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Results from GIS Development Contract 17 September 1991 — 16 April 1992 BMR Record 1992/63

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by
Robyn Gallagher

Minerals and Land Use Program

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister for Resources: The Hon. Alan Griffiths
Secretary: G.L. Miller

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
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Introduction

This record contains the results of a GIS Development Contract for the Minerals and Land Use Program of the Bureau of Mineral Resources.The objectives of the contract work were:

1) To develop database structures, procedures and software links to allow for the coordinated development of ARC/INFO GIS geological map databases suitable for export to external clients;

2) To allow two-way transfer of vector data between the BMR Cartographic Services Unit Intergraph system and the Minerals and Land Use Program Arc/Info system, and;

3) To convey the results of the work to other interested parties through a national conference on GIS, cartographic and database standards.

4) Liaise closely with a GIS Working Group, set up separately to improve the integration of map production and analytical spatial databases in Minerals and Land Use Program, Information Systems Branch and Cartographic Services Unit.

The record includes a brief summary of the work carried out during the contract. The appendices contain all additional documentation produced during the contract, and also a reprint of two discussion papers presented by Gallagher at the national conference.

1. Standard Data Sets: The Data Dictionary

After investigation of existing data sets for several of the Eastern Goldfields mapsheets, comparison of them with the provisional data standard proposed by Peter Williams, and discussion with geologists and other members of the GIS Working Group, a data dictionary was formulated.

This contains definitions for 'new' data sets created within the mapping programme as well as coverages which will be created from existing Oracle databases.

Because it is possible to link new attribute tables to Arc at any future time, and because the ultimate aim is to make use of existing Oracle tables, the data dictionary has been kept as simple as possible. Its data layers and

attributes can be periodically extended or refined as experience is acquired. The current data dictionary is documented in detail as Appendix A.

2. Image Data

It is possible to create images in I2S suitable for display in Arc/Info. Images must be byte data, may be multi-channelled, and must have certain header information (origin, pixel size, projection) to be useful within the GIS. The I2S command for creating an image is DISK'WRITE'ERDAS. If relevant header information is absent from the I2S file, the user must supply it.

3. Extracting Data from ORACLE

Until ORACLE is available to Arc/Info via SQL*NET, data sets will be extracted from the database on the Data General and built into GIS coverages on the SUN. Four SQR utilities are available on the D G for creating ASCII files specifically formatted for input into coverages described in the data dictionary: SITES, DEPOSITS, ROCKCHEM and STRUCTURES. The user documentation for those utilities is included as Appendix B.

4. Coverage Descriptor Files

All data sets originating in the GIS will be accompanied by a descriptor file: a table which contains information about the spatial and attribute parts of the coverage. This table is based on the information required by FINDAR (National Resources Information Centre), and is similar to a scheme being used by the forestry industry.

A descriptor file will be constructed automatically when a coverage is created, and the geologist is required to enter a small amount of information, such as the relevant mapsheet name and number. Most information is standard for a given coverage, and is put into the table automatically. The table must be checked and updated when the coverage is archived.

The Arc/Info program which creates a descriptor file may be run at any time to provide a table for coverages which existed before this scheme was implemented.

An example of the table and its contents for a coverage containing geological polygons is included in Appendix C.

5. BMR Symbol Set

A small number of BMR symbols were transferred from Intergraph to Arc/Info via design files, to demonstrate that the process is feasible. The task of creating an Arc/Info symbol set using this methodology is currently being undertaken.

6. Data Export and Exchange Procedures

Feedback from companies which have purchased digital map data sets was taken into account in formulating provisional guidelines for exchanging data (Appendix D)

Exchange of data with the BMR Intergraph system was tested using the Minerie 1:100 000 map data sets. It was found necessary to send very simple data sets: lines and text with no other attribute data; entities in different levels or different design files if they were to be differentiated in Intergraph. Import of cartographic data from design files into Arc/Info is a simpler process, but not without problems.

The experiences gained from transferring data between Arc/Info and Intergraph were the basis of some of the data transfer menu utilities.

7. Menu Utilities

a) General menu utilities

This group of utilities is used to standardise data transfer procedures. They illustrate the type of utility which can be implemented within Arc/Info. It is very easy to modify these procedures or add new options, and this is certain to occur as the experience base broadens. The documentation for the utilities is in Appendix E.

b) Menu utility **create_covs**

A menu-driven utility was developed to create standard coverages as defined in the data dictionary. This will ensure that coverages have correctly named and defined attributes as well as descriptor files where appropriate, and can be created with minimum tedium. The options which have been implemented are those which create coverages from data obtained from ORACLE: DEPOSITS, MINLOC, ROCKCHEM, SITES and STRUCTURES. The first four of those are point coverages; the last contains both points with attributes and line segments suitable for display purposes only. The code to create those line segments was moved from the DG to the SUN, and now functions invisibly behind Arc/Info.

