Developing a GIS-based exploration-activity spatial index for the WAMEX open-file system

by K. M. Ferguson

Abstract

A GIS-based spatial index to company mineral-exploration reports held in the WAMEX open-file system has been developed as a pilot project on the SIR SAMUEL 1:100 000 sheet. Specific areas of exploration activity, under the general headings of geological mapping, geochemical exploration, geophysical exploration, and drilling, and a related attribute database have been retrieved from the open-file company reports and developed as an interactive display in Arc/Info and Arcview. This adds value to the WAMEX database and greatly facilitates its use.

KEYWORDS: Yilgarn Craton, Sir Samuel, GIS, mineral exploration, data processing, data bases, indexes, geological mapping, geochemical sampling, geophysical surveys, drilling.

A major drawback of the Western Australian Mineral Exploration Index (WAMEX) open-file database, in its present form, has been the relative difficulty in finding what exploration work was done, and where. It has been difficult to select reports, or groups of reports, which cover a specific area or geological feature, and also to precisely locate the exploration activities described within a selected report. Companies formulating exploration programs need to know what specific information is available in the areas of prospective ground outlined by their project-generation process. Alternatively, they are interested in locating areas that have been lightly or inadequately tested.

The present WAMEX database can only be searched spatially on 1:50 000 sheet areas, on the outer coordinates of a group of tenements, or on locality or project names. This very non-specific approach has meant that the vast volume of vital data contained in WAMEX has probably been underused, has been poorly used or has proved very time consuming to use effectively. In particular, it has been difficult to make regional or local comparative studies of a number of exploration programs.

To counter this, and to give WAMEX that vital spatial dimension, it has been decided to develop a Geographic Information System (GIS) spatial index for the database. This will allow easy access to more-detailed information on specific areas of previous exploration activity.

The pilot project has been conducted in the Eastern Goldfields in association with the 1:100 000 mapping program of the Geological Survey of Western Australia (GSWA). The WAMEX exploration-activity GIS database has been combined with 1:100 000 geological mapping, airborne-geophysical, and Landsat datasets for industry groups to assess. Feedback from the trial will result in improvements and refinements to the display and analytical capabilities of the database in the GIS. For this pilot project the process has been limited to the SIR SAMUEL[1] 1:100 000 sheet.

Data collation

Data collation involved the examination of hardcopy exploration reports in combination with a print-out or screen view of the WAMEX textual database. Spatial information was plotted manually on 1:25 000 topographic basemaps with separate sheets for geological mapping, geochemical surveys, geophysical surveys, and drilling. Areas of exploration activity were acquired from report plans, figures or text (e.g. drillhole coordinates), often by photocopying to the base-map scale. Topographic features, particularly drainage, contour patterns, and traces of old exploration grids, commonly provide the best control for the location of activity. The areas of activity were then digitized using a computer-assisted drafting (CAD) system Microstation, converted into Arc/Info, and then transferred into Arcview.

A database was developed in Microsoft Access to tabulate the exploration statistics, extracted from the reports and attached to the areas of exploration activity, for the sheet area. Figure 1 illustrates the range of activities that have been plotted as polygons, lines or points. An Activity[2] table in Access lists, as a record, each separate activity

[1] Capitalized names refer to standard map sheets.

[2] Table names and field names within tables in Arcview have the first letter capitalized.

TYPE_VERB	Description
AMAG	Airborne magnetic surveys
ARAD	Airborne radiometric surveys
AEM	Airborne electromagnetic surveys
AGRA	Airborne gravity surveys
MAG	Magnetic surveys
GRAV	Gravity surveys
RAD	Radiometric surveys (includes downhole logging)
EM	Electromagnetic surveys (includes TEM, Sirotem, etc.)
GEOP	Other geophysical surveys (includes IP, resistivity, etc.)
SEIS	Seismic surveys
SSED	Stream sediment surveys
SOIL	Soil surveys
REGO	Regolith surveys (includes laterite, pisolite, ironstone, etc.)
NGRD	Non gridded geochemical surveys (includes chip, channel, dump and gossan)
RAB	RAB drilling (includes other shallow geochemical drilling such as auger)
HYDR	Groundwater surveys
RC	RC drilling
ROT	Rotary drilling - predominantly percussion drilling
DIAM	Diamond drilling
GEOL	Geological mapping

