This report is incomplete.

The original, printed version had missing pages. We apologize for the inconvenience.

ALBERTA GEOLOGICAL SURVEY
COAL GEOLOGY

COAL GEOLOGY DATA BASE

R.J.H. Richardson
G.B. Mandryk
D.W. Fietz

Open File Report 1989-02A
Alberta Geological Survey
Alberta Research Council

DISCLAIMER

TABLE OF CONTENTS

APPENDICES

FIGURES

Table

FORWORD

In the early to mid 1980's, during three major regional subsurface coal studies, it was realized that there were strong reasons to establish a Coal Data Base within the Alberta Geological Survey. It was found that information had been retrieved several times from the same area and that interpreted (new) information was stored electronically (in ASCII) and in a variety of formats. In addition, there was no central repository or data base for the new and expensive information. Without a uniform and flexible storage and retrieval system for the data, much effort would need to be expended in future projects just to duplicate what had already been done. Scarce resources, more accountability, and technological advances in relational data base design and data storage indicated that work towards establishing a coal research oriented data base at the Alberta Geological Survey should begin.

Data generated by the research activities of the Alberta Geological Survey, the coal industry, and the Energy Resources Conservation Board's (ERCB) coal hole file will be collected and added to the data base. This will ensure that a standardized source of data will be available to support Geological Survey research and the activities of the coal industry, while simultaneously archiving valuable and costly data.

The Coal Data Base will form the foundation for all future coal geology and related studies at the Alberta Geological Survey. In addition to serving as a data repository, the data base will support mapping, geostatistical, well log, and geographic information systems activities. This report serves as an introduction and as supporting documentation to the Alberta Geological Survey Coal Data Base.

EXECUTIVE SUMMARY

A data base of coal-related information has been developed at the Alberta Geological Survey. The Coal Data Base's prime function is to support the information requirements of the Alberta Geological Survey's Coal Geology Group as well as those of industry and government. It will also provide a centralized collection of coal data in a consistent format, regardless of the source of the data, while simultaneously archiving costly-to-obtain data. It should be stressed that the data base itself, and not this report, is the primary product of this project. This report reflects the state of the data base project at the end of December 1988; improvements and modifications to the data base will continue.

The following broad data categories can be stored within the Coal Data Base: location information, geological picks, lithological descriptions, sample types, coal quality information, structural geology attributes, and sample storage information. We plan to enhance our coal geology glossary (one of the project's products) and make it widely available as part of an effort to standardize and improve the level of technical dialogue in Alberta. Currently, the Coal Data Base contains data from the Alberta Geological Survey (AGS) and data from the Energy Resources Conservation Board (ERCB) coal hole file. Data from the AGS consists of geology picks from three coal-bearing units of the Alberta plains to a maximum depth of 400 m. These units are the Ardley coal zone, the Horseshoe Canyon Formation, and the Belly River Group comprising a total of 5125 holes with 10 000 formation picks and 24 976 coal seam picks. Coal quality data is available for 205 holes. The majority of the coal-related information in the data base is from the ERCB's coal hole file. The ERCB's data spans the foothills/mountains and plains coals. Their coal hole file held data, as of March 1988, on 49 216 holes, with 2938 having coal quality (proximate or ultimate analyses) information.

The Coal Data Base is a relational data base, implemented in INGRES data base software on a VAX computer. It is intended that the data be a resource for all those involved in the coal sector. One attraction of the relational data model is that it gives users the freedom to query the data base with their own unique questions rather than being locked into fixed format queries. For example, one person may request data related by company, another can request data related by date of sampling and log types. A common request will be, "tell me all you can about coal in this area". The Coal Data Base runs on both mainframe and microcomputers which allows portions of the data base to be transferred digitally into a user's office microcomputer for further querying or analysis.

The Coal Data Base can serve as an exploration, research, and information tool for the 1990's. The result of queries can be sent from office to office on the same day it is retrieved. The data base speeds gathering data for a project's initiation and forms a foundation to the true spatial data and map analysis systems (i.e. geographic information systems) which will be a dominant geoscience tool in the 1990's.

INTRODUCTION

OBJECTIVES

The Coal Data Base's prime function is to support the information requirements of the Alberta Geological Survey's Coal Geology Group as well as those of industry and government. The consolidation and integration of data produced by the AGS Coal Geology Group since 1983 was an important objective of the project (Mandryk and Richardson, 1988). The data base must also provide a centralized collection of coal geoscience data in a consistent format, regardless of the source of the data, while simultaneously archiving costly-to-obtain data.

SCOPE

The data base is designed to include any coal related information, regardless of the source, for the whole of Alberta. The following broad data categories can be stored within the Coal Data Base: location information, geological picks, lithological descriptions, sample types, coal quality information, structural geology attributes, and sample storage information. Currently, the Coal Data Base contains data from the Energy Resources Conservation Board (ERCB) coal hole file while data from the Alberta Geological Survey (AGS) has been formatted for input in the spring of 1989. The majority of the coal-related information in the Data Base for the near future will be from the ERCB's coal hole file.

The ERCB is the primary repository for coal exploration information collected in the province. Filing of coal exploraion results with the ERCB is required under the Coal Conservation Act and Regulations. The initial collection of all the industry produced data and its inclusion (data input) in a provincial data base is clearly outside the mandate of the Alberta Geological Survey. A cognitive effort has been made to insure no duplication of effort between the ERCB data base (coal hole file) and the AGS's Coal Data Base. Although a considerable amount of

data is resident in both data bases the key difference is in the scope of the two data bases. The ERCB data base has a repository focus and the AGS Coal Data Base has an interpreted and research oriented focus.