The option to create cartographic coverages (a graticule, frame etc.) makes use of the Fortran code generated by Peter Williams, with some upgrades. Geological polygons and linear structures coverages are less routine than the others, and it is only possible to automate part of their creation.

A description of the utility, which is used to fully or partially create MLUP coverages as described in the data dictionary, is in Appendix F.

c) Menu utilities **export_standard** and **export_covs**

A menu-driven utility, **export_standard,** is used to convert standard coverages to the exchange formats supported by the Arc/Info mapping system. A description of its options appears as Appendix D. The DLG option for **export_standard** is described in Appendix G. This utility is similar in purpose to **export_covs,** except that it is tailored to exporting the subset of standard coverages which may be sold: it searches for coverages with particular names, and exports them so that they correspond to the accompanying documentation.

When using these export utilities for preparation of material for sales, all coverages should be exported and re-imported, with the imported version checked against the original, to ensure data integrity in the final product.

d) menu utility **standard_plot**

This is a prototype aml to create a plot file for a map constructed from standard coverages. The user must supply the following information:

1. the name of the workspace containing the standard coverages
2. the name of the plot file, which will be created in the current directory
3. the map angle to be used by Arcplot
4. the scale of the map (default is 100,000)
5. the name of the INFO lookup table used to colour the geological polygons and legend boxes. It must have items map_symbol and symbol.
6. whether additional coverages are to be used (roads, culture, spot heights,...)

As well as the plot file, a second file is created with the same name but an extra extension '.aml': for example if the plot file is minerie.plt, the other file will be minerie.plt.aml. This file contains a listing of all commands used to generate the map and may be modified and run at any time to create a variant of the map.

More work will be required on this utility as users decide whether it meets their needs.

e) menu utility **archive_standard**

This utility copies a (sub)set of standard coverages from one workspace to another, checking that the coverages contain the correct items, descriptor files and expansion tables.

The user is prompted for the name of the workspace containing the coverages, which will be copied to the current workspace.

The categories of coverages to be archived are selected via buttons in a menu which closely resembles that for **create_covs.** After each selection the user is prompted for name of the input coverage to be used. The output coverage receives the standard name, and the next highest version number is assigned if a copy already exists in the current workspace.

Before a coverage is archived, a check is made that its feature attribute table has the correct items, that descriptor files exist where required and that expansion files are present and contain the correct items. Coverages which do not conform to the standard are not archived.

8. Workshop on Geographic Information Systems, Cartographic and Geoscience Data Standards

The GIS Working Group assembled a program and invited speakers for the workshop held on 18th-20th March, 1992. The workshop was designed primarily to provide a forum for government geoscience organisations, but a number of external client groups was also represented. Discussion papers presented as a result of this contract, and others from the working party, are available in BMR Record 1992/27, the Proceedings of the Workshop on Geographic Information Systems, Cartographic and Geoscience Data Standards.

9. Documentation

A description of the directory structure used for Arc/Info utilities has been prepared (Appendix H)

Documentation for completed utilities has been added to Arc/Info, and can be obtained in the same way as **help** for Arc.

Documentation to be included on a data tape sent to a customer was developed. Every customer receives a file containing a description of the data contained in the relevant Arc/Info coverages: it is a modified version of the data dictionary. In addition, sites receiving DXF or design file format require a second description of the modifications made to the data in writing that format.

APPENDIX A

Minerals and Landuse Program Digital Map Database
Proposed GIS Data Dictionary 16th April, 1992

This design builds on initial proposals described by Peter Williams in "MINERALS AND LANDUSE PROGRAM PRIMARY DIGITAL MAP DATABASE: a discussion paper". It is a data dictionary for coverages already in production; coverages proposed by Peter Williams, but not yet available, are not considered here; neither are auxilliary data sets such as hydrology or cultural features for which others are custodians.

1. Geological Boundaries

Coverage Name : GEOLPG_n
Features : polygons
arcs

Polygon attributes :

geolpg_n-id	4,5,B
polylabel	4,5,B unique identifier used instead of -id
map_symbol	6,6,C

Related expansion table (GEOLPG_n.EXP):

map_symbol	6,6,C used for relates
rock_unit_name	64,64,C
legend_text	256,256,C
rock_unit_descn	1024,1024,C

Arc attributes :

geolpg_n-id	4,5,B
bmr_code	6,6,I see notes
class	1,1,I optional qualifier for BMR symbols code

*** redefined item for plotting

big_code	7,7,I concatenation of bmr_code & class

Because the coverage may be built as arcs and/or polygons, there is no need for a second coverage GEOLLN, which no-one was using. Arc attributes are expressed in terms of BMR symbols codes, if available.

It is considered imperative to keep an early copy of the polygon linework, before cleaning, attributing etc., as a backup.

