Ministry of Energy, Mines
and Petroleum Resources
Hon. Anne Edwards, Minister

MINERAL RESOURCES DIVISION
Geological Survey Branch

MINFILE - A Mineral Deposit Information System for British Columbia

by L.D. Jones and C.B. McPeek

Information Circular 1992-2

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ABSTRACT

Information on mineral deposits in a country or province is valuable to the mining industry and essential for government planning, particularly when it is easily stored, searched and distributed. The British Columbia Geological Survey Branch maintains a comprehensive mineral inventory database of over 10 500 metallic, industrial mineral and coal occurrences, known as MINFILE. This database has evolved over the past 20 years from a simple card-based file to a powerful mainframe and microcomputer-based geoscience information system. Each occurrence record contains 43 data elements which describe mineral deposits in terms of geography, geology and economics. The data elements are organized within a relational database management system and application development software, and operate within both mainframe and micro-computer environments. The strength of the MINFILE system is its ability to efficiently and easily search, sort and manipulate data in various information fields, which include *location, tectonic belt, commodity, mineralogy, host-rock name and age, deposit type, lithology, production,* and *reserves*. An expanded geological description in text form is in the *capsule geology* and information sources are included in the *bibliography*.

The MINFILE database is available to a diverse and vast user-community through MINFILE/pc, a menu-driven data-entry, search and report program for the IBM/PC-compatible computer. This program is used to provide answers to specific queries, such as the relationship between mineralization and geologic features of an area, thus forming a basis for prospecting, ground acquisition and other geoscience and environmental research.

MINFILE/pc helps provide solutions in mineral exploration, land-use planning and mineral resource management. Industry geologists may use MINFILE to better predict the location of new mineral deposits; land-use experts query MINFILE and channel extracted data into external support systems to make informed land-use decisions. A comprehensive mineral inventory database is an invaluable tool for academic research in metallogeny and related disciplines. MINFILE information may be used in other programs such as word processors, plotted using computer-aided mapping systems, and integrated with conventional Geographic Information Systems. MINFILE data are sold in both hard-copy and digital formats and the MINFILE system is licensed for sale worldwide for use by other geological surveys.

ACKNOWLEDGMENTS

We would like to acknowledge the contributions made to the project by Brian Grant, Gordon Lowe, Allan Wilcox, and the MINFILE team, both past and present, including David Ballantyne, Shielagh Banfield, Laura de Groot, Dorthe Jakobsen, George Owsiacki and Garry Payie. Also a significant contribution to the project was given by staff of the Geological Survey and Information Services branches.

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1. INTRODUCTION

The purpose of this paper is to describe the historical, present, and future development of the MINFILE system. MINFILE, as a computerized mineral inventory system, represents a readily accessible information base for describing the nature and distribution of over 10 500 mineral occurrences within British Columbia. This information is used in geoscience research, mineral exploration, prospecting, land-use management and a host of related applications requiring data on the Province's mineral resources and production. The geological understanding of mineral deposits helps provide a major stimulus to mineral exploration, leading to the discovery of new ore bodies.

The MINFILE project is dedicated to ensure that information in the database is up-to-date, complete and easily accessed. The system must be robust, functional, user-friendly, flexible and well documented. The foundation of the MINFILE system facilitates the use of standard formats and specifications, and its data model permits accommodation of other applications and environments. Future developments will build on enhanced platforms, communication protocols, data formatting and functionality in the end-user application process.

1.1 General Comments on Mineral Databases

A mineral database is an organized inventory of data related to mineral occurrences, which are considered to be any known, naturally occurring concentration of a metallic or non-metallic mineral commodity. A mineral occurrence is defined as in-situ bedrock or placer mineralization, either on surface, in drill holes, or in underground workings. A database management system (DBMS) consists of a database and a set of programs to use the database. The primary goal of a DBMS is to provide a structured environment that is both convenient and efficient to use in storing, accessing and reporting data. A well-organized mineral database will represent a readily accessible information base for describing the nature and distribution of mineral occurrences.

When establishing a database, a designer should take into consideration how the data will be used and who will be using the data. Proper management of digital data sets will improve access, retrieval, duplication and distribution costs, accommodate the safe storage of large volumes of data, and improve the ability to integrate with other databases. The mineral occurrence data should be available in standard, compatible file formats and data structures. Data use will increase with the increase in data accessibility and quality.

In a database file, all the data for a particular entry is called a record. Each item of information within a record is called a field. For example, in a mineral occurrence database file, each record contains all the data for one occurrence, which contains fields for the occurrence name, commodity, location and others. The database file is defined by a database structure. This includes the names of fields in a record, the number of characters in a field, and the type of information allowed in each field. Each record must contain a database key which uniquely identifies each record. The data dictionary contains details of the structure of the database, definitions of the contents of each field, and listings of acceptable entries for fields of explicit content, such as a mineral field in which entries are limited to a standard list of mineral abbreviations.

The systematic, consistent, standard and structured organization of data is important to prepare for the integration of data into more sophisticated systems at a later date when such are required and available.

2. HISTORICAL DEVELOPMENT

The database is over 20 years old and has evolved from a simple card-based file to a powerful microcomputer-based geoscience information system. In 1967, the Geological Survey Branch maintained a manual, mineral-inventory card file with one card per occurrence. It included *identification, location, historical, geological,* and *reference* information (figure 1). The card file system was difficult to use and maintain and lacked geological information, so, plans were made to redesign and computerize the system.

MINERAL DEPOSIT INVENTORY

Map No. 104B-21 Property No. 3302

Metal ☒ Industrial Mineral ☐ Placer ☐ Coal ☐ Lapidary ☐

Name: Granduc Mine

Claim ____ Owner ____
Operator ____ Year(s) ____

Claim ____ Owner ____
Operator ____ Year(s) ____

Claim ____ Owner ____
Operator ____ Year(s) ____

Location: N.T.S. 104B/1W Lat. 56°13.0' Long. 130°20.8' U.T.M. ____
M.D. Skeena In park ____ E. & N. ☐ El. ____
Loc. plot. ____ Source ____ Prec. 1

Status: Producer ☒ Dev. Prospect ☐ Prospect ☐ Showing ☐

Production: Tons 6,491,898 Grade: Au 23,243 oz Ag 1,476,742 oz Cu 153,422,617 lb ... Zn ...
Others ____ Year(s) 1970 to 1973
Reserves; Tons 32,951,000 Grade 1.64% Cu Year 1973
Tons ____ Grade ____ Year ____
Tons ____ Grade ____ Year ____

Development: Surface ____
Underground 40,146'
Drilling 68,273'
Surveys: Geol. ____ Geophys. ____ Geochem. ____

References: M.M.A.R. 1931-47, 1953-82, 1956-15, 1961-8, 1962-8, 1964-18, 1965-44, 1966-38, 1967-31, 1968-46
Expl. Form 1974
G.E.M. 1969-54, 1970-66, 73, 1971-34, 1972-514, 1973-497, 1974 - 532
As. Rpt.: L.C. ____ Prosp. ____ D.D. ____ Other ____
Geol. ____ Geophys. 3739 Geochem. ____
Geol. and maps Preliminary Map Granduc - 1956, NMI.Cul-

Summary description mineralized shear zones in metaseds.

Attitude of deposit: Strike ____ Dip ____ Azimuth ____ Plunge ____
Size: Length ____ Width ____ Depth ____

Minerals Chalcopyrite, pyrite, pyrrhotite, magnetite, galena, sphalerite, arsenopyrite.
Economic minerals ____
Assays ____

Remarks ____

Recorded by pg 4/71 Revised by ____ Lib. Res. Comp. ____

BRITISH COLUMBIA DEPARTMENT OF MINES AND PETROLEUM RESOURCES

Product(s) Cu, Ag, Fe, Au, Co
Map No. 104B-21
Property No. 3302

Figure 1 - Example of a manual card.

In 1973, a research project was initiated with the Department of Geological Sciences at The University of British Columbia. The goal was to develop a computerized mineral deposit data file and to design methods for data retrieval and manipulation. Information on the card file was incorporated into the computerized file, called MINDEP. In 1976, MINDEP was transferred to the B.C. Geological Survey Branch, Ministry of Energy, Mines and Petroleum Resources and renamed MINFILE. In 1981, a forced conversion of the programming and system file structure to the IBM mainframe resulted in increased costs. Batched queries were very expensive and consisted of a limited combination of searches, which included one of deposit type, mineral code or commodity, combined with one of map sheet ID, NTS map or mining division.

The Geological Survey Branch initiated a redesign of MINFILE in 1984 to update the file and to establish a better knowledge base for mineral inventory data. The system redesign centered around a table-driven, relational database schema with third and fourth generation computer languages for the VAX minicomputer. The additions included new multiple-fields containing extensive mineralogical and geological data. Comment fields were expanded and allowed input of unlimited amounts of textual information. The main objectives were to update the existing information, expand the geological content, eliminate system conversion problems, develop an interactive and user-friendly system, improve search capabilities, control excessive computer costs, download data to micro-computers, provide graphic output links, and provide a lead into 'expert' systems. With the help of funding by the Canada/British Columbia Mineral Development Agreement, several geologists were hired to research and to input coded data to the redesigned database.

2.1 MINFILE/vax - 1987-1991

The MINFILE database design uses an *entity-relationship* model comprised of tables of codes (entities) with interrelated tables of deposit data containing MINFILE numbers as the key element.

MINFILE/vax data resided in a directory driven database management system (DBMS), known as SUPRA and the user interacted with the database through Logical User Views (LUVs), which were interfaced between the physical data set and either third or fourth generation programming languages, such as COBOL, FORTRAN, SPECTRA, or MANTIS. SPECTRA, although ideal for custom queries because it navigates easily on the database, is costly on the mainframe system and is not accessible to all users.

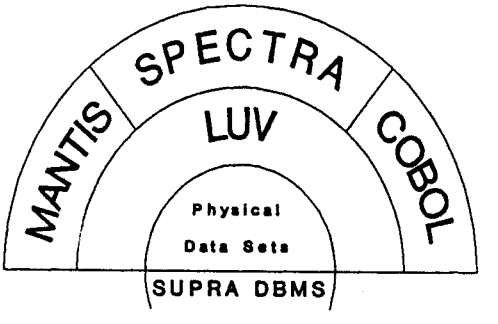

Figure 2 - The VAX system model.