Figure 1. Activity Types table in Access

contained in the WAMEX open-file company reports that apply to Sir Samuel (Fig. 2). The table includes the following fields:

- ID: record/activity identification number
- Report (Text): WAMEX report accession catalogue number for text volume
- Report (App/Plans): as above for volumes of related appendices and plans, or for other reports that contain the same activity
- Points: number of plotted polygons/lines/points attached to this activity
- Verb Code: activity-type abbreviation. See Figure 1 for explanation.
- Drill M: average depth of drillholes
- Activity: details of the activity. The scale of the source plan is indicated along with numbers of holes and/or samples, total metreage of drilling, all elements assayed (with a # as a rough guide to the presence of anomalism), and other necessary descriptive text, such as Sirotem, Lag, Gossan, Aerodata, Geobotanical.

Not all the activities in this table are represented spatially in Arcview but for those which are this identifier is the link with the plotted feature. In some cases the reports do not contain enough information to adequately determine the location of particular activities. In these cases, where no plans are available, the location of other activities in the report, or group of reports covering the same tenements, may give a rough guide to the location. For instance, rock-chip sampling is commonly reported but rarely indicated on plans. To include a polygon, line or points in the geochemical theme in Arcview in order to represent chip sampling would be misleading. However, it seems logical to assume that the sampling has occurred within the area of geological mapping.

In other cases in the Activity table, where an activity shows no spatial representation under the Points field, it may be that the same activity is contained in another report and is therefore attached to another ID. The Report (App/Plans) field may help to locate the activity in this case.

A Report table in Access contains the more general information for each WAMEX open-file report in the sheet area. Fields in the Report table include the WAMEX Group number and Item number, 1:50 000 Sheet, Company, Year of activity, Commodity, and names of related Locality/Prospects and Mine/Workings. A Summary field records other relevant information from the report such as whether the report constitutes text, plans or appendices, whether a literature review is included or whether petrographic studies have been carried out. The first report for each related group of reports also includes an outline of the geology of the report area and a summary of exploration for the group in this field.

Exploration data in Arcview

In Arcview, elements of the Activity and Report tables are combined into an Attribute table for each of the four general headings for exploration: geological mapping, geochemical exploration, geophysical exploration, and drilling. These only include activities linked to spatial features, and each attribute table represents a spatial **Theme**[3]. Figure 3 shows part of the attribute table for the surface geochemistry **theme**.

The spatial **themes** in Arcview include the four exploration types described above. Figures 3, 4, and 5 show the Arcview screen with the **view** as the main image and **theme** legends to the left of the **view**. The **themes** that are displayed are indicated by the ticked boxes. The exploration **themes** may be combined with topographic **themes** as an aid to location, including roads, tracks, fencelines, hills, bores, townsites, locality names, and the drainage pattern. The information can be displayed in a variety of map projections, linked to Australian Map Grid (AMG) coordinates.

Other **themes** can be combined with the exploration and/or topographic **themes**. Recent GSWA 1:100 000 geological mapping (Liu et al., in prep.) has been incorporated and can be displayed in a number of ways, highlighting Precambrian lithologies and structural elements, regolith (Fig. 4) or as a solid-geology tectonic sketch (Fig. 5). The current tenement distribution is present as a **theme**. Digital satellite and regional geophysical images can also be incorporated.

For the purpose of the product trial, a number of textual and graphical **images** have been scanned from exploration reports and included in the Arcview package to show the types and visual quality of exploration results that can be presented.

[3] Arcview terms are indicated in bold.