2. Linear Structures

Coverage Names : FAULTS_n
FOLDS _n
LINEARS_n
VEINS&DYKES_n
HORIZONS_n

Features : arcs
points

Arc attributes :

coverage-id	4,5,B	
arclabel	4,5,B	identifier to link arcs with expansion tables
bmr_code	6,6,I	see notes
class	1,1,I	optional qualifier added to BMR symbols code
*** redefined item for plotting		
big_code	7,7,I	concatenation of bmr_code & class

Related expansion table VEINS&DYKES_n.EXP :

arclabel	4,5,B	used for relates
vein_subtype	64,64,C	textual description of vein type

Related expansion table HORIZONS_n.EXP :

arclabel	4,5,B	used for relates
rock_type	64,64,C	textual description of rocktype

Point attributes :

coverage-id	4,5,B	
arcnumber	4,5,B	unique identifier to link points with arcs
bmr_code	6,6,I	see notes
value	4,5,B	value of dip or plunge

This dual structure is suggested because of the presence of any number of dip and plunge values which may be placed along the arc. These are stored as points, but are linked back to the arcs via arcnumber.

3. Point Structures from the Oracle STRUCTURES database

Coverage Names :

BEDDING_n	type = 1
CLEAVAGE_n	type = 2
FOLIATION_n	type = 3
IGNEOUS_n	type = 4
AXIAL_SURF_n	type = 5
MINOR_FAULT_n	type = 6
MINOR_VEINS_n	type = 7
JOINTS_n	type = 8
MINOR_FOLDS_n	type = 20
LINEATION_n	type = 21 - 29
OTHER_STRUC_n	type > 29

Features : arcs
points
annotation

Arc attributes :

coverage-id	4,5,B
priority	4,3,B (default 0)

Priority is the same value as that assigned to the point features. It is included to allow selective plotting of structural symbols based on priority. Annotation accompanying arcs with priority 1 is in level 1; all other annotation is in level 2.

Point attributes :

coverage-id	4,5,B
origno	5,5,C
locno	16,16,C
*** redefined item for relates	
unique_id	21,21,C concatenation of origno, locno

Related table (coverage.REL) :

origno	5,5,C
locno	16,16,C
type	4,2,B
subtype	4,2,B
azimuth	4,3,B
inclin	4,2,B (default 0)
pitch	4,2,B (default 200)
octant	2,2,C (default blank)
generat	4,1,B (default 9)
priority	4,3,B (default 0)
*** redefined item for relates	
unique_id	21,21,C concatenation of origno, locno

These items are defined with Arc/Info's closest equivalent to the Oracle definitions,and the same item names as in the STRUCTURES database.The exception is origno, which is a character item for the purpose of redefinition.

4. BMR Sites from the Oracle STRUCTURES database

Coverage Name : SITES_n
Features : points

Point Attributes :

sites_n-id	4,5,B	
origno	5,5,C	
locno	16,16,C	
*** redefined item for relates		
unique_id	21,21,C	concatenation of origno and locno

Related table (SITES_n.REL) :

origno	5,5,C	
locno	16,16,C	
dlong	8,F,11,6	
dlat	8,F,11,6	
mapno	22,22,C	
*** redefined item for relates		
unique_id	21,21,C	concatenation of origno and locno

These items are defined with Arc/Info's closest equivalent to the Oracle definitions, and the same item names as in the STRUCTURES database. The exception is origno, for the purpose of redefinition.

5. Deposits and Prospects from MINLOC database

Coverage Name : MINLOC_n
Features : points

minloc_n-id	4,5,B	use Oracle item id_minloc
cod_longitude	8,F,11,6	
cod_latitude	8,F,11,6	
code_accuracy	8,8,C	
name_locality	80,80,C	
name_ref_point	60,60,C	
map_or_reference	10,10,C	
commodities	110,110,C	

Coordinates will be projected to AMG

6. Geochemistry Samples from ROCKCHEM MAJORS database

Coverage Name : ROCKCHEM_n
Features : points

Point Attributes :

rockchem_n-id	4,5,B	
origno	5,5,C	
sampno	16,16,C	
*** redefined item for relates		
unique_id	21,21,C	concatenation of origno & sampno

Related table (ROCKCHEM_n.MAJ) :

origno	5,5,C	
sampno	16,16,C	
sio2	4,F,5,2	
tio2	4,F,5,2	
al2o3	4,F,5,2	
fe2o3tot	4,F,5,2	
fe2o3	4,F,5,2	
feo	4,F,5,2	
mno	4,F,5,2	
mgo	4,F,5,2	
cao	4,F,5,2	
na2o	4,F,5,2	
k2o	4,F,5,2	
p2o5	4,F,5,2	
h2oplus	4,F,5,2	
h2omin	4,F,5,2	
co2	4,F,5,2	
loi	4,F,5,2	
rest	4,F,5,2	
total	4,F,6,2	
*** redefined item for relates		
unique_id	21,21,C	concatenation of origno & sampno

7. Cartographic Coverages

These coverages are used to plot a geological map in the standard cartographic style. They are :

FRAME	The map frame (normally parallels of latitude and lines of longitude plotted accurately)
BORDER	A drawn border around the map, outside the annotation.
GRID	The AMG grid lines
GRATICULE	The latitude and longitude graticule as 1 minute small tics and 10 minute large tics on the map frame, and 10 minute intersection crosses internally.
ANNOFRAME	Annotation on the frame, grid and graticule
LEGEND	A polygon coverage containing the recommended geological reference for the map
MAPSURROUNDS	Information surrounding the geological map: location diagrams, scale bar, orientation information ...