Recently, MINFILE/vax operated on a DEC-VAX 8850 mainframe computer, using the VMS operating system.

2.2 MINFILE/pc - 1987-1991

MINFILE/pc, Version 1.0 was released in November 1987. It was developed initially to reduce search costs on the VAX system and make the database more accessible. This menu-driven program searched 20 prime aspects of the database. MINFILE/pc, Version 2.0, released in March 1989, saw the addition of a reports module, which produced tabular,

capsule geology, bibliography and master reports. A geographic mapping program known as QUIKMap, by AXYS Software Ltd., is used to plot mineral inventory maps at a 1:250 000 scale, with 1:50 000 scale inserts when required. MINFILE/pc, Version 2.13, released in September 1989, included a new production report, a parcelling utility, a faster commodity search, and other enhancements to Version 2.0.

MINFILE/pc, Version 3.0, released in July 1991, offers numerous enhancements over the previous releases, including simpler installation and packaging of data, a data entry and browsing system, the ability to append and delete sets of occurrences, expanded reporting, and application wide performance improvements. Users may edit, update and append their own data using a user-friendly interface with pull-down menus and pop-up windows. A highly efficient text searching system, using software from Proximity Technology Inc., allows automatic input of codes to the database. Other new features include a code table maintenance system and the ability to transfer, compare and update database changes to another PC using floppy diskettes.

3. MINFILE DATA

The content of MINFILE emphasizes information useful in economic geology/resource management applications, reflecting part of the mandate of the British Columbia Mineral Resources Division, which is, to provide industry with the data and maps to encourage and promote mineral exploration in the province. The MINFILE database contains current and historical geological information on metallic, industrial mineral, and coal occurrences. Each occurrence record contains 43 data elements which describe a mineral deposit in terms of *location, tectonic belt, commodity, mineralogy, host-rock name and age, deposit type, lithology, production,* and *reserves*. An expanded geological description in text form is in the *capsule geology* and information sources are included in the *bibliography*. The data elements are organized with a set of codes, using a relational database management system and application development software. Collectively, this information forms an excellent database that may be used to evaluate mineral occurrence characteristics and distribution. The information in the database has been upgraded and updated by experienced geologists over the last several years.

A MINFILE occurrence is defined as in-situ bedrock or placer mineralization, either on surface, in drill holes, or in underground workings. It does not include float, geochemical or geophysical anomalies. Coding information for the MINFILE database is generally carried out within a 1:250 000 scale National Topographic System (NTS) area. The steps involved include assembling general NTS basemap information, obtaining information on existing mineral occurrences from previous records and files, and communicating with geologists with expertise in the area. Historic information cited includes Ministry reports, published articles and industry assessment report data.

Several fields in the MINFILE database, such as the *commodity, mineralogy* and *lithology* fields, are listed in decreasing order of importance. The status or stage of development of the occurrence is recorded as *showing, prospect, developed prospect, producer* or *past producer*. Deposit types are handled by ranking four entries in the following two fields: deposit character, which is derived from field observations; and deposit classification, which is an interpretation of the genesis of an occurrence.

4. MINFILE/pc SYSTEM OVERVIEW

MINFILE/pc is a modular-based system with sub-systems consisting of search, report, data entry, data transfer, utility and code table maintenance modules. The flexibility of the system allows for easy upgrading, replacing with new technology or adding new modules. The strength of the MINFILE/pc system is its ability to efficiently and easily search, sort and manipulate data entered into information fields. MINFILE information can be plotted using computer-aided mapping systems (CAD) or integrated with geographic information systems (GIS). Editing, updating and appending new mineral occurrences is possible with the new data entry module and the revised information may be transferred to other computers. Figure 3 illustrates the various modules and menu functions.

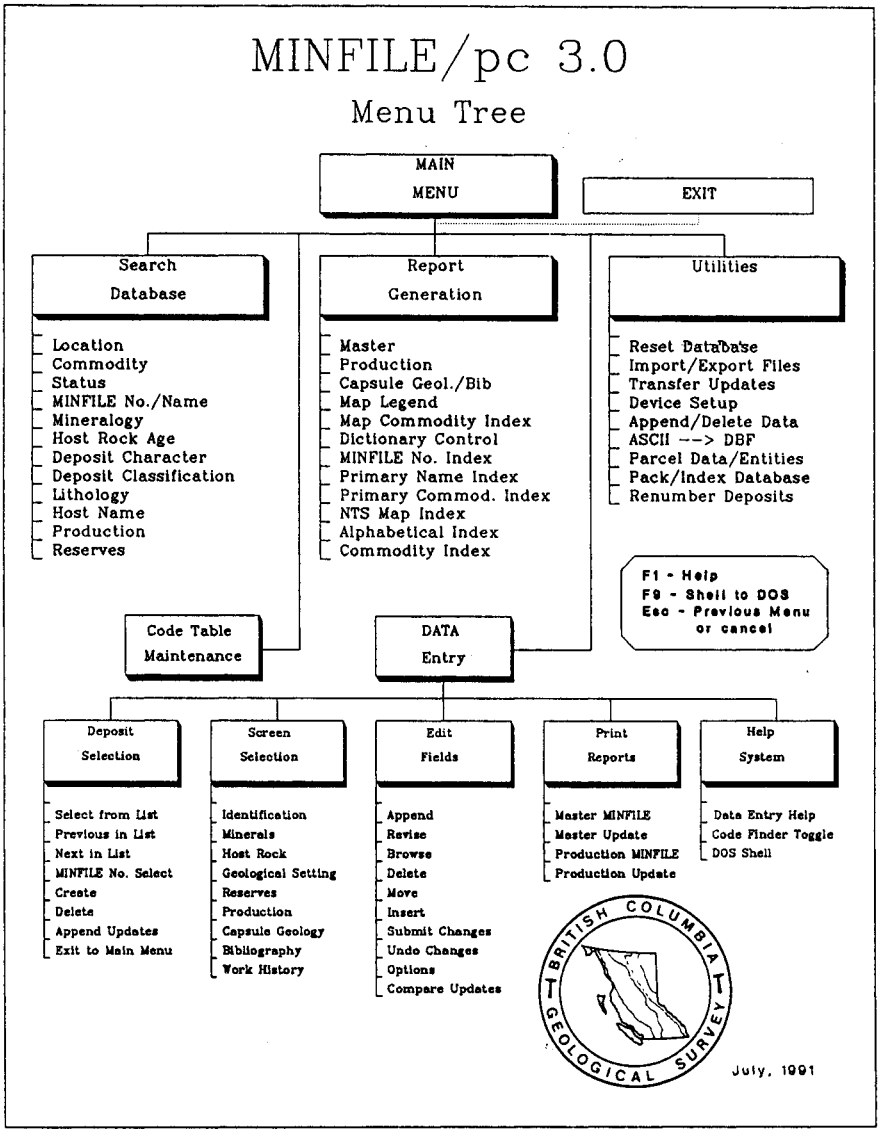

Figure 3 - MINFILE/pc, Version 3.0 menu tree.

4.1 System Requirements and Components

MINFILE/pc is a stand-alone, menu-driven program, operating within 640 kilobytes of RAM, in the MS-DOS environment of IBM-compatible microcomputers. The program requires MS-DOS Version 3.21 or higher, a 1.2-megabyte, 5.25-inch floppy drive, and a

hard-disk drive with sufficient space to accommodate a configured data set. The MINFILE/pc system requires 2.0 megabytes of disk space and the data require about 10 megabytes of disk space per 1000 occurrences. The province wide database of over 10 500 occurrences currently occupies 53 megabytes of space. MINFILE data are distributed in ASCII files, which are configured into searchable database (dBASE) files with indices. The ASCII format, along with a data dictionary, allows flexibility for use in many database management systems.

The MINFILE/pc program is written and compiled in FoxBASE+. R&R Relational Report Writer is used to generate the reports. These programs are delivered as stand-alone runtime versions. A program called Friendly Finder (purchased separately from Proximity Technology Inc.) may be used with MINFILE/pc to import the MINFILE codes directly into the search screens. An installation program is distributed as an executable file used for automatically loading the MINFILE/pc system onto a hard disk.

Other components to the MINFILE/pc system are the entities and data files (appendix A). The entities, also referred to as tables, contain 28 files of all MINFILE codes and descriptions, which apply to the entire Province of British Columbia. These codes, versus full text, save computer file space and result in substantial improvements in database access and file management. A licensed utility from Proximity Technology Inc. allows users to automatically enter codes into the database. The data files consist of 29 related files and 12 comment or text files.

5. THE SEARCH-AND-REPORT SYSTEM

5.1 General Overview and Features

MINFILE/pc has the ability to interrogate the provincial database and break it into a variety of manageable subsets. Searches are conducted by inputting parameters into the simple, user-friendly screen menus. Information files are then created which can be saved for future reference, to produce mineral occurrence distribution plots or to generate reports on the search results.

5.2 The Search System

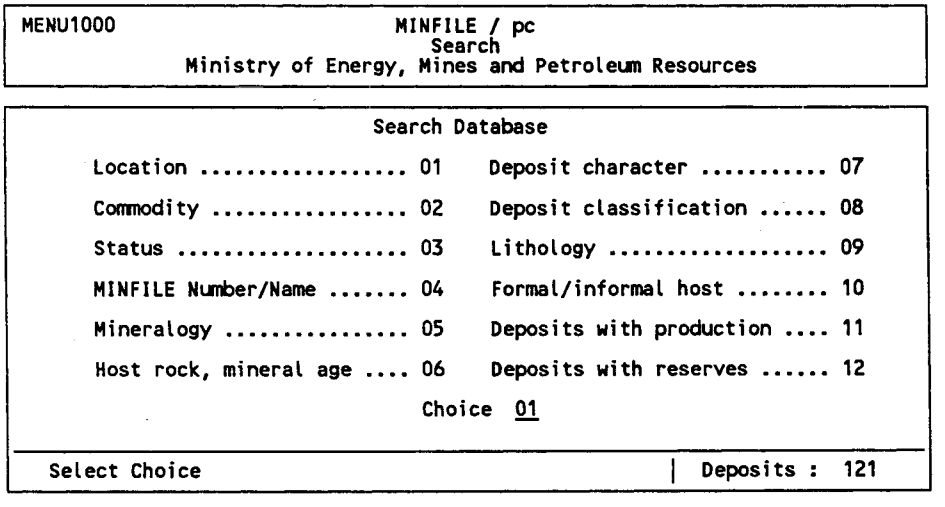

Figure 4 - Search menu screen.