ID	REPORT	REPORT (APP/PLANS)	POINTS	VERB_CODE	DRILL M	ACTIVITY (Scale of Source)
157	35467	34567		NGRD		Chip Au* - 6
158	35467	34567	8	RAB	16	79 holes 1235m Au As Cu Pb Zn Co Ni - 173
159	35467	34567	1	RC	59	8 holes 474m Au - 237
160	35465	34565	3	SOIL		Lag Au - 6709
161	35465	34565		NGRD		Chip Au - 5
162	35465	34565	20	RAB	22	173 holes 3742m Au As Cu Pb Zn Co Ni - 289
163	31140	31140		RAB	36	44 holes 1565m Au
164	32800	32800	2	SOIL		Lag Au* - 358
165	32800	32800	1	RAB	30	331 holes 9996m Au As Cu* Pb Zn Co* Ni* - 916
166	32961	32961	1	SOIL		Lag Au - 725
167	12399	12399 12400		MAG		Gmag
168	12399	12399 12400		GEOP		RRMIP
169	12399	12399 12400	2	NGRD		Gossan Co Cr* Ni* Cu* Pb Zn As* Au Pt Pd Mn - 496
170	12399	12399 12400	14	ROT		Percussion 14 holes 1522m Ni* Cu* Pd* Pt* Zn Cr Pb As Au - 746
171	12399	12399 12400	1	DIAM	162	1 hole 162m Ni* Cu Cr* Co Zn Pb As Au Pd - 39
172	12248	12248	1	MAG		Gmag
173	12248	12248		NGRD		Chip
174	12248	12248		ROT	33	Percussion 14 holes 458m Ni Cu Zn Ag Pb Au Nb La* Ta W Ti P
175	11820	11820 11822		NGRD		Chip
176	11820	11820 11821 11822	1	RAB	19	Auger 829 holes 15872m Ni Cu Zn Pb Cr As Mn Fe Co - 1633
177	14519	14519	1	EM		Sirotem
178	16712	16712	1	EM		Sirotem
179	19056	19056		NGRD		Chip Au* Ni Cu Zn Pb As Mn Cr Fe Al2O3 MgO CaO K2O TiO2 P2O5 Ag Co Bi V Mo Sr Y Be Ce Zr Sn - 25
180	19056	19056	7	ROT	54	Percussion 9 holes 489m Au* Ni* Cu Zn Pb As Mn Cr Fe Co Bi V Mo Sr Y Be Ag Ce Zr Sn Al2O3 MgO CaO Na2O K2O TO2 P2O5 - 489
181	26004	26004 11822	1	RC	38	11 holes 416m Au* - 208
182	26400	26400		EM		Sirotem 1:12 000
183	9248	9248		NGRD		Chip
184	9248	9248		RAB	13	88 holes 1114m
185	10323	10323 10324	1	AMAG		(1:10 000)
186	10323	10323 10324	2	MAG		(1:10 000)
187	10323	10323 10324	1	NGRD		Chip Cu Pb Zn* Ag Ni Co Cr Mn Au - 244
188	10323	10323 10324	9	RAB		104 holes Ni* Zn*Cu* Pb Cr Ag - 364
189	10323	10323 10324		ROT	93	Percussion 7 holes 652m Cu Pb Zn* Cr Ni Ag
190	8132	8132	1	AMAG		(1:50 000)
191	8132	8132		NGRD		Chip Cu Pb Zn* Ag - 33
192	8133	8133	4	MAG		Gmag
193	8133	8133	4	GRAV		Gravity
194	8133	8133		NGRD		Grab Cu Pb Zn Ag Au - 12