STATUS

This report reflects the state of the Coal Data Base to the end of December 1988; improvements and modifications will continue. The Coal Data Base has been identified as an ongoing activity of the AGS Coal Geology Program.

METHODS

DESIGNING AND IMPLEMENTING THE Coal Data Base

Designing and implementing a relational data base involves a number of basic steps. The following outlines the development path followed by the Coal Geology Group.

1. Establish objectives that list what the purpose of the data base is and what its functions are to be.
2. Establish a data dictionary that lists the data types and their formats for all types of data that will be stored.
3. Produce an Entity-Relationship Model (ERM) which groups data into categories. Establish data relations based on and optimized on the queries which may be posed as outlined in the prospectus.
4. Test the ERM to see if the structure of the data base will support the queries. Revise where necessary.
5. Create the data base tables in the computer data base system.
6. Acquire and format available data.
7. Load data into the data base.
8. Test structure and queries; revise to optimize the data base.

DATA DICTIONARY

To use and extract data from the Coal Data Base, a data dictionary must identify 'which' specific data types are stored within the data base, what their format is, and how equivalent data is identified in other data bases. Future versions of the data dictionary will be available in electronic form and distributed on diskettes.

To facilitate use, the data dictionary (Appendix 2) was divided into numerous sections. These sections are described below.

Section 1

Provides general information by listing the names and abbreviations of the tables in the Coal Data Base and the names and abbreviations of the attributes of each table. A brief definition of each table and attribute names is given.

Section 2

Gives detailed information about the attributes in the Coal Data Base. The columns in section 2 contain the following information.

TBL_ABBREV
- Abbreviated table names. The abbreviated names are used exclusively in the Coal Data Base.

CLMN_ABBREV
- Abbreviated column name (attribute); used exclusively in the data base.

STORAGE UNITS (K_TYP STORED_UNITS)
- The units in which an attribute is stored, provided the attribute has units, i.e., mm, kg.

DATA RANGE (INTEG_CHECK)
- The range of numbers or codes which the attributes are known to span or are allowed to span.

STORAGE FORMAT (INGRS_STGE_FMT)
- The INGRES data type defined for each attribute.

DISPLAY FORMAT (I_FLT_PNT_FMT)
- The format in which numeric attributes should be displayed.

Section 3

Sorted version of section 2. Sorted on attribute abbreviation.

Section 4

This table relates the data elements in the Energy Resources Conservation Board (ERCB) Coal Hole File to attributes stored in the AGS Coal Data Base.

Section 5

Sorted version of section 4. Sorted by ERCB data element name.

Section 6

A list of all tables in the Coal Data Base. This list also provides a summary of the type of information in the table (i.e. geology, location) and the table's purpose (i.e. relational, data, reference).

Section 7

This table lists all the attributes in the Coal Data Base which serve as relational attributes. The relational attributes are tuple identifiers.

Relational tuple identifier numbers, or relational keys are either;

(i) unique numbers for an entity tuple (i.e. unique internal data base number for a location, i.e. SITID) or;

(ii) unique numbers for a reference tuple (i.e. ATOMNUM, used to signify the atomic number of an element, ATOMNUM would correspond to an actual list of names in a reference table, in this case the table ATOMIC_NO).

Data from the agencies listed in sections 8 and 9 are not presently entered in the Coal Data Base. The relationship of data elements and terminology is presented to allow for reference and comparison.

Section 8

This table relates the data elements in the Institute of Sedimentary and Petroleum Geology (ISPG), of the Geological Survey of Canada (GSC) "Coal Data Base" to attributes in the Alberta Geological Survey Coal Data Base.

Section 9

This table relates the data elements found in Alberta Geological Survey, Open File Report 1988-07 (Mandryk and Richardson, 1988), to the AGS Coal Data Base.

Section 10

This table permits the recording of comments for an attribute. It is intended for the use of users of the Coal Data Base or for the convenience of those who have access to other data bases.