The MINFILE/pc program employs 12 coordinated search screens (figure 4). The first search criterion is usually location, which incorporates search criteria on latitude/longitude, UTM coordinates, NTS map sheets, mining divisions, tectonic belts, physiographic regions or terranes (figure 5). Other search criteria may be selected from commodity, development status, deposit name, MINFILE number, mineralogy, host rock or mineralization age, deposit character, deposit classification, lithology, formal/informal host rock, deposits with production or, deposits with reserves. On most of the screens, search parameters are entered into the program using Boolean logic (AND, OR, NOT) expressions (figure 6).

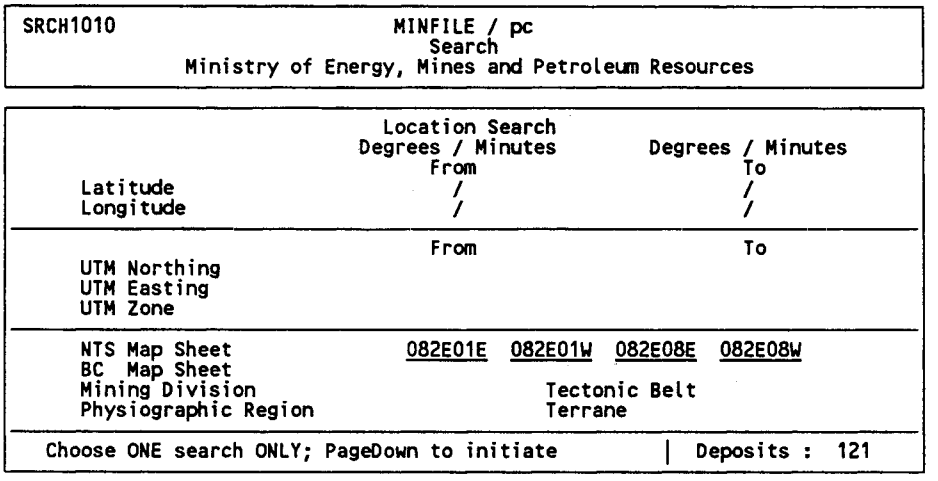

Figure 5 - Location search screen.

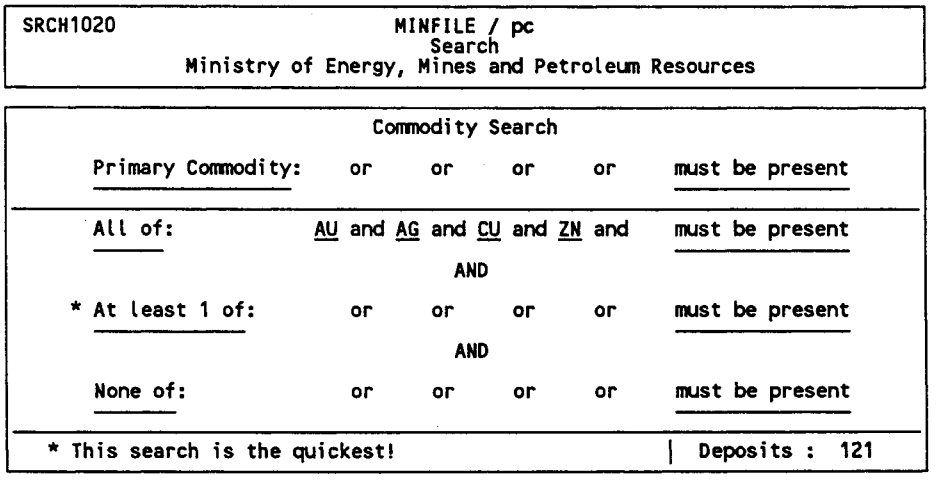

Figure 6 - Commodity search with Boolean logic.

5.3 The Report System

Reports resulting from a MINFILE/pc search may be directed to the screen, a file or a printer. They include a master report (appendix B), which contains all data for each occurrence with the exception of production figures, a production report (appendix B), a capsule geology/bibliography report, a map legend report, which includes a customized commodity legend, a data dictionary control report and tabular reports, which are sorted by MINFILE number, primary name, primary commodity, NTS map, all names and all

commodities (figure 7). Output as ASCII files and on EPSON and HP Laser printers are supported.

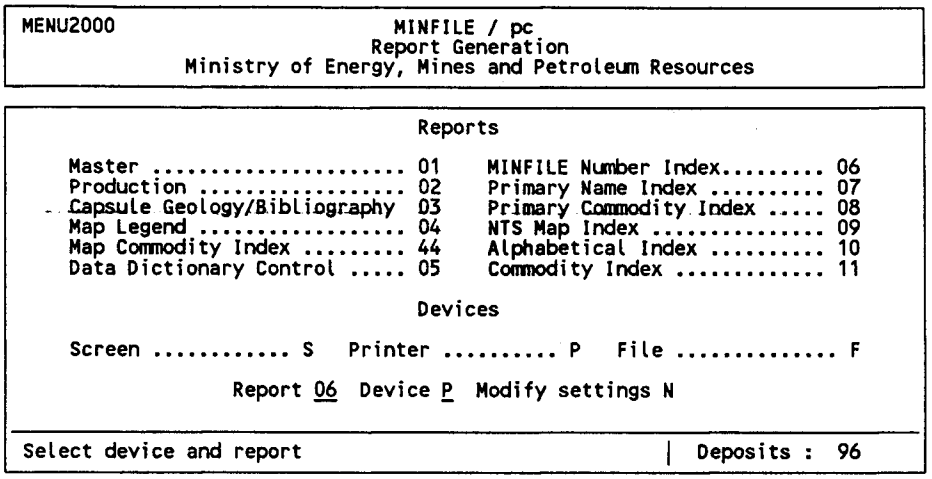

Figure 7 - Report screen.

6. UTILITIES AND CODE TABLE MAINTENANCE

6.1 Utilities

MINFILE/pc utilities provide a series of functions which assist in setting up the database, exporting and importing data, and maintaining and configuring the system. They include the ability to configure and reset the database, import/export search files, import/export updates to the database, setup devices, append/delete mapsheets, parcel search results, pack/reindex the database and renumber a MINFILE occurrence (figure 8). A graphical interface file in standard data format (.SDF) or dBASE format (.DBF), may be produced from the import/export search file function under the utilities menu. This file, which may be used for plotting, includes MINFILE number, primary name, commodities, status, latitude/longitude, UTM coordinates and NTS map number (figure 9).

The parcel utility allows a user to create a customized data set using any of the search parameters of MINFILE/pc. For example, if you want a data set of all copper occurrences in B.C., the commodity copper is searched and subsequently parcelled. This parcelled subset may be configured with MINFILE/pc, which becomes the default (or starting) data set for further searching and reporting. Also the subset may be loaded onto another computer using the append mapsheet function of MINFILE/pc. Effective use of the utilities in MINFILE enables the user to manipulate the efficient and flexible transfer of data among MINFILE systems, CAD and GIS systems and commercial software packages, such as spreadsheets and word processors.

6.2 Code Table Maintenance

MINFILE/pc code table maintenance allows the users to add, delete and modify the contents of the various codes and tables used within MINFILE (figure 10). This function has restricted access as minor changes to the tables can adversely effect the distributed data. Users who update the MINFILE database are required to formally submitted all requests for modifications to existing tables to the MINFILE central office for approval and processing.

```
MENU3000                    MINFILE / pc
                              Utilities
            Ministry of Energy, Mines and Petroleum Resources

                          Utility Choices

      Reset total deposits ....... 1    Configure ASCII to DBF ..... 6
      Import/Export search file .. 2    Parcel search data/entities  7
      Import/Export updates ...... 3    Pack/reindex database....... 8
      Device setup ............... 4    Renumber MINFILE occurrence  9
      Append/Delete mapsheets .... 5

                            Choice 7

 Select utility                                  | Deposits :  121
```

Figure 8 - Utilities screen.

dBASE structure for GRANDUC.DBF

Field	Name	Type	Length	Content	Field	Name	Type	Length	Content
1	Minfilno	Character	9	104B 021	11	Status_c1	Character	4	PAPR
2	Name1	Character	30	GRANDUC	12	Utm_zone1	Character	2	09
3	Commod_c1	Character	2	CU	13	Utm_east1	Character	6	416700
4	Commod_c2	Character	2	AG	14	Utm_nort1	Character	7	6230200
5	Commod_c3	Character	2	AU	15	Ntsmap_c1	Character	7	104B01W
6	Commod_c4	Character	2	PB	16	Lat_deg1	Character	2	56
7	Commod_c5	Character	2	ZN	17	Lat_min1	Character	2	12
8	Commod_c6	Character	2	CO	18	Lat_sec1	Character	2	41
9	Commod_c7	Character	2		19	Long_deg1	Character	3	130
10	Commod_c8	Character	2		20	Long_min1	Character	2	20
					21	Long_sec1	Character	2	35

Figure 9 - Exported search file for plotting.

```
MENU5000                    MINFILE / pc
                          Code Table Maintenance
            Ministry of Energy, Mines and Petroleum Resources

                  Code Table Maintenanee Choices

 01 Status Types          11 Terranes              21 Dating Methods
 02 Dominant Host Rocks   12 Physiographic Areas   22 Stratigraphic Names
 03 Deposit Modifiers     13 Metamorphic Types     23 Stratigraphic Ages
 04 Deposit Characters    14 Metamorphic Grades    24 Rock Types
 05 Deposit Shape Types   15 Metamorphic Rel'ps    25 Rock Modifiers
 06 Deposit Classific'ns  16 Years                 26 Ore Zones
 07 Mining Divisions      17 Commodities           27 Sample Types
 08 NTS Mapsheets         18 Mineralogy Classes    28 Reserve Categories
 09 BC Mapsheets          19 Minerals              29 Exit
 10 Tectonic Belts        20 Alteration Types

                            Choice 19

                                                  | Deposits :  121
```

Figure 10 - Code table maintenance screen.