Figure 2. Activity table in Access

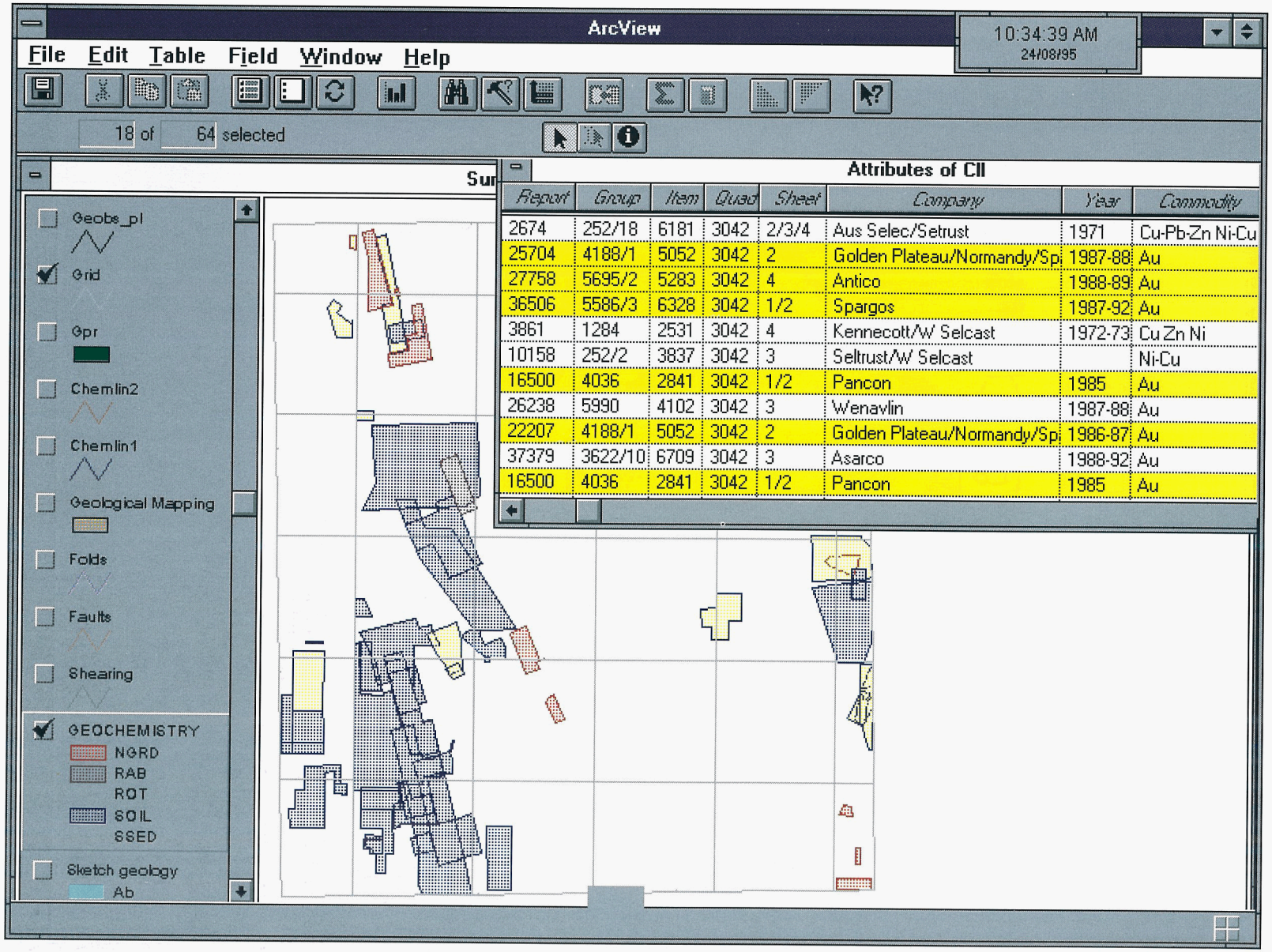

Figure 3. Surface geochemistry with anomalous Au selected (View and Attribute Table) in Arcview