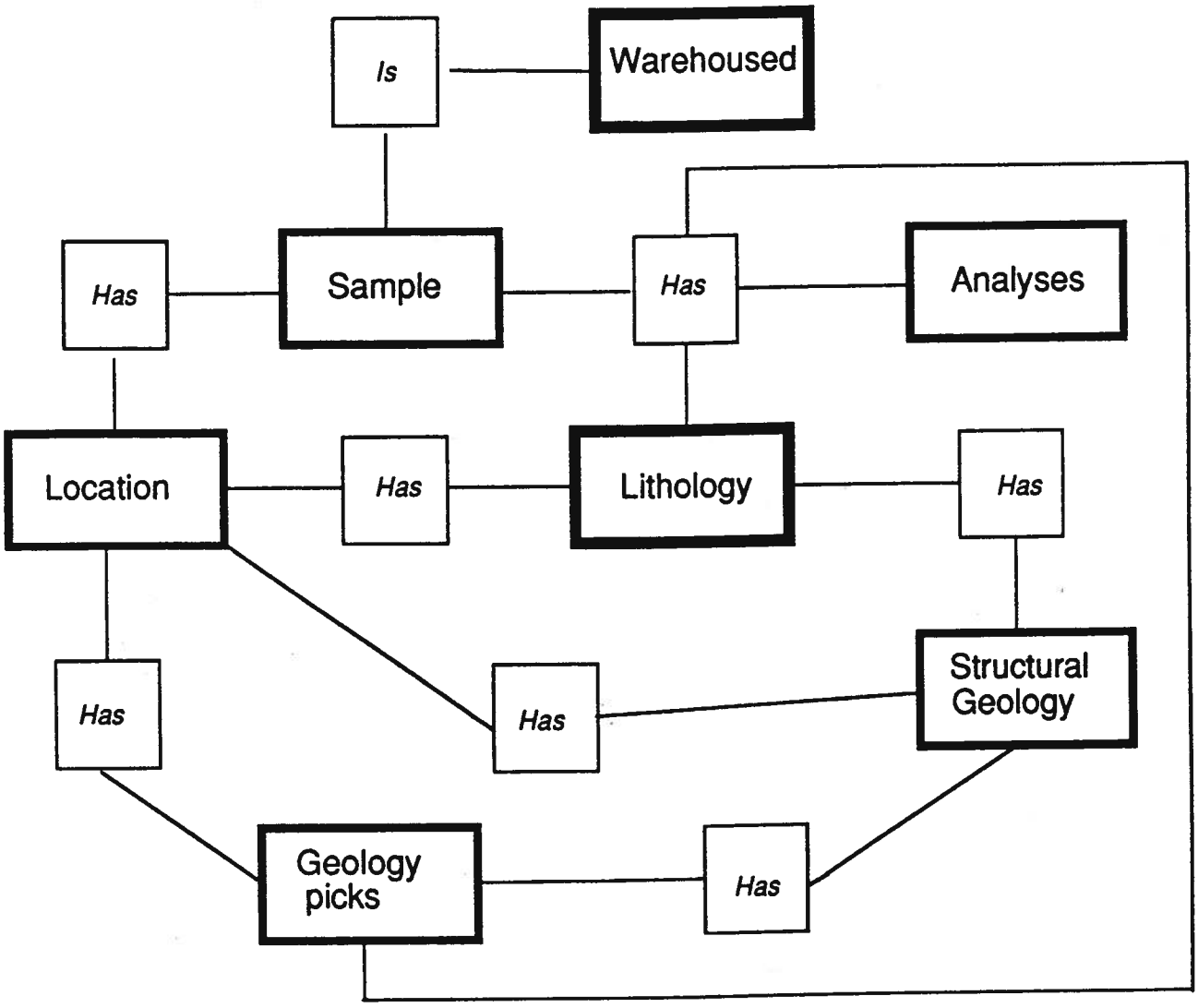


FIGURE 1. Simplified Entity Relationship Model (ERM).

ENTITY-RELATIONSHIP MODEL

Simply defined, an Entity Relationship Model (ERM) is the logical model of a data base. The ERM forms the design framework that determines the nature, capabilities, and ultimately the success of a relational data base. The major advantage of an ERM is in it's efficiency; it presents the data base diagrammatically thereby conveying a great deal of information in an easy to understand form (Figure 1; and Appendix 3). Almost nine man months of effort went into the careful planning, organization and cross checking of the ERM.

PURPOSE OF COAL ERM

The Coal Entity-Relationship Model shows the kinds of data in the relational data base and how it is related (Appendix 3). The ERM serves other important functions:

1. The ERM was used to test, on paper, whether the data base structure could meet the requirements of the Coal Geology Group. For example, could the lithology, stratigraphic level, and coal quality analyses be stored and retrieved for any sample from any location?
2. The ERM, combined with the data dictionary, serves as a blueprint for creating the actual computer data base.
3. The ERM is a map of the data base and indicates what is available and the necessary relations needed to extract information.

DESIGN PHILOSOPHY

The overriding design philosophy was to allow complete flexibility for the type and number of data attributes stored. New fields or data types could be added or deleted at any time without seriously disrupting the integrity of the data base. The design would enable increases in

the bulk or amount of information and hardware storage constraints would be minimized through normalization of the data (third normal form). At present the data base can run with subsets of data on mini and microcomputers as separate data sets or the data can be entirely loaded onto a mini system. Another attraction of a relational data model is that it gives users the freedom to query the data base with their current questions rather than being locked into fixed queries.

An ERM descibes data in terms of **entities** {rectangles}, **relations** {diamonds}, and **attributes** {ovals} (Appendix 3). **Entities** are groupings of real-world information about something, such as information about a drill hole; entities are tables. **Attributes** contain the information about an entity, such as when the hole was drilled; attributes are columns in a table. **Relations** relate entities and are also a type of entity. However, relations differ in a important way from entities by having relational attributes which then serve to relate entities. In the Coal Data Base two or more entities can be related.

DATA SOURCES

Currently, the Coal Data Base contains data from the Energy Resources Conservation Board (ERCB) coal hole file (Table 1 and ERCB Coal Hole Locations map in Appendix 6). Data from the Alberta Geological Survey (Mandryk and Richardson, 1988 map Appendix 6) has been formatted for input during the spring of 1989. Information obtained from industry sources for use by the AGS Coal Group have not, as yet, been formatted for merging with the data base. The Geological Survey of Canada's (GSC) National Coal Inventory program (data base) holds a considerable amount of Alberta coal information that is unavailable elsewhere; no formal cooperative understanding on data exchange exists at present (McCabe et. al. 1987; Langenberg et. al. 1986). Efforts to arrange access to the ISPG Alberta data are continuing. Comparison of data elements between the GSC and AGS data bases appears in the data dictionary; Appendix 2, Section 8.