LEGEND and MAPSURROUNDS have an integer arc attribute called LINELABEL, used as the linesymbol in plotting.

LEGEND has a polygon attribute called MAP_SYMBOL corresponding to the MAP_SYMBOL used in GEOLPG, used to colour legend boxes.

Notes:

The following items occur in many coverages:

bmr_code	is an integer derived from the Symbol No. in "Symbols Used on Geological Maps". For example, 5.5.1 becomes 551.

An Info table containing the code numbers and their descriptions has been created. It is /gis/master/common!bmrsymbols and has the following structure:

bmr_code	6,6,I
description	128,128,C

class	is an integer derived in similar fashion from the classification section of the symbols book, and will be used as a modifier (inferred, concealed, ...) where necessary.

An Info table of classifiers and their descriptions has been created. It is called /gis/master/common!bmrclass and has the following structure:

class	1,1,I
description	30,30,C

Each coverage for which the mapping groups are custodians will contain two descriptor (.DES1, .DES2 Info) files. These will be created automatically at coverage creation time, with a fixed set of attributes corresponding to the FINDAR entries. Most entries will be defaulted, but the geologist creating the coverage will be asked to supply a few entries using input forms.
The file will be upgraded again at the time of archiving the coverage.

APPENDIX B

SQR Utilities for Extracting Coverage Data from Oracle on the DG.

There are four SQR utilities available for extracting data from Oracle tables. They all function in a similar manner to obtain data for a single 1:100K mapsheet, and each creates an ASCII file for direct input into one of the standard Arc/Info coverages defined in the data dictionary.

They have the following names:
SITES.SQR obtains data for the SITES coverage from the LOCALITIES table
DEPOSITS.SQR obtains data for the MINLOC coverage from the MINLOC tables
ROCKCHEM.SQR obtains data for the ROCKCHEM coverage from the MAJORS table
STRUCTURES.SQR obtains data for one of the point structures coverages from STRUCTURES and STRUCTYPES

All utilities are invoked in the same manner:

SQR utility username/password <-Ffilename> <mapnumber>

The last two parameters are optional. If a filename is not supplied, the ASCII output file will have the same name as the utility, with the extension .LIS (note -F precedes the file name). If the mapnumber is not supplied in the calling sequence, the user is prompted for it by the utility.
For example,
SQR SITES GEOCHEM/ISTRY
will create an output file called SITES.LIS containing the data for a sites coverage, prompting the user for a map number
and
SQR ROCKCHEM GEOCHEM/ISTRY -FMASON.DAT 2939
will create the output file MASON.DAT containing data for a rockchem coverage for the Mt Mason 1:100,000 map.

STRUCTURES is slightly more complicated in that it requires **two** parameters - a map name and one or more integers specifying structure type. A complete list of structure type values and their explanation may be found in BMR Record 1990/79.

The following is an abbreviated list:

Type	1	Bedding
	2	Cleavage
	3	Foliation
	4	Igneous layering
	5	Axial surface
	6	Fault
	7	Vein
	8	Joint
	20	Fold hinge
	21	Lineation
	22	Paleocurrent
	23	Boudin axis
	31	Kink band
	32	Shearing direction
	35	Mylonite fabric

If several structure values are supplied, the integers must be separated by commas.

SQR STRUCTURES GEOCHEM/ISTRY 2939 20,21,22,23
will create the output file STRUCTURES.LIS containing data for all lineation types for the Mt Mason 1:100,000 map.

APPENDIX C

A.1.NAME =GEOLOGICAL BOUNDARIES MT MASON 2939
A.2.REFERENCE =GEOLPG
A.3.OTHER.NAME =
A.4.ABSTRACT =GEOLOGICAL BOUNDARIES FOR THE MT MASON MAPSHEET 2939
A.5.OWNER =BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
A.6.OTHER.ORG =
A.7.OTH.ORG.DESC =
A.8.AUTHORS =M DUGGAN
A.9.OTH.DIR.REF =
A.10.COPY =NO
A.11.M.D.DIR.ID =
A.12.DIR.PUBLIC =YES
A.13.TRANSFER =NO
C.1.DIR.SPAT.REF =COMPLETELY
C.2.PROJECT.TYP =AMG
C.3.COORD.UNITS =MTR
C.4.SPAT.FEAT.T =LIN POL
C.5.TOPOL.STRUCT =YES
C.6.TOPOL.DESC =NONE
D.1.GENERAL.AREA =WA
D.2.ON/OFF.CODE =ONSHORE
D.3.SPAT.DESC =MAPSHEET MT MASON 2939
E.1.FED/ST.AREA =WA
E.2.1.MAP.SHEETS =100,000 2939 MT MASON
E.2.2.MAP.SHEETS =
E.2.3.MAP.SHEETS =
E.2.4.MAP.SHEETS =
E.5.1.MIN.LONG =
E.5.2.MIN.LAT =
E.5.3.MAX.LONG =
E.5.4.MAX.LAT =
E.6.1.SW.ZONE =
E.6.2.SW.EAST =
E.6.3.SW.NORTH =
E.6.4.NE.ZONE =
E.6.5.NE.EAST =
E.6.6.NE.NORTH =
F.1.DATA.FORM =GIS VEC
F.2.WORK.MEDIUM =MDI
F.3.SUPP.DOC =