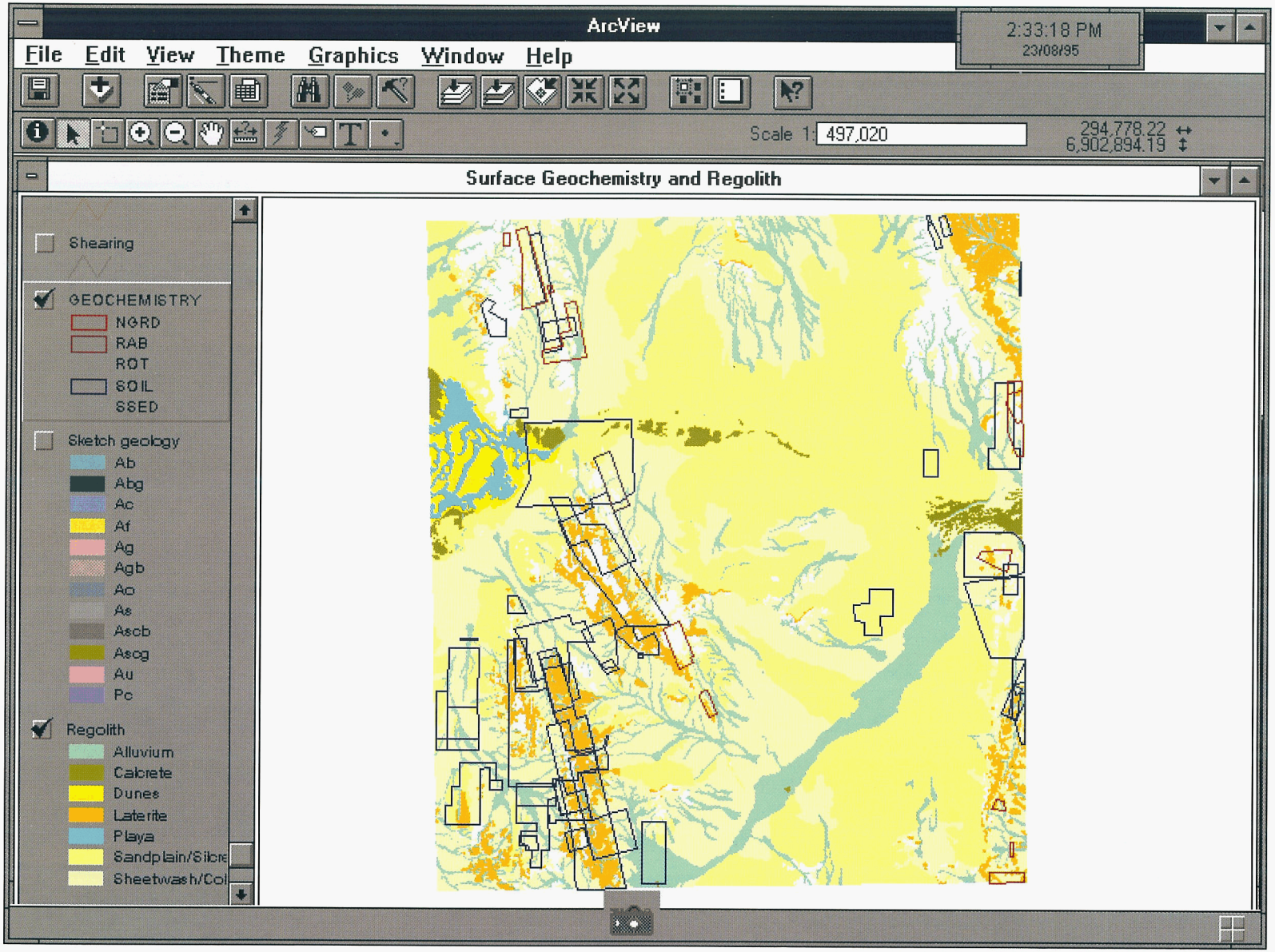

Figure 4. Surface geochemistry and regolith in Arcview

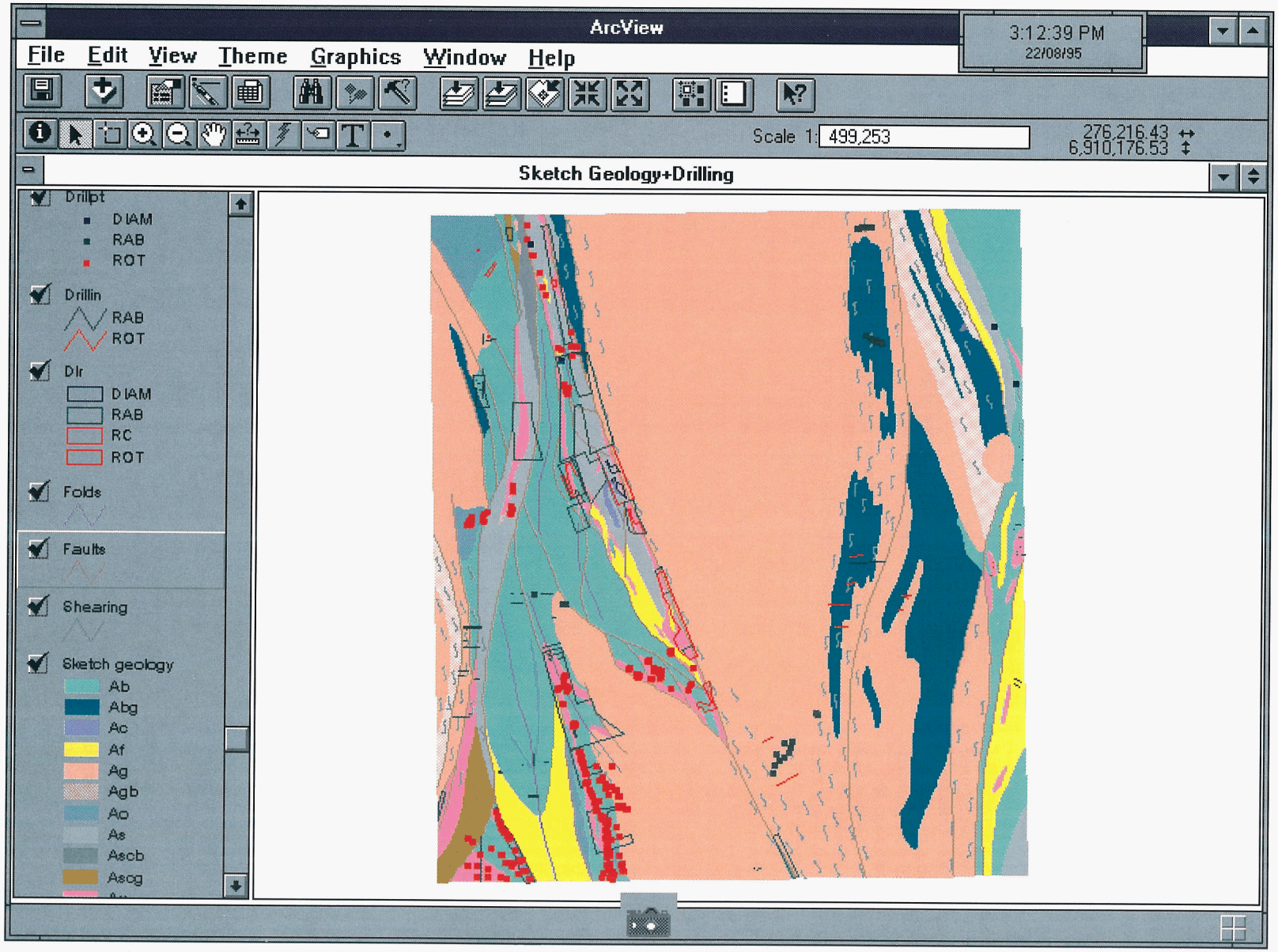

Figure 5. Sketch geology and drilling in Arcview

Display

The spatial information is displayed in Arcview as a **view**. The **view** is an interactive map which allows display, **querying**, and, to some extent, analysis of exploration data. It includes a scale that can be customized and gives AMG or latitude and longitude coordinates at the cursor point.