ENERGY RESOURCES CONSERVATION BOARD

The ERCB is the prime repository for coal exploration information collected in the province, as required under the Coal Conservation Act. The majority of the coal-related information in the data base is from the ERCB. The ERCB's data spans the foothills/mountains and plains coals regions. Their data base, as of March 1988, contained information on 49 216 holes; 2938 with coal quality information (proximate or ultimate analyses; Table 2 and maps Appendix 6). Their coal hole file is constantly being updated and a major effort, by the ERCB, to include coal quality data has been underway for the last two years.

ALBERTA GEOLOGICAL SURVEY

Data from the AGS is a consolidation and integration of data produced by the Coal Geology Group between 1982 and 1986 (Mandryk and Richardson, 1988) and consists of geology picks from three coal-bearing units of the Alberta plains to a maximum depth of 400 m. These units are the Ardley coal zone, the Horseshoe Canyon Formation (Drumheller coal zone), and the Belly River Group coal zones (5125 holes with 10 000 formation picks, 24 976 coal seam picks; Appendix 6). Coal quality data is available for 205 holes.

During the next year outcrop data on lithology, structure and coal quality collected since 1986, during our recent program, will be entered in the data base as funding is found.

INDUSTRY

Information from coal companies has been collected and decoded for use in a number of AGS coal research projects. Much of the information is duplicated in the ERCB Coal Hole File while some additional data elements are present. The data in some cases is not yet in the public domain and therefore can not be made available (in an uninterpreted form) by the AGS prior to normal public release by the ERCB. Data be released with the written permission of the owner of the data.

DATA CODING

STORAGE

The Coal Data Base is designed to store all text information related to coal geology (descriptive geological information of coal and associated sediments), location (three dimensional), and coal analytical information (coal chemistry, petrography, palynology). In general the approach is to:

- store field locations of sample data in 3-D;
- record where a sample is stored;
- store geological picks (formations, marker horizons, lithological zones including coal) and their ages;
- store analytical results (grain size, coal petrography, palynology etc.);
- store which company performed any action which resulted in data (drilling company, laboratory);
- store what person or group of people (source and date of information) interpreted geology, collected samples, or performed analysis (i.e. petrography, palynology);
- store multiple identifications/tests of the geological horizon, sample analysis for the same point in space;
- store information related to structural geology. Dip, dip direction, trend, plunge, contact, sample, or measurement point.

Future data base development will store and relate both graphical and text information within a GeoScience Information System environment, as well as present time relationships.

SAMPLE INTERVAL CODING

Information in the Coal Data Base is stored with reference to 3-dimensional space. The 2-dimensional location of a drillhole or an outcrop is recorded, for example, using latitude and longitude or UTM meterage, or by Dominion Land Survey coordinates. The location of a

sample, a formation boundary, or a lithological description at a 2-dimensional location requires the third dimension to fully define its location. Depending on the kind of location, the third dimensional distance to a piece of information may be measured either downwards (drillhole information) or upwards (outcrop information, channel information) Table 1. Figures 2 to 6 illustrate these intervals.

For example, information collected along a drillhole is measured downwards as depth; information collected from an outcrop or a channel is measured upwards from the origin, usually the ground surface. The distance up or down is always stored as a positive number in the Coal Data Base. The data source (i.e. outcrop, drillhole) dictates how the distance is stored in the data base. The Data Base table name and the table attribute names let the user know what type of location an interval is from and whether the interval is measured up or down from the ground surface, refer to Figures 2 to 6 for diagrammatic sketches of intervals.

Table 1. Mechanism of recording 3-D data in database.

Information measured downwards from the surface:

1. Drillhole information.
   - Sample interval
   - Lithological description interval
   - Depth interval of a geological pick
   - Cored interval
   - Deviation data

Information measured upwards from the surface:

1. Outcrop information.
   - Sample interval
   - Lithological description interval
   - Formation boundary (Geological pick)
   - Structural geology feature

