential if the transfer of the database is to be accomplished in a realistic timescale. Generally, such gaps in 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 a few 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. Such a period of overlap between the manual and computerised system is also recommended for sustainability reasons. The input of licence area boundaries from maps has to be undertaken systematically, and as the paper records are not tied to the maps of licence areas, there will be a further period of data checking to correct inconsistencies.

It should be noted that in addition to Guyana where the test implementation was set up, three other countries have expressed serious interest in obtaining the mining licence system even before the report is published. It is concluded that the potential for using this research and development project for meeting a clear need of developing countries is very high.
5.1 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.
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