The **view** legend allows access to the **themes** so that all or a particular combination of themes may be displayed (Figs 3, 4, and 5). Within a single **theme**, for example geochemistry, with the whole theme displayed a legend can be used to colour code the polygons and lines, differentiating stream-sediment, soil, regolith, and non-gridded sampling. Alternatively, the individual types of geochemical sampling can be displayed as separate **themes** allowing more flexibility. The distribution of a wide variety of exploration activities can thus be visually compared with each other and with the more regional geological, geophysical, and topographic/satellite **themes**.

Details from the attribute tables that relate to the spatial feature **themes** can be accessed on screen in **view**.

Spatial features can be combined, for example, to:

- make a direct visual comparison of areas of stream-sediment sampling with the drainage pattern;
- view a combination of soil sampling and rotary air blast (RAB) drilling programs;
- compare areas of ground electromagnetic surveys with regolith and basement lithologies;
- assess areas of greenstones not presently under tenement and compare them with areas of low historical exploration activity.

The visual display can also be used to quickly assess, at any selected scale, the exploration coverage in a particular target area. Individual exploration programs can be identified by clicking on the appropriate polygon, line or point to display an Identify Results table which gives the ID and Report number along with other attribute information for the selected activity/record.

Query

The information stored in the attribute tables of the **themes** can be queried to select specific attributes or combinations of attributes on screen. Such a selection results in the highlighting of the appropriate polygons in the **view** and in the attribute tables (Fig. 3). **Queries** can be carried out through a spatial **query** from the **view** or a textual **query** direct from the attribute tables. The attribute tables are dynamic and allow sorting of records in any field, alphabetically or numerically in ascending or descending order, making selections relatively simple.

Examples of possible **queries** of the WAMEX data are as follows:

- Select drill programs or ground geochemical surveys that have targeted particular elements, and further select those for which anomalism is indicated (Fig. 3). This could be approached in a conceptual way through the Commodity field or in a more specific way through the Activity field.
- Establish approximate depth of regolith over parts of the sheet for which RAB drilling programs have been undertaken. This could be related to the mapped distribution of regolith types.
- Select all geological mapping polygons for which petrographic studies are reported.
- Select all geological mapping at scales of 1:10 000 or less.
- Establish sample density for geochemical surveys. This can be indicated by shades of colour in polygons or in graphical form (see below).
- Establish drillhole density for different programs, expressed as numbers of holes or total metreage, and compare for various projects or for years within a project. Again this could be colour coded or graphed.
- Select activities for a particular company.
- Select exploration activities for specific commodities.
- Select exploration activities over a particular time frame.
- Select exploration activities in the vicinity of a specific mine or prospect.

Charts

A variety of **charts** or graphs of numerical data from the attribute tables can be produced. For example, quantified areas of cover for specific survey types can be compared for all projects dealing with a specific commodity. Some other possible graphical **queries** have been indicated above. In a broader sense the relationship between time and volume of exploration can be graphed to display the changing nature of the historical search for various commodities.

Layouts

High-quality full-colour maps of **views** depicting the broad variety of combinations of spatial data, the results of **queries**, and graphs can be produced from Arcview, customized to desired scales. The great range of colour and shading combinations allows for clear highlighting, overlaying, and presentation of the required information.

Conclusion

This spatial, value-added index to the WAMEX open-file material is a major upgrade, and will greatly facilitate its use. However, it is limited in terms of accessing on screen, or allowing processing of, the actual data. Its function, at this stage, is as a more efficient conduit to the reports themselves or to their microfiche copies. The next step, to a result-based database, is being tested in other States, notably by the Queensland Geological Survey in the Mount Isa Inlier, and would involve a very labour-intensive process. For the moment the development of the WAMEX GIS will provide a significant boost to the use of the WAMEX data.

Reference

LIU, S. F., GRIFFIN, T. J., WYCHE, S., WESTAWAY, J. M., and FERGUSON, K. M., in prep., Sir Samuel, W.A.: Western Australia Geological Survey, 1:100 000 Geological Series.