2. Channel information
   - Sample interval
   - Lithological description interval

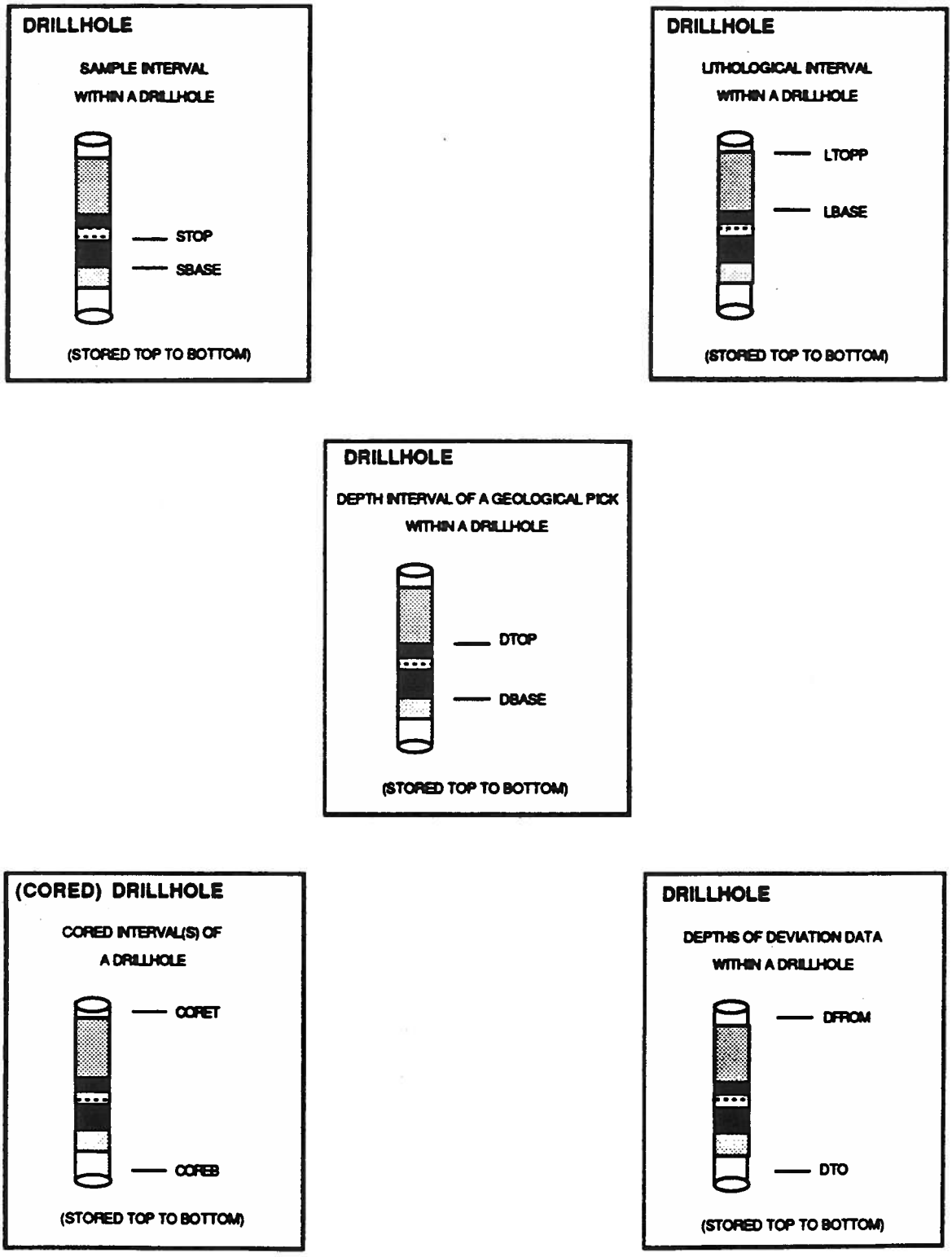


Figure 2. Drillhole intervals. STOP and SBASE (for example) represent the top and bottom depth of a sample measured from the ground surface down. STOP and SBASE ARE ATTRIBUTES IN THE COAL DATA BASE.

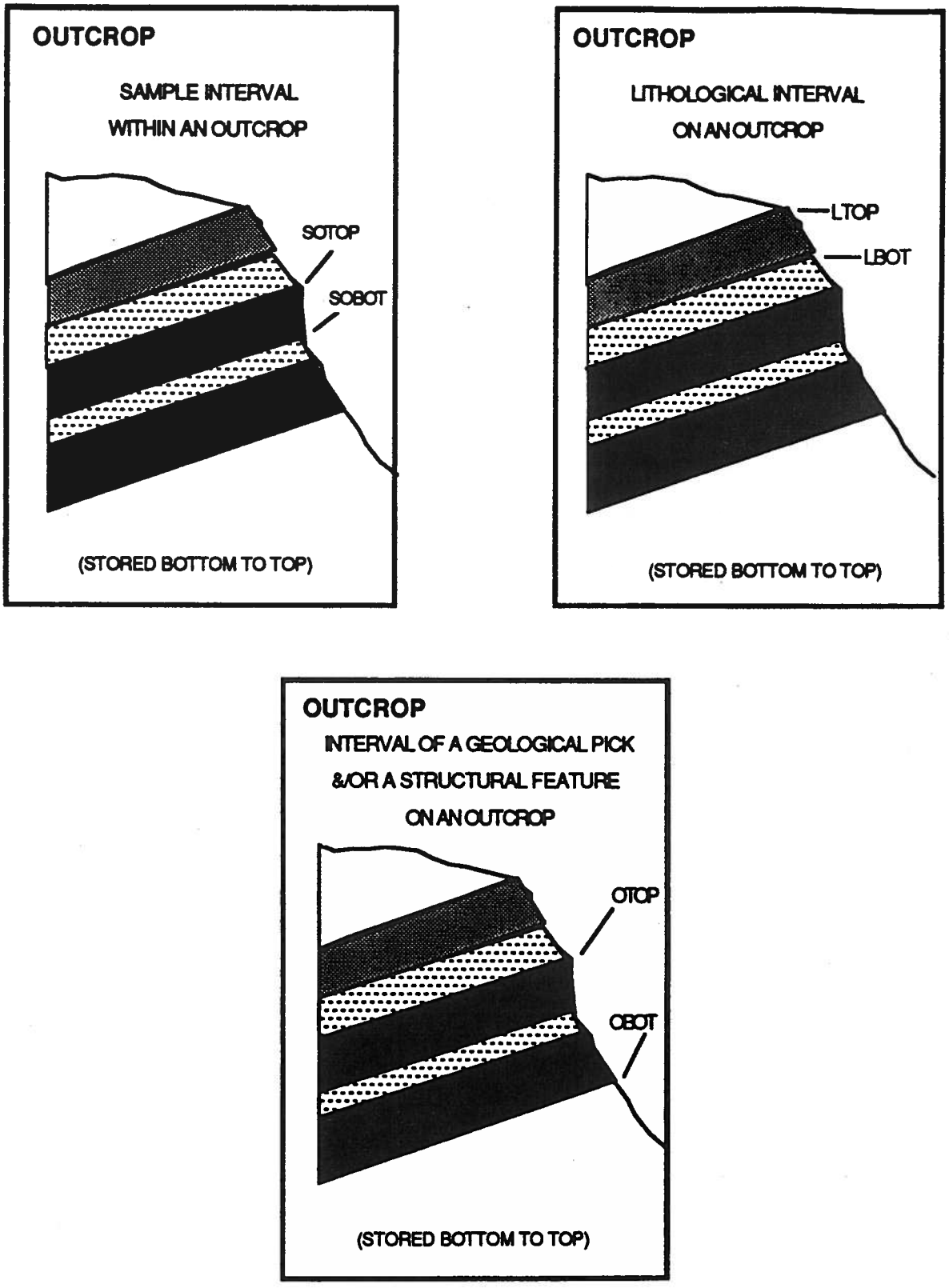
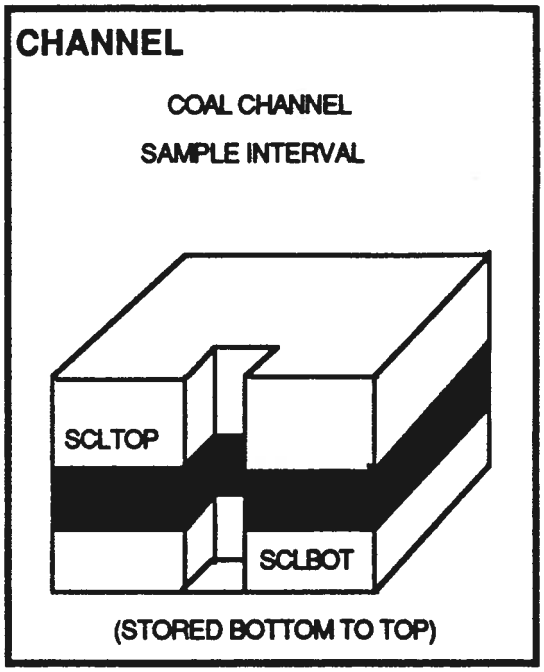