7. THE DATA ENTRY SYSTEM

The purpose of the MINFILE/pc Data Entry system is to provide users with a process to browse, create, alter or delete mineral occurrence data in the MINFILE database. The

major functions of the system include selecting an occurrence, screen or edit mode, obtaining help, and comparing updates. It also contains a report output function to enable a user to produce a master or production report on the occurrence they are presently viewing. Figure 11 shows the integration and processes of the data entry system. The primary users of MINFILE/pc's Data Entry system will be research geologists, typically employees of the Geological Survey Branch, who update the MINFILE database. The system may also be distributed to geologists working in the field and clients in the mining industry for their own use.

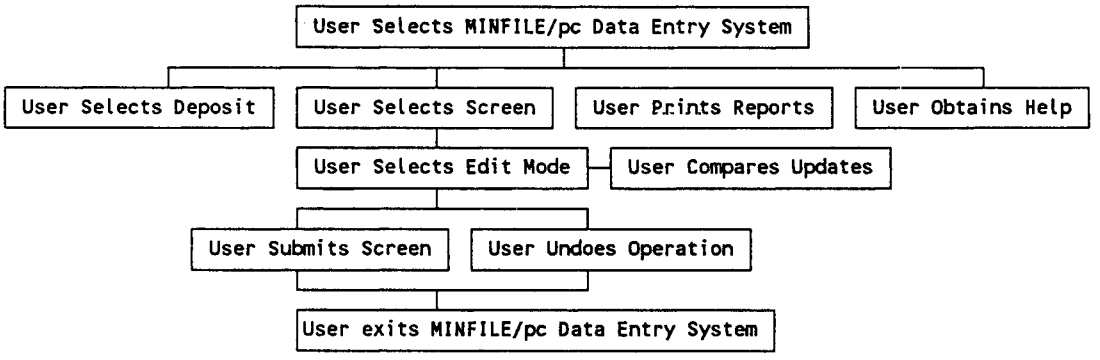

Figure 11 - Data-entry system flow chart.

The MINFILE/pc Data Entry system is integrated into the MINFILE/pc Search-and-Report system. The system boasts a user-friendly interface with pull-down menus, pop-up windows, and non-ambiguous error messages (figures 12 and 13).

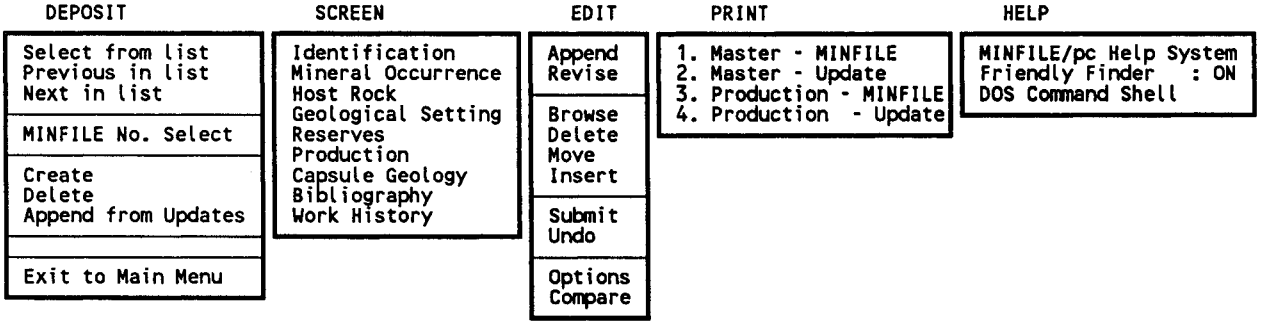

Figure 12 - Data-entry system pull-down menus.

An efficient text searching system, using software from Proximity Technology Inc., allows automatic input of codes to the database (figure 14). The text fields (capsule geology and bibliography) are revised or added with a text editor of the user's choice. A compare routine is used to compare the currently displayed screen with data on the same occurrence previously imported from other users' diskettes. It highlights fields to show differences between the occurrences and aids the user in detecting changes to the data.

8. HELP SYSTEM AND DOCUMENTATION

Proximity-Scan is a pop-up code finding utility built into the data entry system. The user enters part of the full field description of the code and the program will find the closest matches. Codes are automatically entered into the database and, therefore invisible to the user (figure 14). An end-user license agreement is necessary. Proximity-Scan is the

software engine behind another program called Friendly Finder, which may be purchased separately and customized to work with the MINFILE/pc database. It is useful for looking up codes during the searches and carrying out searches directly on database files. Other uses include incorporating dictionaries for spell checking and direct searches for keywords on capsule geology and bibliographic text fields. MINFILE/pc also has several help screens on how to use the system (figure 15 is an example).

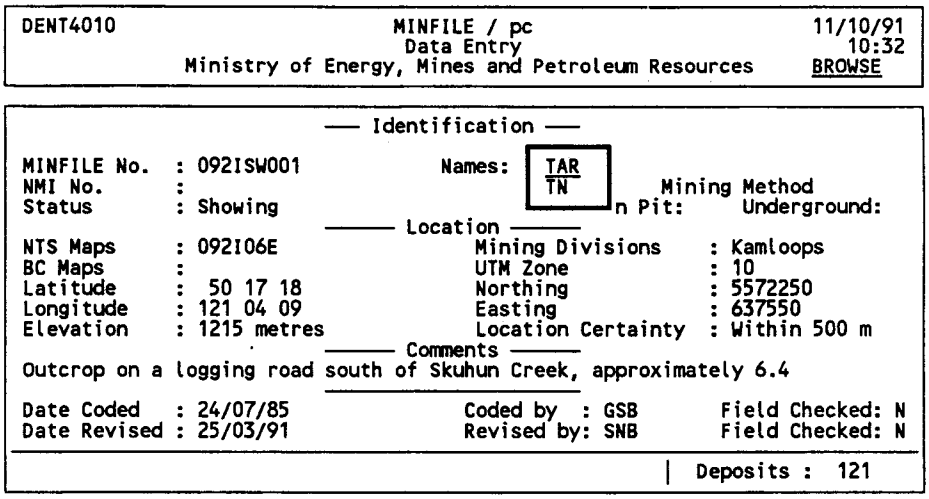

Figure 13 - Data-entry for identification screen.

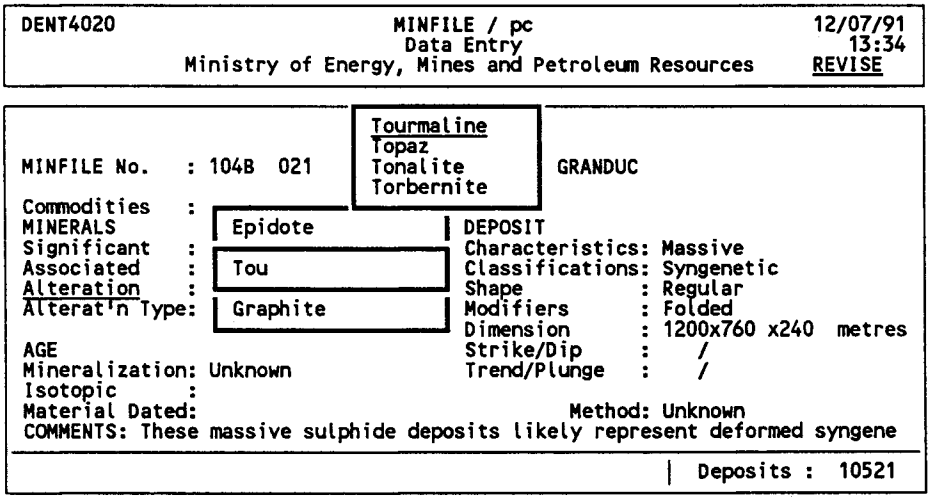

Figure 14 - Data-entry screen showing use of Proximity-Scan for code table look-ups.

Although location information in MINFILE is in both Universal Transverse Mercator (UTM) coordinates and Longitude/Latitude, the user needs only to enter one as a program converts one to the other. Supporting documents for MINFILE/pc include a coding manual, which details the characteristics, editing factors and limitations of each data field and a user's manual, which describes the search, report and data entry systems of MINFILE/pc, Version 3.0. Maintenance and technical documents are also available.

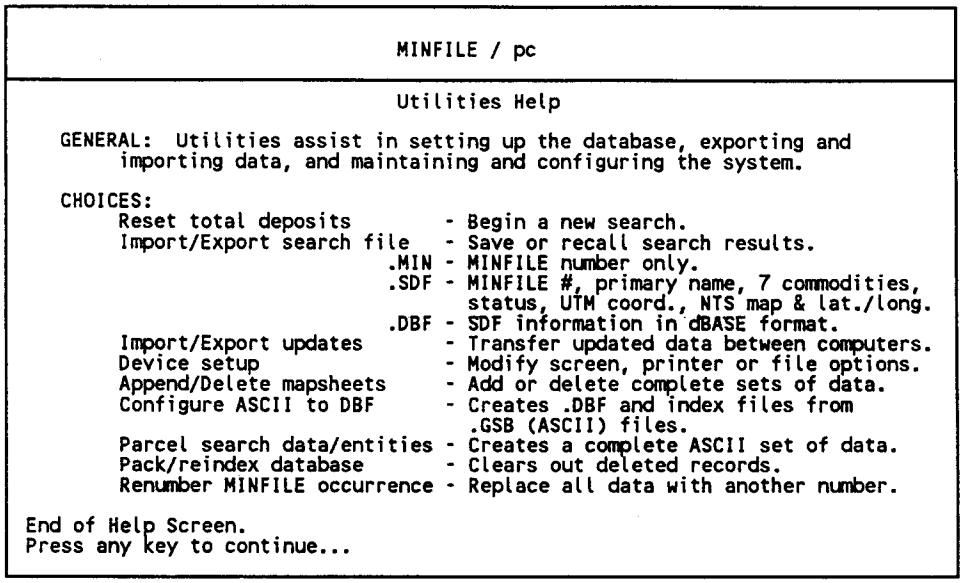

Figure 15 - Example of the Utilities help screen.

9. USES OF MINFILE

The power of MINFILE lies in the flexibility of its relational structure and the simplicity of the user-interface of the MINFILE/pc program. The scope for manipulating the database to develop new perspectives on the distribution of mineral occurrences is limited only by the imagination of the user. MINFILE/pc results may range from mineral occurrence listings generated from simple searches to complete reports from complex searches which identify environments similar to major new mineral discoveries.