F.4.DIG.DATA =COMPLETELY
F.5.SOFTWARE =ARC/INFO
F.6.HARDWARE =SUN
F.7.INT.FORMATS =ASCII EXPORT DXF DLG3 IGDS
F.8.SIZE =100 KBYTES
G.1.CUST.ORG =BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
G.2.CUST.POS =HEAD OF PROGRAM, MLUP
G.3.STATUS =INPROGRESS
H.1.PRIM.DATA =COMPLETELY
H.2.DATA.COLL =RSS RSA FME FNO FSP LME API
H.3.SOURCE.MAT =
H.4.SOURCE.DESC =
H.5.DP.DET =
H.6.POS.ACC =10 M to 100 M
H.7.POS.ACC.DESC =GPS & AUSLIG BASE MAPS
H.9.LOG.CONS =GRAPHICAL COMPARISON WITH OTHER DIGITAL DATA SETS AND IMAGES
H.10.COMPLETE =BASED ON REGIONAL TRAVERSES AND IMAGE INTERPRETATION
J.1.ACC.RES =NO RESTRICTIONS
J.2.1.OUT.PROD =DIGITAL DATA ON MAGNETIC TAPE
J.2.2.OUT.PROD =
J.2.3.OUT.PROD =
J.2.4.OUT.PROD =
J.2.5.OUT.PROD =
J.3.1.PROD.CH =$300
J.3.2.PROD.CH =
J.3.3.PROD.CH =
J.3.4.PROD.CH =
J.3.5.PROD.CH =
J.4.SUPP.ORG =BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
J.5.SUPP.POS =SALES CENTRE
J.6.ORD.PROC =THROUGH BMR SALES CENTRE
J.7.ORDER.TIME =2 WEEKS
K.1.1.KEYWORD =GEOLOGY
K.1.2.KEYWORD =GEOLOGICAL MAP
K.1.3.KEYWORD =GEOLOGICAL STRUCTURES
K.1.4.KEYWORD =
K.1.5.KEYWORD =
O.1.ORG.NAME =BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS
O.2.ORG.TYPE =FEDERAL GOVERNMENT

O.3.ORG.ACC =BMR
O.4.POS.TITLE =SALES CENTRE
O.5.POS.ACC =
O.7.RES.ADD =ANZAC PARK EAST BDG, CNR
CONSTITUTION AVE & ANZAC PDE,
PARKES ACT 2600
O.8.POST.ADD =GPO BOX 378, CANBERRA ACT 2601
O.9.PHONE.NO =06-249-9519
O.10.FAX.NO =06-257-6466
O.11.EL.MAIL.ADD =PETERW@BMR.GOV.AU
O.12.NET.NAME =INTERNET

B.1.1.ITEM.NAME =POLYLABEL
B.2.1.ITEM.DESC =4,5,B UNIQUE IDENTIFIER FOR
POLYGON
B.3.1.SPAT.RES =1:25000
B.1.2.ITEM.NAME =MAP_SYMBOL
B.2.2.ITEM.DESC =6,6,C
B.3.2.SPAT.RES =1:25000
B.1.3.ITEM.NAME =ROCK_UNIT_NAME
B.2.3.ITEM.DESC =64 C ROCK UNIT NAME IN OPTIONAL
RELATED TABLE
B.3.3.SPAT.RES =1:25000
B.1.4.ITEM.NAME =LEGEND_TEXT
B.2.4.ITEM.DESC =256 C MAP LEGEND TEXT IN
OPTIONAL RELATED TABLE
B.3.4.SPAT.RES =1:25000
B.1.5.ITEM.NAME =ROCK_UNIT_DESCN
B.2.5.ITEM.DESC =1024 C DESCRIPTION OF ROCK UNIT IN
OPTIONAL TABLE
B.3.5.SPAT.RES =1:25000
B.1.6.ITEM.NAME =BMR_CODE
B.2.6.ITEM.DESC =6,6,I BMR SYMBOLS CODE FOR ARC
B.3.6.SPAT.RES =1:25000
B.1.7.ITEM.NAME =CLASS
B.2.7.ITEM.DESC =1,1,I CLASSIFIER ADDED TO BMR CODE
FOR ARC
B.3.7.SPAT.RES =1:25000

APPENDIX D

Procedures for Exporting Data from Arc/Info Coverages

The following export formats are suggested for sending data to customers:

1. Arc/Info export format (.e00 files obtained using EXPORT)
This is the preferred option since the exact coverage structure, including topology and attributes, is preserved.
The coverage files are converted to a single compressed ASCII file.
The customer must have access to Arc/Info - not necessarily runnning on the same type of computer as used for the EXPORT.