FIGURE 3. Outcrop intervals. SOTOP and SOBOT (for example) represent the upper and lower sample intervals from an outcrop as measured upwards from the bottom part of the outcrop.



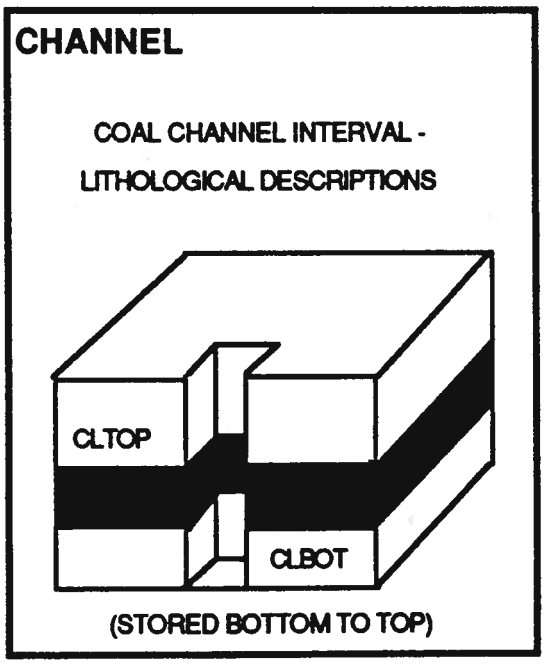


Figure 4. Channel interval. SCLTOP and SCLBOT (for example) represent the upper and lower sample intervals from a channel as measured upwards from the bottom of the channel.

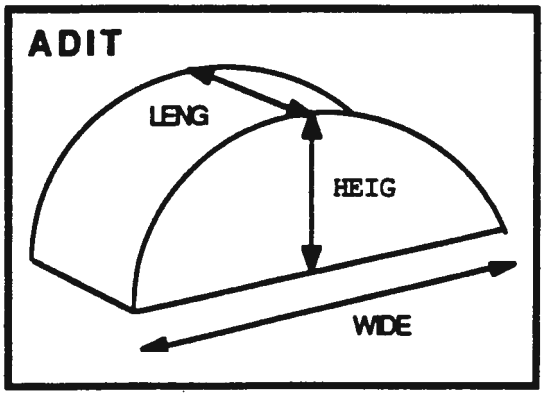


Figure 5. Adit dimensions. LENG, WIDE and HEIG are the Coal Data Base attributes where length, width, and height of an adit are stored in the Coal Data Base.