9.1 System Users

The program is widely used as an inexpensive research tool by industry, academic researchers and government. MINFILE has one of its greatest applications in area selection for exploration or research projects. This selection process incorporates careful analysis of the geology, metallogeny and distribution of mineral occurrences within a broad region. From this analysis, patterns may emerge showing the association of mineral occurrences with specific geological settings. Mineral occurrence distribution and graphical plots of the data lead to further research to help select prospective areas for mineral potential. A variety of multivariate statistical procedures may be used to define data sets with potential high priority exploration targets.

MINFILE is routinely used to identify mineral values in land-use planning areas. In British Columbia, proposed parks must first be assessed for their mineral resource potential. Legislators and policy advisors also require basic resource information for the development of rational and far-sighted policies. Other users of the database include those active in acid rock drainage studies, litigation issues, and dissemination of public information. MINFILE data are also used by in-house research geologists to supplement various reports and publications.

MINFILE is a compilation of historical and current exploration data, and thus is sometimes limited by incomplete, inaccurate or ambiguous reporting. An appreciation of the way MINFILE data are recorded permits the user to draw meaningful conclusions

regarding the significance of the occurrence and the data. Users of the MINFILE system should understand how the data are collected and stored before attempting to "navigate" and query the database. For example, if interested in alkaline porphyry gold deposits, the user should search on modifiers typical to the model. In this case, search parameters could include copper, gold, diorite, syenite, monzonite, and possibly alteration or age parameters. Such an approach would bring the user closer to expected results and leave less chance of missing occurrences resembling the desired ore deposit type.

9.2 Some Search Examples

The following are examples of queries that may be handled efficiently by MINFILE/pc:

1. List mineral occurrences representative of Kuroko-style stratiform, volcanogenic, massive sulphide deposits.
2. Provide a file for plotting all mineral occurrences in the Intermontane Belt that contain both copper and gold, but no molybdenum, lead and zinc.
3. Find similar occurrences to an epithermal deposit, containing quartz, dolomite and pyrite as alteration minerals within tuff, limestone and breccia of Permian age.
4. Extract production and reserve data for gold skarns within different geological terranes.
5. Produce a complete report on all copper deposits with reserves over 1 000 000 tonnes with a grade over 1.0 per cent.
6. Compile all references related to a historical mining area.

A MINFILE Geological Workstation

The flexibility and usefulness of the modular design of MINFILE/pc is shown in the generation of the following custom report. A search on skarns in the Province of B.C. was performed and a complete report generated. An expert reviewed the report and edited the data with the data entry module. The search was repeated and a graphical interface file was saved for plotting purposes. A set of data was parcelled from the provincial database and reconfigured to contain only the 700 skarn occurrences. An analysis on production figures for different skarn types within tectonic belts was graphically presented. MINFILE/pc was used to create *flat* files in dBASE format which was the basis for a custom report. The result was imported to a word processor for final editing and a summary tabular report was used in the appendix of a paper on skarns in B.C. Part of the report is shown here.

MAP NO.	MINFILE NUMBER	NAME(S)	LATITUDE LONGITUDE	METALLIC ELEMENTS	ALTERATION MINERALS
316	092K 115	PELICAN CORMORANT	50 11 49 125 15 16	CU	Epidote Garnet Amphibole Quartz Calcite
317	092K 141	NAT 4 GREAT GOLD	50 13 01 125 16 15	AU AG CU WO ZN	Diopside Garnet Carbonate Silica

9.3 Data Management

Integration of the appropriate software allows for the effective transfer, manipulation and display of information (see A MINFILE Geological Workstation). MINFILE reports may be imported into word processors to be used as appendices for geological papers. Parcelled or exported sets of data may be reconfigured for custom data sets. Saved search and report files may be edited using a text editor then imported back into MINFILE for reporting or, imported into other programs for custom reports. Search results may be statistically manipulated and displayed using graphic presentation programs. Representation of the data, as histograms, statistical charts, tabular reports and thematic maps, provides a quantitative and qualitative analysis of the frequency and distribution of mineral occurrences and ranking of information.

10. BUDGET AND MARKETING

10.1 MINFILE Staff and Budget

The MINFILE team consists of a Senior Geologist who leads the project and reports to the Manager of the Geoscience Information Section; a Database Administrator who maintains and monitors enhancements to the MINFILE system; and 2 research geologists who update and maintain the MINFILE database and provide client support. Additional staff and contractors join the team as the budget allows. Technical and system development support is provided by the Information Services Branch and contractors in the area of systems integration. The yearly operating budget is about $400,000.

10.2 Partners-in-Enterprise Agreement

MINFILE has achieved a significant degree of success in the last few years. Since 1986, Systemhouse and the Geological Survey Branch have worked closely together, drawing upon each other's expertise within the disciplines of computer science and geology, respectively. Having become quite expert within the taxonomy of Geoscience Information Management, the two organizations have entered into an official business relationship. A Partners-in-Enterprise agreement between the Province of British Columbia and SHL Systemhouse Inc. allows Systemhouse to market and enhance the MINFILE Mineral Inventory System for sale worldwide for use by other geoscience organizations. The Department of Indian and Northern Development, Exploration and Geological Services, Yukon is presently adapting the MINFILE solution for their mineral database needs through this agreement.

11. PLANNED SYSTEM ENHANCEMENTS

11.1 MINFILE/pc Upgrades

With the release of MINFILE/pc, Version 3.0, changes and enhancements to this new program were a result of in-house project requirements and external client needs. The majority of client inquiries for support were related to program installation. Many of these problems were due to user-unfamiliarity with the DOS operating system and because of incompatibilities with various DOS versions. As MINFILE data were previously distributed on 360 kilobyte floppy diskettes and some files are larger than the disk storage allows, improved ways to distribute such large files were investigated. The solution was to use 1.2 megabyte diskettes, a compression utility by PKWARE, Inc., and DOS's copy

command. A more rugged and flexible installation procedure was subsequently designed and programmed.

Upgrades to MINFILE/pc functionality are continually being planned. Enhancements to be implemented will include additional fields for confidential information, a work history subsystem, better handling of deposit type and reserve categories for reporting, enhanced documentation, a context sensitive help system, and links to other databases, such as exploration activity data and land-related data. MINFILE/pc will also move towards an in-house multi-user/network rather than a stand-alone system. This will secure data integrity and reduce the transfer of data through floppy diskettes. The MINFILE team will also investigate user-interfaces with Microsoft WINDOWS, the use of digital maps, and expert systems.

11.2 MINFILE System Plan

The mandate of the Geological Survey Branch is to assemble, maintain, and disseminate an up-to-date, comprehensive geoscience database for British Columbia so as to provide a sound base for private sector exploration and development of the province's mineral resources, for resource management decisions by Government, and for public information. The MINFILE project provides critical data to achieve this mandate. Overall objectives of the MINFILE project are to improve personal and workgroup productivity through shared hardware and software resources, to provide better access to the data and encourage information sharing, and to maintain data integrity.

Technological advances in hardware and software provide functional and economic rationale for installing a local area network (LAN). Such a platform would improve the efficiency of selected operations of the system and help meet the objectives of the project The MINFILE team is currently investigating options and designing a LAN solution that will provide a stable growth path for the MINFILE system.

One option is to phase in a PC/Unix hybrid LAN. Such a platform offers interoperability (the ability of dissimilar computer systems to share data and support applications), connectivity (application portability from computer to computer), an association with open systems and a vendor-independent operating system. Unix is easily integrated with existing hardware and software investments and combined with proprietary-based applications, such as MINFILE. A phased approach would reduce the impact and disruption of implementing a new system, while providing maximum functionality and maximum cost savings at the earliest date. Outsourcing, or sharing of responsibilities of some of this information technology with systems-integration professionals, would allow adjustment of equipment and system needs based on changing technology.

MINFILE information is used in concert with other databases within geographical information systems (GIS). Data exchange protocols are being established to allow for GIS connectivity and improved links to other databases.

12. MINFILE PRODUCTS

12.1 MINFILE/pc

The MINFILE/pc Data-Entry, Search-and-Report system, Version 3.0 is available free of charge to purchasers of MINFILE data sets. It includes a complimentary end-user license from Proximity Technology Inc.

12.2 MINFILE Data and Maps

MINFILE data are sold in hard copy as maps and printouts and in computer format on floppy diskettes. The maps show the location of known mineral occurrences on a physiographic, topographic and geological base map at a 1:100 000 or 1:250 000 scale, based on the National Topographic System (NTS). The number labels refer to the MINFILE number and the symbols classify the occurrence according to categories of showing, prospect, developed prospect, producer or past producer. A legend keys the map number with occurrence name and mineral commodities. Reports are provided which sort the occurrences by primary commodity, primary name and NTS area. As of January 1992, 75 per cent of the total database has been updated and entered into the computer. Of this, 58 per cent or 51 map areas have been released to the public (figure 16). Additional maps areas are released periodically as the database is updated. The cost of each diskette is $5.00; maps are $5.00 each; and printouts range from $5.00 to $50.00 per NTS area.