2. DXF format (obtained using ARCDXF)
This is the AutoCAD interchange format, supported by many software systems.
It is a less than satisfactory export format since topology and attributes are essentially lost: lines, points and annotation may be exported, and some attribute information may be transmitted using CAD parameters such as layer and color.
This is an ASCII file format.

3. IGDS format (Intergraph design file obtained using ARCIGDS)
This format is also unsatisfactory: topology is lost and attributes are only preserved in a very simplistic form, since the format is designed for cartographic products.
The Arc/Info translator has bugs which cause small line segments to be 'lost'; it is also unable to create Intergraph structures, such as polygons.
This is a binary format.

4. DLG3 (Digital Line Graph 3 Optional format from ARCDLG)
If a customer does not have Arc/Info it is worthwhile asking whether he has a DLG3 translator since this is a very common format in the USA.
This may be the way to send data to other GIS such as Geovision, Genamap or SPANS.
Topology is preserved, and it is possible to attach attributes via a code and subcode; projection information may be included; and an ASCII header, containing additional coverage information, may be added. Character attributes and annotation can only be transmitted in a very cumbersome manner.
This is an ASCII format.

5. ASCII files.
This is feasible for small coverages, and may require someone at the other end to reformat the data before it can be used.
The spatial data may be UNGENERATEd into a file containing point or line coordinates, and one of the INFO export options can be used for the attributes.

Sending the data:

The method used to send the data depends on the interchange format and the medium used:

1. ASCII formats
To write a 1/2 inch 9-track magnetic tape, use the Arc/Info TAPEWRITE command (if a tape drive is attached to the computer running Arc/Info), or an equivalent UNIX utility.
To write a 1/4 inch UNIX cassette, use tar.
e.g. tar cvf /dev/rst0 minerie
To write floppy disks, use tar, DOS copy or some other DOS utility such as pkarc. For safety, include the unpacking utility on a floppy. There is a parameter in EXPORT which allows the user to split the export into several smaller files which will each fit on a floppy disk.

2. IGDS format
To write a 1/2 inch 9-track magnetic tape DO NOT use TAPEWRITE since it is for ASCII files.
Use dd if=... of=/dev/rmt0
To write 1/4 inch cassettes or floppies, follow the same procedure as for Arc/Info EXPORT format.

Remember:
Only tar format preserves a directory of the files on the tape.
TAPEWRITE or dd just copy 'anonymous' files to a tape. Therefore, it is wise to include an ASCII file at the start of the tape detailing its contents.
Such a list should be sent on paper with all tapes, floppies etc.

All tapes, floppies should have a sticky label with clear identification of contents and format (including density for 9-track tapes)

APPENDIX E

MLUP Menu Utilities

ARC2IGDS

Converts coverages to design files.

The input coverage(s) may come from any specified workspace for which the user has read access. The output design file(s) are written to the current directory.

The contents of a design file are determined by the features to be converted and the mapping table used. There are buttons to select ARCS/POINTS/ANNOTATION (POLYGONS do not convert satisfactorily) and the selected combination is converted if the feature exists in the coverage. The default mapping table writes lines to level 1, points to level 2, and annotation to level 3 of the design file. A more sophisticated design file may be created by supplying an appropriate mapping table.

The utility is designed to convert a series of coverages from within a workspace. A default name for the design file is generated by taking the coverage name and adding the suffix .dgn.

When all conversion options have been selected, the translation is effected by the CONVERT button. A summary of the conversion is displayed, then the menu reappears to allow the next coverage to be selected. The process is terminated using the FINISH button.

IGDS2ARC

Extracts levels from a design file into coverages.

The user must know which levels he has in the design file if he wishes to extract only some of them (information obtained using Arc command igdsinfo). To extract all levels, use $rest in the menu slot reserved for the list of levels required.

The input design file(s) may be in any specified directory for which the user has read access. The output coverage(s) are written to the current workspace.

It is anticipated that the user will extract a series of coverages from a design file and the menu is structured for that purpose: the design file information remains current for as long as the user wants to specify levels.

A coverage may contain the information from any number of levels: these are entered as a string of integers separated by comma or blank. To obtain all levels use $rest instead of a list of numbers.

When the CONVERT button is hit, the current set of levels are converted into the named coverage, which will be overwritten if it already exists. The utility assumes the design file coordinates are kilometers, and transforms them into meters.

The user may continue converting levels to coverages for as long as necessary.

EXPORT_COVS

Exports a set of coverages from a workspace.

The coverage workspace may be any for which the user has read access. The output export file(s) are written to the current directory.