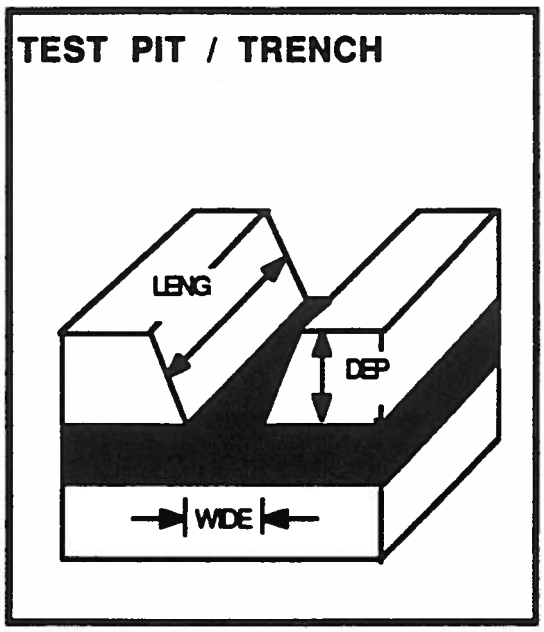


Figure 6. Test pit or trench dimensions. LENG, WIDE and DEP are the Coal Data Base attributes where the length, width, and depth of a test pit or trench are stored in the Coal Data Base.

INPUT

Data will be mainly loaded by copying ASCII files into the data base. Other ways in which loading will occur is by digital file loading via interative direct keyboard input using the database's menu system. A series of data coding forms for manual recording have been created and are presented in Appendix 4. These forms will need to be modified as the data base develops but are now available for coding new field data or existing data that is not in a digital form. The manual forms will be replaced, in time, by direct keyboard input or digital files as field computers become more commonplace.

PROCESSING

HARDWARE

The bulk of the data base development has been carried out on a DIGITAL VAX 780 mini computer with some additional processing on a DIGITAL VAX 8600. It is calculated that during the project, nearly $25,000 was spent in machine time directly related to database development (some expenditures in support of other coal group projects are not separately identifiable). Some of the more costly procedures involved decoding the ERCB data tapes which are not VAX compatible being IBM format data. Converting a tape to ASCII format can cost more than $500. Data update flags are lacking on the ERCB tape and this adds complexity to updates. At present we cannot always recognize updated data in the ERCB Coal Hole File. Discussions with the ERCB are continuing.

SOFTWARE

The data base software for the AGS Coal Data Base is a relational 4th generation package called INGRES. One of the advantages of this type of software is the capability to subset data and operate on PC

class machines. This can reduce project costs and provide the capability for both downloading and uploading of data sets. This capability was demonstrated at the 1988 AGS Geoscience Forum, in Calgary, some 300 km from the parent data base. The ability of the software to upload and download data may reduce storage and hardware costs since only the data base structure and minimal data need to be on-line at all times. The bulk of the data base can be stored on inexpensive tapes or CD-ROM type devices.

As well as the data base software a number of FORTRAN routines were written for data extraction and a line editor was used for data manipulation.

EXTRACTING DATA

AVAILABLE DATA TYPES

The types of data available can be seen on Figure 1, or identified in Appendix 2 (Section 1), and the Glossary (Appendix 1). Some discussion of the type of data stored can also be found in the section on data storage. The data can be grouped into the following categories:

SITID (LINK OR KEY IN THE data base)
LOCATION
(e.g. TEN TM, THREE TM, MINE GRID, NTS, DLS-CORD., DLS LSD, UTM, LLELEV)
STRUCTURAL GEOLOGY
LITHOLOGY
COAL QUALITY
PALYNOLOGY
COAL PETROGRAPHY
SAMPLE INFORMATION
SAMPLE STORAGE
ANALYSIS INFORMATION
GEOTECHNICAL INFORMATION

DATA COVERAGE/AVAILABILITY

The current surface spacial availability of data within the data base can be seen in Appendix 6 (map, distribution of data ERCB Coal Hole File and ARC Map, Richardson and Mandryk, 1987). Information availability in the subsurface is highly variable but little information is attainable for depths greater than 400 meters.

Coal quality information is even more restricted in areal distribution. Seven index maps in Appendix 6 shows the distribution of proximate, ultimate, chemical, fusion, trace element analysis and coking test data sites in the province.

RELIABILITY

At present the database does not include a guide to data reliability with the exception of that provided by the ERCB. The confidence level (CNF_LVL; Appendix 1) or data reliability is a subjective measure of the reliability of the data, especially the logs, on an ascending scale of confidence; the value '1' is reserved for poor quality holes, (i.e. short holes, caved holes, etc.); the value '0' has the meaning not assessed (ref: ERCB 'Data Element Description Report; this code is used internally at and by the ERCB). It was beyond the scope of the present study to evaluate the reliability of all data within the data base. Problems are known to exist (Strobl et. al., 1989; Macdonald et. al., 1989) with the data. Future evaluations by the AGS on the data and an estimate of it's reliability will be noted in the data base as the data is examined in AGS studies. This is not a trivial problem; the matter requires additional research to address the larger problem of the recognition of reliable data.

QUERY PROCEDURES

SIMPLE RETRIEVAL

The Coal Data Base Search Request Form (Appendix 5) can be used (beginning in May 1989) as a guide to simple data retrievals from the AGS Coal Data Base. Presently data is queried using interactive Structured Query Language (SQL) commands. Next year (1990) SQL commands embedded in other application software, such as a GIS routines, will query the data base for attributes based on a region "drawn" on a GIS display. Other queries will be made through the data base's menu system, or through a number of customized user friendly query procedures that will be developed for common requests (presently under development). Examples of query procdures could be: find locations where any type of an analytical result, geological occurrence, or other any type of specified data or the values associated with those attributes is located; with associated qualifies, questions such as how many?, when?, by whom?