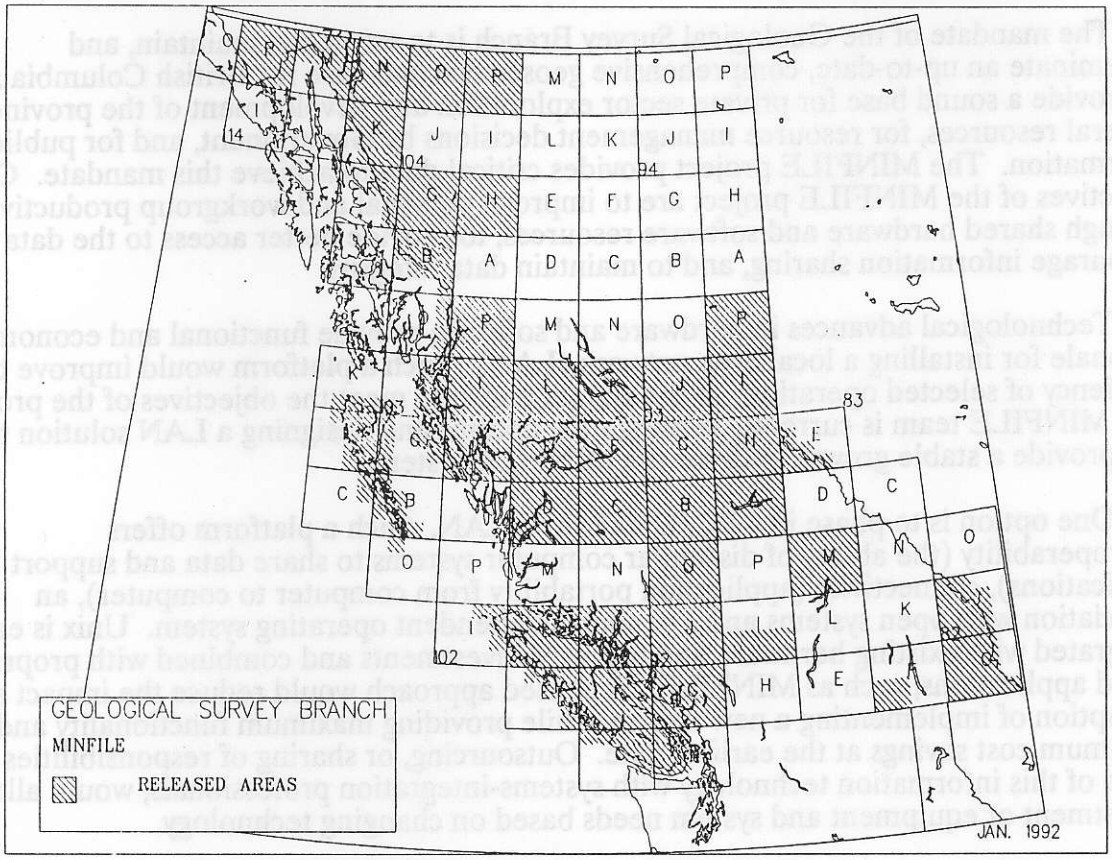

Figure 16 - Index map of MINFILE releases.

12.3 MINFILE Distribution, Client Sales and Support

Over 400 copies of various versions of MINFILE/pc have been distributed to clients within Canada and other countries. Over 3000 units or data sets for various map areas are sold every year. Along with sales and distribution of MINFILE products, the MINFILE team handles up to 1500 client inquiries each year, including about 300 demonstrations on the MINFILE system, 160 visits to Property File, which is a hard copy backup file to MINFILE, 350 requests for MINFILE data, 450 requests for product information, and 250 calls for program support.

During the last few years the level of sophistication of MINFILE/pc has increased, the client-base is growing and becoming more diversified, and hardware and software often cause inter-application problems. Support issues include application specific problems, such as use of MINFILE/pc, program bugs and data formats; and system specific problems such as DOS incompatibilities, hardware conflicts and commercial software applications. Support and distribution functions are handled in-house with a help-desk style of implementation, that logs problems and provides solutions. The MINFILE team also conducts talks and workshops on the MINFILE system.

12.4 Order Information

Requests for MINFILE information, MINFILE Coding Manual, User's Manuals and MINFILE/pc system diskettes are available from: MINFILE, Geological Survey Branch, Ministry of Energy, Mines and Petroleum Resources, 201-553 Superior Street, Victoria, B.C., Canada, V8V 1X4; contacts: Larry Jones (604) 356-2825 and Cindy McPeek (604) 356-2826; Fax (604) 356-8153. MINFILE paper reports, mineral occurrence maps and data diskettes are available from: Crown Publications Inc., 546 Yates Street, Victoria, B.C., Canada, V8W 1K8; Phone: (604) 386-4636, Fax: (604) 386-0221.

13. SUMMARY

The provincial mineral deposit database is continually being improved by the work of the British Columbia mineral industry and reported on in Assessment Reports filed in compliance of the Mineral Tenure Act. The wealth of new information is used to constantly upgrade the MINFILE database. This ever expanding database requires that MINFILE keep pace with new technology for the capture, management and display of the information to ensure that the system does not become static or obsolete. Metallogenic and related geoscience research require that MINFILE data be accessible, not only by database management software, but by new Geographical Information Systems. A readily accessible geological database can provide a framework for informed, resource management. It may also focus mineral resource exploration and aid in the discovery of new ore bodies. MINFILE has been continually refined to take advantage of technological advances to become a comprehensive and user-friendly system. The power and strength of the MINFILE system is its flexibility and efficiency in searching and manipulating geological data from thousands of mineral occurrences.

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APPENDIX A - MINFILE ARCHITECTURE

1. MINFILE/pc Database Structure

ENTITY FILES:

File	Field	Size	Alias
E01	MINFILNO	9	MINFILE_NUMBER
	LAT_DEG	2	LATITUDE_DEG
	LAT_MIN	2	LATITUDE_MIN
	LAT_SEC	2	LATITUDE_SEC
	LONG_DEG	3	LONGITUDE_DEG
	LONG_MIN	2	LONGITUDE_MIN
	LONG_SEC	2	LONGITUDE_SEC
	UTM_ZONE	2	UTM_ZONE
	UTM_EAST	6	UTM_EASTING
	UTM_NORT	7	UTM_NORTHING
	ELEV	4	ELEVATION
	LOC_ACC	1	DEPOSIT_LOCATION_ACCURACY
	DEPSIZEL	4	DEP_SIZE_L
	DEPSIZEB	4	DEP_SIZE_B
	DEPSIZEW	4	DEP_SIZE_W
	DIP	3	DEPOSIT_DIP
	STRIKE	3	DEPOSIT_STRIKE
	PLUNGE	6	DEPOSIT_TREND_PLUNGE
	NATMINNO	18	NAT_MIN_INV_NO
	CANMINNO	6	CANMINDEX_NUMBER
	CODED	8	DATE_CODED
	REVISED	8	DATE_REVISED
	GREVISED	4	GEOLOGIST_REVISE
	FREVISED	1	FIELD_REVISED
	FCHECKED	1	FIELD_CHECKED
	GNAME	4	GEOLOGIST_NAME
	OPENPIT	1	OPEN_PIT
	UGROUND	1	UNDER_GROUND
E02	STATUS_C	4	STATUS_TYPE_CODE
	STATUS_D	20	STATUS_TYPE_DESC
E03	DOMHRK_C	1	DOMINANT_HOST_ROCK_CODE
	DOMHRK_D	15	DOMINANT_HOST_ROCK_DESC
E04	DEPMOD_C	1	DEPOSIT_MODIFIER_CODE
	DEPMOD_D	15	DEPOSIT_MODIFIER_DESC
E05	DEPCHR_C	2	DEPOSIT_CHARACTER_CODE
	DEPCHR_D	20	DEPOSIT_CHARACTER_DESC
E06	DEPSHA_C	2	DEPOSIT_SHAPE_TYPE_CODE
	DEPSHA_D	12	DEPOSIT_SHAPE_TYPE_DESC
E07	DEPCLA_C	2	DEPOSIT_CLASSIFICATION_CODE
	DEPCLA_D	15	DEPOSIT_CLASSIFICATION_DESC
E09	MINDIV_C	4	MINING_DIVISION_CODE
	MINDIV_D	15	MINING_DIVISION_DESC
E10	NTSMAP_C	7	NTS_MAPSHEET
E11	BCMAP_C	7	BC_MAPSHEET
E12	TECBLT_C	2	TECTONIC_BELT_CODE
	TECBLT_D	18	TECTONIC_BELT_DESC

File	Field	Size	Alias
E13	TERRAN_C	3	TERRANE_CODE
	TERRAN_D	30	TERRANE_DESC
E14	PHYSIO_C	4	PHYSIOGRAPHIC_AREA_CODE
	PHYSIO_D	30	PHYSIOGRAPHIC_AREA_DESC
E15	META_T_C	1	METAMORPHIC_TYPE_CODE
	META_T_D	10	METAMORPHIC_TYPE_DESC
E16	META_G_C	2	METAMORPHIC_GRADE_CODE
	META_G_D	15	METAMORPHIC_GRADE_DESC
E17	META_R_C	1	METAMORPHIC_RELATIONSHIP_CODE
	META_R_D	20	METAMORPHIC_RELATIONSHIP_DESC
E18	YEAR	4	YEAR
E19	COMMOD_C	2	COMMODITY_CODE
	COMMOD_D	30	COMMODITY_DESC
E20a	MINCLA_C	1	MINERALOGY_CLASS_CODE
	MINCLA_D	15	MINERALOGY_CLASS_DESC
E20b	MINERL_C	4	MINERAL_CODE
	MINERL_D	20	MINERAL_DESC
E21	ALTER_C	4	ALTERATION_CODE
	ALTER_D	12	ALTERATION_DESC
E22	DATMET_C	2	DATING_METHOD_CODE
	DATMET_D	30	DATING_METHOD_DESC
E23	STNAME_C	6	STRATIGRAPHIC_NAME_CODE
	STNAME_D	30	STRATIGRAPHIC_NAME_DESC
	STINFORM	1	STRATIGRAPHIC_NAME_INFORMAL
	STIGMETA	1	STRATIGRAPHIC_NAME_IG_META
	STGROUP	1	STRATIGRAPHIC_NAME_GROUP
	STFORM	1	STRATIGRAPHIC_NAME_FORMATION
E24	ST_AGE_C	3	STRATIGRAPHIC_AGE_CODE
	ST_AGE_D	20	STRATIGRAPHIC_AGE_DESC
E25	ROCK_T_C	4	ROCK_TYPE_CODE
	ROCK_T_D	30	ROCK_TYPE_DESC
E26	ROCK_M_C	4	ROCK_MODIFIER_CODE
	ROCK_M_D	30	ROCK_MODIFIER_DESC
E27	OREZON_C	5	ORE_ZONE_CODE
	OREZON_D	30	ORE_ZONE_DESC
E28	SAMPLE_C	4	SAMPLE_TYPE_CODE
	SAMPLE_D	30	SAMPLE_TYPE_DESC
E29	RESCAT_C	2	RESERVE_CATEGORY_CODE
	RESCAT_D	30	RESERVE_CATEGORY_DESC

RELATIONSHIP FILES:

File	Field	Size	Alias
R02	MINFILNO	9	MINFILE_NUMBER
	STATUS_C	4	STATUS_TYPE_CODE
R03	MINFILNO	9	MINFILE_NUMBER
	DOMHRK_C	1	DOMINANT_HOST_ROCK_CODE
R04	MINFILNO	9	MINFILE_NUMBER
	DEPMOD_C	1	DEPOSIT_MODIFIER_CODE
R05	MINFILNO	9	MINFILE_NUMBER
	DEPCHR_C	2	DEPOSIT_CHARACTER_CODE
R06	MINFILNO	9	MINFILE_NUMBER
	DEPSHA_C	2	DEPOSIT_SHAPE_TYPE_CODE
R07	MINFILNO	9	MINFILE_NUMBER
	DEPCLA_C	2	DEPOSIT_CLASSIFICATION_CODE
R08	MINFILNO	9	MINFILE_NUMBER
	NAME	30	NAME
R09	MINFILNO	9	MINFILE_NUMBER
	MINDIV_C	4	MINING_DIVISION_CODE
R10	NTSMAP_C	7	NTS_MAPSHEET
R11	MINFILNO	9	MINFILE_NUMBER
	BCMAP_C	7	BC_MAPSHEET
R12	MINFILNO	9	MINFILE_NUMBER
	TECBLT_C	2	TECTONIC_BELT_CODE
R13	MINFILNO	9	MINFILE_NUMBER
	TERRAN_C	3	TERRANE_CODE
R14	MINFILNO	9	MINFILE_NUMBER
	PHYSIO_C	4	PHYSIOGRAPHIC_AREA_CODE
R15	MINFILNO	9	MINFILE_NUMBER
	META_T_C	1	METAMORPHIC_TYPE_CODE
R16	MINFILNO	9	MINFILE_NUMBER
	META_G_C	2	METAMORPHIC_GRADE_CODE
R17	MINFILNO	9	MINFILE_NUMBER
	META_R_C	1	METAMORPHIC_RELATIONSHIP_CODE
R18a	MINFILNO	9	MINFILE_NUMBER
	YEAR	4	YEAR
	MINED	12	ORE_MINED
	MILLED	12	ORE_MILLED

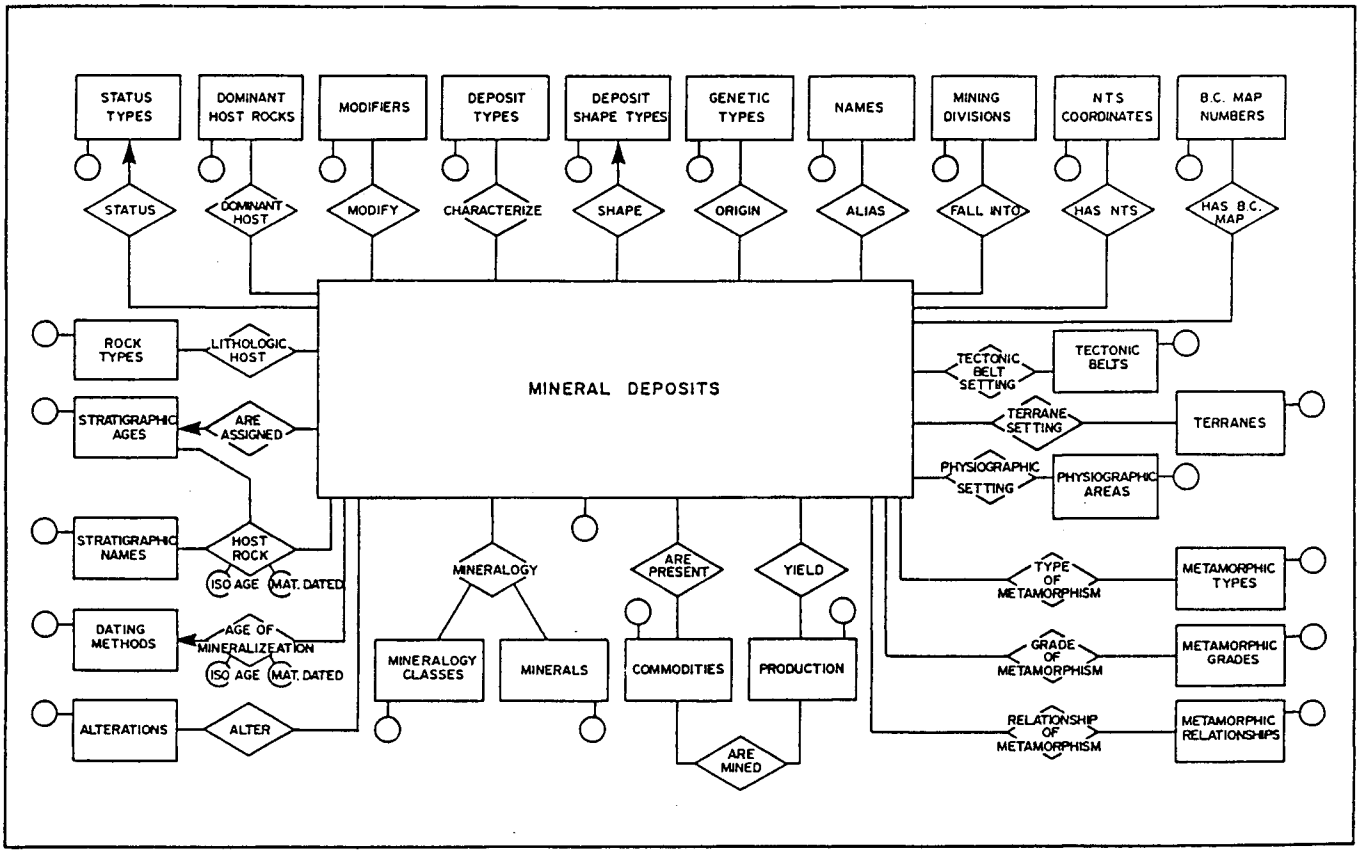
File	Field	Size	Alias
R18b	MINFILNO	9	MINFILE_NUMBER
	YEAR	4	YEAR
	COMMOD_C	2	COMMODITY_CODE
	QUANTITY	12	QUANTITY
R19	MINFILNO	9	MINFILE_NUMBER
	COMMOD_C	2	COMMODITY_CODE
R20	MINFILNO	9	MINFILE_NUMBER
	MINCLA_C	1	MINERALOGY_CLASS_CODE
	MINERL_C	4	MINERAL_CODE
R21	MINFILNO	9	MINFILE_NUMBER
	ALTER_C	4	ALTERATION_CODE
R22	MINFILNO	9	MINFILE_NUMBER
	DATMET_C	2	DATING_METHOD_CODE
	ISOAGE	20	ISOTOPIC_AGE_MINERALIZATION
	MATERIAL	30	MATERIAL_DATED_MINERALIZATION
R23	MINFILNO	9	MINFILE_NUMBER
	ST_AGE_C	3	STRATIGRAPHIC_AGE_CODE
	STNAME_C	6	STRATIGRAPHIC_NAME_CODE
	DATMET_C	2	DATING_METHOD_CODE
	ISOAGE	20	ISOTOPIC_AGE_HOST
	MATERIAL	30	MATERIAL_DATED_HOST
R24	MINFILNO	9	MINFILE_NUMBER
	ST_AGE_C	3	MINERALIZATION_AGE_CODE
R25	MINFILNO	9	MINFILE_NUMBER
	ROCK_T_C	4	ROCK_TYPE_CODE
	ROCK_M_C	4	ROCK_MODIFIER_CODE
	LITHUNIT	11	LITHOLOGICAL_UNIT
R26	MINFILNO	9	MINFILE_NUMBER
	OREZON_C	5	ORE_ZONE_CODE
	RESCAT_C	2	RESERVE_CATEGORY_CODE
	A_OR_B	1	A_OR_B
	YEAR	4	YEAR
	QUANTITY	12	QUANTITY
R27	MINFILNO	9	MINFILE_NUMBER
	OREZON_C	5	ORE_ZONE_CODE
	A_OR_B	1	A_OR_B
	YEAR	4	YEAR
	SAMPLE_C	4	SAMPLE_TYPE_CODE
R28	MINFILNO	9	MINFILE_NUMBER
	OREZON_C	5	ORE_ZONE_CODE
	RESCAT_C	2	RESERVE_CATEGORY_CODE
	A_OR_B	1	A_OR_B
	COMMOD_C	2	COMMODITY_CODE
	GRADE	9	GRADE

COMMENT FILES:

File	Field	Size	Alias
C01	MINFILNO	9	MINFILE_NUMBER
	IDENT_T	70	IDENTIFICATION_COMMENT
C02	MINFILNO	9	MINFILE_NUMBER
	SIGMIN_T	70	SIGNIFICANT_MINERALS_COMMENT
C03	MINFILNO	9	MINFILE_NUMBER
	ASSMIN_T	70	ASSOCIATED_MINERALS_COMMENT
C04	MINFILNO	9	MINFILE_NUMBER
	ALTMIN_T	70	ALTERATION_MINERALS_COMMENT
C05	MINFILNO	9	MINFILE_NUMBER
	STRUCT_T	70	STRUCTURAL_COMMENT
C06	MINFILNO	9	MINFILE_NUMBER
	HSTRCK_T	70	HOST_ROCK_COMMENT
C07	MINFILNO	9	MINFILE_NUMBER
	META_T	70	METAMORPHISM_COMMENT
C08	MINFILNO	9	MINFILE_NUMBER
	CAPSUL_T	70	CAPSULE_GEOLOGY_COMMENT
C09	MINFILNO	9	MINFILE_NUMBER
	BIBLIO_T	70	BIBLIOGRAPHY_COMMENT
C10	MINFILNO	9	MINFILE_NUMBER
	YEAR	4	YEAR
	PROD_T	66	PRODUCTION_COMMENT
C11	MINFILNO	9	MINFILE_NUMBER
	OREZON_C	5	ORE_ZONE_CODE
	RESCAT_C	2	RESERVE_CATEGORY_CODE
	A_OR_B	1	A_OR_B
	RESERV_T	70	RESERVES_COMMENT
C12	MINFILNO	9	MINFILE_NUMBER
	OREZON_C	5	ORE_ZONE_CODE
	RESCAT_C	2	RESERVE_CATEGORY_CODE
	A_OR_B	1	A_OR_B
	RESREF_T	70	RESERVES_REFERENCE

NOTE: All fields are character.