There are three possible export formats, selected via a button:
EXPORT creates Arc/Info export format
IGDS produces an Intergraph designfile
DXF creates an AutoCad DXF file

The user is prompted with the name of each coverage in the workspace. If it is not to be exported, the NO button causes the next coverage name to be displayed.

Otherwise, an output file name is created from the name of the coverage, with an appropriate suffix added (.e00/.dgn/.dxf). The user may change this name. Hitting the YES button causes the conversion to be carried out.

The utility loops over each coverage in the workspace. It may be terminated at any time with the CANCEL button.

SUMMARISE_ATTS

Summarises the values of attributes in a coverage.

The coverage workspace may be any for which the user has read access. The output file(s) containing the summary are written to the current directory.

The user supplies the name of each coverage for which a summary is to be created. A default output file name is the coverage name with a .att suffix.

The OK button causes a summary to be written as follows:
- the attributes are considered for the polygon, arc and point attribute tables in that order if they exist
- all attributes from coverage-id onwards are considered
- a table is written for each attribute, containing each different value and the frequency with which it is used

Summaries may be generated until the FINISH button is selected.

APPENDIX F

CREATE_COVS

create_covs is a menu utility for creating standard MLUP coverages, as described in the data dictionary. It is started by typing its name from arc (after using &station).

The main menu consistes of a series of buttons which invoke secondary menus according to the type of coverage to be created. The following options exist:

1. Geology (geolpg_n)
2. Linear structures

(faults_n) (linears_n) (veins&dykes_n)
(folds_n) (horizons_n)

3. Point structures from Oracle

(bedding_n) (cleavage_n) (foliation_n) (igneous_n)
(axial_surf_n) (minor_fault_n) (minor_veins_n) (joints_n)
(minor_folds_n) (lineation_n) (other_struc_n)

4. Sites from Oracle (sites_n)
5. Deposits from MINLOC (minloc_n)
6. Geochemical measurements from ROCKCHEM (rockchem_n)
7. Cartographic coverages

Note that the coverages are created in the current workspace: n is an integer which is incremented to give a new version of the coverage name in the workspace. For example, if a coverage called geolpg_3 exists already, **create_covs** will create a new one called geolpg_4. Cartographic coverages will be overwritten if any with the appropriate names already exist.

The methods of generating coverages within the utility fall into three groups.

1. Geology and Linear Structures.

This is the least automated process. Both options expect that the spatial parts of the coverages have already been created (using ADS or by importing design files, for example), and only help to create attribute, descriptor and expansion tables. This means the geology option looks for a polygon coverage, and the linear structures option looks for a line coverage. The coverages need not be complete but must have the appropriate topology.

In all cases, definition of attribute and expansion tables is the default; if the DEFINE_ADD button is selected for any table, its contents will also be loaded from a specified ASCII file using TABLES ADD FROM. The ASCII file must be in exactly the right (free) format for loading into the table.
The expansion file for GEOLPG need not contain all items: those to be included are selected using appropriate buttons.
Descriptor files are always created, and the user is prompted for a small number of entries which cannot be defaulted: for example mapsheet name, mapsheet code, geologists responsible for data.

Once an appropriate input coverage has been specified, a sub-menu is displayed which varies according to the coverage being created.
a) Geology coverage built only as polygons
This menu has buttons and fields corresponding to the polygon attribute and expansion tables.
b) Geology coverage built as polygons and arcs
This menu has buttons and fields corresponding to the polygon attribute and expansion tables, and to an arc attribute table.
c) Linear structure coverage built only as arcs
This menu has buttons and fields corresponding to the arc attribute and expansion tables.
d) Linear structure coverage built as arcs and points
This menu has buttons and fields corresponding to the arc attribute and expansion tables, and the point attribute table.

2. Coverages Imported from Oracle

Creation of these coverages is a completely automated process.

The user must run the appropriate SQR utility on the Data General to extract ASCII data from Oracle (see separate documentation).
These files must be transferred to a Sun workstation accessible to Arc/Info, using FTP for example.

When the appropriate button is selected in the **create_covs** menu, the user is prompted for the name of the ASCII file from Oracle. Then the coverage is created, and its items defined and filled - all without user action. Note that the ASCII file must have been obtained using the standard SQR utilities.

3. Cartographic Coverages.

Five of the standard cartographic coverages may be created using **create_covs:** LEGEND and MAPSURROUNDS are not yet available.

When this option is selected in the menu, a sub-menu prompts the user for the name of a coverage containing tics, and the latitude and longitude of the lower left corner of the map. If a standard set of tics are to be used for all coverages in the workspace, they can be copied from an existing coverage; otherwise Arc/Info will create default tics.
Note: southern latitudes are negative when supplying the map's lower left coordinates.

All cartographic coverages, with correct names and contents will be generated automatically once the information is supplied via the second menu.