These queries will be done on a cost recovery basis and are expected to cost a few tens of dollars per simple request. As part of the data base development, during 1989-1990 fiscal year, requests for information costing under $1000. will not be charged. In the future simple requests may be paid using VISA. The objective is to provide inexpensive, convenient and equable access to the data.

COMPLEX EXTRACTIONS

Extractions which are very specific, or large and complex extractions of data requiring SQL programming will also be done on a cost recovery basis or can be negotiated. Complex and large retrievals costing more than $1000 can be paid and negotiated through short term contracts with ARC (see example contract form; Appendix 5). The short form contract can be used for standing or open orders from frequent clients.

CONFIDENTIAL DATA

Although one of the reasons for establishing a coal geology research data base is to make information widely available and useful to the Alberta coal sector some information must, at least for a time, be kept confidential. Industry data in some cases is not in the public domain or it has not been released for public use by the ERCB. It therefore, cannot be made available in an uninterpreted form by the AGS without written permission of the individual industry source.

SUMMARY

It is important to stress that it is the Coal Data Base itself and not this report that is the primary product of this project. This report and it's Appendices should, however, document the data base as fully as possible. The Coal Data Base's prime function is to support the coal-related information requirements of the Alberta Geological Survey's Coal Geology Group as well as those of industry and government. It will also provide a centralized collection of coal data in a consistent format, regardless of the source of the data, while simultaneously archiving costly-to-obtain data. The overriding design philosophy was to allow complete flexibility for the type and number of data attributes stored. New fields or data types can be added or deleted at any time without damaging the integrity of the data base. Currently, the Coal Data Base contains data from the Energy Resources Conservation Board (ERCB) Coal Hole File while data from the Alberta Geological Survey (AGS) has been formatted for input in the spring of 1989. The Coal Data Base is fundamental since it supports all present and future projects undertaken by the Coal Geology Group of the Alberta Geological Survey.

FUTURE PLANS

Our future objectives are to enhance and support the capabilities of the Coal Data Base. This will be achieved by keeping the data base operational, adding data, developing reporting capabilities which make querying easier, and by improving the data base's capability to store sedimentary geology information.

To get the maximum benefit it is planned to keep the data base current by adding existing hardcopy data and new data as it becomes available. In addition, data in the data base must become more accessible to project geologists through reporting procedures. Since information in the data base comes from the context of sedimentary geology, the data base must be enhanced to provide more comprehensive sedimentological descriptions. Cooperative ventures with the ISPG will be pursued in this regard.

The data base gives resource companies a current view of the coal information publicly available in Alberta. We plan to increase the level of awareness of the data base to both industry and government, in part, by writing user manuals and pamphlets and by demonstrating the Data Base at technical conferences. A "meta" data base or index of the information held in the AGS Coal Data Base will be produced, on diskettes, thereby providing users with a cost effective means of locating and requesting the information they need.

In the future we hope to move the data base to a more efficient hardware set linked to the Alberta Research Council's computing network. Dedicated hardware will eliminate on-going CPU charges of a time-shared mainframe computer, speed response time, and encourage use and exploration of the data. We plan to update the Data Base regularly with new releases of the ERCB Coal Hole File and with new AGS data. It is estimated that considerable effort will be needed to write an automated update procedure. We plan to enter into cooperative discussions with

the ERCB regarding the nature of the data collected, its format and automated updating.

A major effort in entering hardcopy coal data and new data presently not in digital format will need to be initiated during the next year or two. More time should be spent on developing and enhancing the sedimentary geology module of the Data Base so that complete outcrop and core descriptions can be stored. In addition links with our digital log analysis machine and digitally storing of log records will be explored. New data storage and distribution technologies such as CD-ROM disks will be evaluated. Effort is planned for developing easy to use query and reporting procedures based on identified user needs and to develop links to geostatistical, statistical, and GeoScience Information System mapping software (Richardson et.al., 1989).

REFERENCES

Langenberg, C.W., Macdonald, D.E., Richardson, R.J.H 1986. Geological studies of coal in Alberta. Alberta Reserach Council Open File Report 1986-14. 106 pages.

Macdonald, D.E., Langenberg, C.W., Gentzis, T., and Kalkreuth, W. 1989. A regional evaluation of coal quality in the northern foothills/mountains region of Alberta. Alberta Reserach Council Open File Report 1989-01. 97 pages.

Mandryk, G.B., and Richardson, R.J.H. 1988. Coal resource data in the plains area of Alberta (diskette and map). Alberta Reserach Council Open File Report 1988-07. 12 pages.

McCabe, P.J., Langenberg, C.W., Macdonald, D.E., Richardson, R.J.H., and Strobl, R.S. 1987. Coal geology research program. Status report and workplan for 1987-1989. Alberta Research Council internal report. 114 pages.

Richardson, R.J.H., Mandryk, G.B. 1987. Coal resource data locations plains area, Alberta. Alberta Research Council map.

Richardson, R.J.H., Krzanowski, R.M., Chao, D., GeoScience Information System Pilot Study. Alberta Research Council Open File Report 1989-03.

Strobl, R., Wong, R., Krzanowski, R., Mandryk, G., Chao, D., and Chidambaram, N. 1989. Coal quality in the Ardley coal zone, plains region of Alberta. Alberta Research Council Open File Report 1989-8.

APPENDIX 1
SEE
ARC OFR 1989-02B

APPENDIX 2
SEE
ARC OFR 1989-02C

APPENDIX 3