2. Entity-Relationship Model



"IDEAL" ENTITY-RELATIONSHIP MODEL

APPENDIX B - SAMPLE MASTER AND PRODUCTION REPORTS

1. Master Report

RUN DATE: 05/07/91 MINFILE / pc PAGE: 1
RUN TIME: 13:30:43 MASTER REPORT REPORT: RGEN4000
GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION
MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

MINFILE NUMBER: 104B 021 NATIONAL MINERAL INVENTORY: 104B1 Cu1

NAME(S): GRANDUC, LEDUC, VAUGHN K., EDNA MAY

STATUS: Past Producer Underground MINING DIVISION: Skeena
NTS MAP: 104B01W UTM ZONE: 09
LATITUDE: 56 12 41 NORTHING: 6230200
LONGITUDE: 130 20 35 EASTING: 416700
ELEVATION: 0975 Metres
LOCATION ACCURACY: Within 500M
COMMENTS: Mine location.

COMMODITIES:	Copper	Silver	Gold	Iron	Lead
	Zinc	Cobalt	Phosphate		
MINERALS					
SIGNIFICANT:	Pyrite	Chalcopyrite	Pyrrhotite	Magnetite	Sphalerite
	Galena	Arsenopyrite	Bornite	Cobaltite	
ASSOCIATED:	Quartz	Calcite	Magnetite	Apatite	
ALTERATION:	Epidote	Calcite	Tourmaline	Sericite	Graphite
ALTERATION TYPE:	Epidote	Carbonate	Sericitic		
MINERALIZATION AGE:	Unknown				

ISOTOPIC AGE: DATING METHOD: Unknown MATERIAL DATED:

DEPOSIT

CHARACTER:	Massive	Concordant	Podiform	Vein
CLASSIFICATION:	Syngenetic	Sedimentary	Volcanogenic	
SHAPE:	Regular			
MODIFIER:	Folded	Sheared		

DIMENSION: 1200 x 0760 x 0240 Metres STRIKE/DIP: TREND/PLUNGE:
COMMENTS: These massive sulphide deposits likely represent deformed syngenetic sulphide, of volcanogenic-sedimentary origin.

HOST ROCK
DOMINANT HOST ROCK: Metasedimentary

STRATIGRAPHIC AGE	GROUP	FORMATION	IGNEOUS/METAMORPHIC/OTHER
Lower Jurassic	Hazelton	Unuk River	

ISOTOPIC AGE: 210+24-14 Ma
DATING METHOD: Uranium/Lead
MATERIAL DATED: Zircon
Tertiary Hyder Pluton

LITHOLOGY: Quartz Schist
Quartzite
Chert
Limestone
Biotite Schist
Phyllonite
Mylonite
Iron Formation
Diorite

HOST ROCK COMMENTS: Deposit lies within the South Unuk cataclasite zone, likely part of Lower Jurassic Unuk Formation. Isotopic age reference: Brown, 1987.

GEOLOGICAL SETTING
TECTONIC BELT: Intermontane PHYSIOGRAPHIC AREA: Boundary Ranges
TERRANE: Stikinia
METAMORPHIC TYPE: Regional RELATIONSHIP: Post-mineralization GRADE: Amphibolite

RESERVES

ORE ZONE: GRANDUC

CATEGORY: Indicated Ore YEAR: 1986
QUANTITY: 9890000 Tonnes

MINFILE NUMBER: 104B 021

COMMODITY	GRADE
Copper	1.7900 Per cent

COMMENTS: Includes minor silver and gold.
REFERENCE: Map 65

CAPSULE GEOLOGY

The Granduc Mine is located on the east side and near the head of Leduc Glacier on Lots 6566 and 6567. Production began in 1971 and continued until 1978 when low metal prices forced the mine to shut down. The mine was brought back into production in 1980 and continued until 1984.

The Granduc ore deposit comprises a series of concordant massive sulphide lenses, localized within a complex sequence of volcanic-sedimentary rocks that have been deformed by cataclasis. The deposit lies 6 kilometres east of granodiorites of the Tertiary Coast Plutonic Complex. The sulphide lenses are confined to a 120-metre-wide, vertical zone within the north-trending South Unuk cataclasite zone (Lower Jurassic). The cataclasite zone includes calc-silicate cataclasites, mylonites and phyllonites. The zone is bounded on the west by north-trending mixed granodiorite gneisses and on the east by variably deformed epiclastic volcanic conglomerates and andesitic volcanics. All rocks are cut by Tertiary quartz diorite plutons and dykes.

The volcanics east of the Granduc orebodies are pillow lavas, intercalated with graphitic siltstones, thin-bedded lithic and crystal tuffs and volcanic sandstones. This sequence is overlain by the ore zone, graphitic siltstones, silty argillites, thin-bedded lenticular gypsum-bearing limestones, and quartz pebble and quartz cobble conglomerate lenses. These rocks underwent several periods of later deformation, intrusion, alteration, faulting and erosion, culminating in Tertiary time with Hyder plutonism. The ore deposit lies along part of the deformed, overturned, west limb of a pre-Middle Jurassic, north-trending anticlinal fold. The less deformed rocks to the east of the ore deposit include a complex volcanic-sedimentary sequence, which is considered to be part of the Juro-Triassic Unuk River Formation (Hazelton Group).

Recrystallization of the rocks in the ore horizon has converted the fine-grained laminated rocks to compositionally banded, brown to pale grey quartz-rich biotite and sericite schists, quartzites and metacherts. Feldspathic and andesitic tuffs are converted to massive, or banded biotite, and biotite-epidote-actinolite schists. Massive rocks are more common in the lower half of the ore horizon. The upper part of the orebody occurs in the finely laminated quartz-rich brown biotite schists which are derived from silty argillites.

Several steep north-trending faults cut the orebodies. The Western and Granduc graphitic fault zones are west of the ore zone. Several of the orebodies have been offset by apparent right-hand strike-slip movement.

The several ore zones, which make up the Granduc deposit, comprise pancake-like, overlapping, and commonly merging lenses, which extends vertically for 760 metres, laterally for 1200 metres and over a 120 to 240 metre lenticular width. The orebodies, designated as A to F, consist mainly of pyrite, chalcopyrite, pyrrhotite, magnetite, sphalerite, galena, arsenopyrite, bornite and cobaltite. Gangue includes blocks of brecciated country rock, quartz as lenses, stringers and blebs, recrystallized coarse-grained calcite as lenses and stringers, and apatite. Minor alteration minerals consist of calc-silicate lenses and tourmaline.

Individual ore zones, which are up to a few tens of metres thick and extend laterally up to hundreds of metres, consist of massive lenses, irregular streaks and blebs, and veinlets of sulphide. Repeated deformation of the massive sulphide lenses resulted in an irregular and feathery nature to the orebodies, which have been called stringer lodes.

The Granduc massive sulphide deposits likely represent deformed syngenetic sulphide, of volcanogenic-sedimentary origin (Bulletin 63). The magnetite-apatite-calcite assemblage occurs as thinly banded layers intercalated with calc-silicate, limestone bands up to

CAPSULE GEOLOGY

6 metres thick, graphitic quartzo-feldspathic cataclasites and the massive sulphide lenses.

Original deposit reserves were estimated at 49 million tonnes of ore grading 1.55 per cent copper and 6.9 grams per tonne silver, with minor gold, lead and zinc (Bulletin 63). Total production from 1971 to 1978 and from 1981 to 1984 included mining of 15.2 million tonnes to give 190 million kilograms of copper, 124 million grams of silver and 2 million grams of gold. Current reserves are reported as 9.89 million tonnes of 1.79 per cent copper, with minor silver and gold (Map 65).

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DATE CODED: 850724 CODED BY: GSB FIELD CHECK: N
DATE REVISED: 880725 REVISED BY: LDJ FIELD CHECK: N

MINFILE NUMBER: 104B 021

2. Production Report

RUN DATE: 05/07/91
RUN TIME: 13:35:09

MINFILE / pc
PRODUCTION REPORT
GEOLOGICAL SURVEY BRANCH - MINERAL RESOURCES DIVISION
MINISTRY OF ENERGY, MINES AND PETROLEUM RESOURCES

PAGE: 1
REPORT: RGEN5000

MINFILE NUMBER: 104B 021 NAME: GRANDUC STATUS: Past Producer

Production Year	Tonnes Mined	Tonnes Milled	Commodity	Grams Recovered	Kilograms Recovered
1984		352,630	Silver	3,944,057	
			Gold	55,771	
			Copper		5,602,592
1983	1,031,805		Silver	7,950,859	
			Gold	133,273	
			Copper		11,925,042
1982	500,335		Silver	3,606,800	
			Gold	52,627	
			Copper		5,380,913
1981	613,936		Silver	4,850,000	
			Gold	75,283	
			Copper		7,626,025
1978	722,782	741,648	Silver	9,056,914	
			Gold	160,460	
			Copper		14,780,100
1977	1,252,362	1,252,362	Silver	8,631,953	
			Gold	130,011	
			Copper		13,262,755
1976	1,315,905	1,315,905	Silver	10,373,566	
			Gold	154,800	
			Copper		15,569,210
1975	1,499,585	1,499,585	Silver	9,604,482	
			Gold	162,606	
			Copper		16,222,977
1974	2,457,307	2,457,307	Silver	19,216,895	
			Gold	315,198	
			Copper		29,055,142
1973	2,538,242	2,538,242	Silver	20,259,654	
			Gold	342,257	
			Copper		31,548,799
1972	1,881,151	1,895,884	Silver	13,570,114	
			Gold	229,820	
			Copper		21,702,538
1971	1,359,730	1,359,730	Silver	12,983,667	
			Gold	187,955	
			Copper		17,467,617

SUMMARY TOTALS: 104B 021 NAME: GRANDUC

	Metric		Imperial	
Mined:	15,173,140	tonnes	16,725,524	tons
Milled:	13,413,293	tonnes	14,785,624	tons
Recovery:				
Silver:	124,048,961	grams	3,988,261	ounces
Gold:	2,000,061	grams	64,303	ounces
Copper:	190,143,710	kilograms	419,195,006	pounds

Comments:
1984: Cu conc. 20251 T.