APPENDIX G

EXPORT_STANDARD

export_standard is a menu utility for converting MLUP standard coverages into a range of interchange formats for export to other systems. There are four possible formats: Arc/Info export, Autocad DXF, Intergraph design file, and Optional DLG3.

The utility is invoked by typing its name from arc (after using &station). It prompts the user for the name of the workspace containing the standard coverages, and writes the output files to the current directory. Buttons are used to select the interchange format required.

The following coverages will be converted if they exist in the workspace:
1. Geology
2. Linear structures
3. Point structures (linework and annotation only)
4. Sites
5. Cartographic coverages

The highest version of a coverage will be converted, and the version number will be dropped at conversion. For example, if a workspace contains geolpg_1 and geolpg_2 only geolpg_2 will be exported, and all related output files will be named geolpg.

Arc/Info Export Format

Coverages are converted to the standard Arc/Info e00 files. Expansion files and descriptor tables are exported automatically with a coverage. For point structures, the linework and annotation is reselected for export, but the pat is not included.

Autocad DXF

This conversion attempts to preserve as much of the Arc/Info attribute information as possible, using the DXF graphics attributes.
For all coverages with bmr_code and class:
bmr_code becomes dxf-layer
class becomes dxf-color
For geolpg:
map_symbol is written as dxf-text

For linear structures:

arclabel becomes dxf-thickness
For point structures:
arc priority becomes dxf-color
For sites:
origno becomes dxf-layer
locno is written as dxf-text
Cartographic coverages are simply converted to lines and text.

All descriptor and expansion tables are converted to ASCII files with the same name (e.g. geolpg.exp) using INFO LIST.

Intergraph Design Files (IGDS)

This conversion writes Arc/Info attribute information as text strings located on the map, and makes use of the IGDS graphical property 'color'. It is an extremely unsatisfactory method of transmitting attribute data.
The following attributes are converted to text:
map_symbol in geolpg
bmr_code in all linear structure coverages
origno in sites
Attributes which are converted to color are:
arclabel in linear structures
priority in point structures

Any annotation (in cartographic coverages and point structures) is written as text.

For all design files lines are written to level 1, points are written to level 2, and text is written to level 3.

All descriptor and expansion tables are converted to ASCII files with the same name (e.g. geolpg.exp) using INFO LIST.

Optional DLG3

DLG3 has the advantage of preserving topology, but is inappropriate for exporting character attributes or annotation. It requires numeric attributes to be named MAJOR1, MINOR1, MAJOR2, MINOR2, ...

Standard coverages are handled in the following ways
For geolpg:
map_symbol is written into an ASCII table called geolpg.pat, with a record for each coverage#
If arc attributes exist,
bmr_code is major1
class is minor1
For linear structures:
coverage-id is major1
arclabel is minor1
bmrcode is major2
class is minor2
If point attributes exist,
bmr_code is major1
value is minor1
For point structures:
annotation accompanied by its location is written into an ASCII file called coverage.ann
arc coverage-id is major1
arc priority is minor1
For sites:
origno and locno are written into an ASCII file called sites.pat, with one record for each coverage#

All descriptor and expansion tables are converted to ASCII files with the same name (e.g. geolpg.exp) using INFO LIST.

APPENDIX H

/gis/master/common

All MLUP utilities, documentation and special tables have been centralised in directories below /gis/master/common.

The subdirectory structure required by ESRI has been complied with, but additional directories are used.

The following directory structure is in place:

/gis/master/common contains tables needed by all users.
There are four Info tables:

structypes	has the plot strings for each symbol in the Oracle Structypes table. It is used to create the line segments for the point structures coverages.
bmrsymbols	is the expansion table for bmr_code
bmrclass	is the expansion table for the classifiers which may accompany bmr_code
template.map	is used by arc2igds, to map lines, points and annotation to levels 1, 2 and 3 of a design file.
seed.dgn	is a seed file supplied by CSU. It is used in utilities which convert coverages to design files for Intergraph.
bmrsymbols.txt	is an ASCII file containing the information in the Info file bmrsymbols.
3039.lin 3039.mrk	are line and marker symbol sets constructed by Mark Rattenbury

/gis/master/common is set as the &atool path in all station files.
This means that /gis/master/common/atool/arc, /gis/master/common/atool/arcplot, /gis/master/common/atool/arcedit etc. must contain primary amls (those corresponding to utilities which are used like Arc/Info commands).

/gis/master/common/atool/arc contains the primary amls for all MLUP utilities used from Arc:

arc2igds	igds2arc	
export_covs	export_standard	archive_standard
create_covs	standard_plot	summarise_atts

/gis/master/common/aml contains all secondary amls run (via &run) from utilities.
It is the &amlpath in the station files.

/gis/master/common/menus contains all menus used by utilities.
It is the &menupath in the station files.

/gis/master/common/doc contains text files describing the standard MLUP coverages.

/gis/master/common/programs contains Fortran source code, executable code and libraries. Since there is no aml directive which sets this path for Arc, a global variable (.progdir) is used in utilities which execute Fortran programs to point to the location.