The analysis and correlation of some geophysical and geochemical properties derived from computer analysis of the Lachlan Fold Belt Geoscience Database

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Introduction

During 1979–81, the Bureau of Mineral Resources gathered an extensive geoscience database covering the Lachlan Fold Belt of New South Wales, an area of approximately 250 000 km². Values for a wide range of geophysical, geochemical and geological properties were obtained from 895 sample sites. Observations entered into the database include field and laboratory measurements of magnetic, gammaspectrometric and density properties; detailed descriptions of the field geology; geochemical analyses for 11 major elements and up to 23 trace elements; petrographic descriptions; and detailed location data (Wyatt *et al.* 1984).

Computer analysis

These data have been extensively manipulated and analysed, using a database analysis software package on a Hewlett-Packard HP1000 mini-computer. Using this package, files of data have been grouped, sorted, and manipulated in a variety of ways, followed by detailed analysis and plotting of relationships between many of the measured properties. Statistical techniques were applied to the manipulated data, from which tables of summary values for physical and chemical properties were prepared for a range of rock type groupings. A number of plotting options were also available to show up correlations of the manipulated data; these included XY plots, XYZ plots, histograms, bar charts, dendrograms and triangular diagrams.

Grouping of data

Many of the analyses and plots were carried out with the data grouped into rock-type subdivisions. There are three broad groupings—acid plutonics, volcanics, sediments and metasediments—while within each of these groups are several subdivisions based on rock name (10, 10 and 12 subdivisions, respectively).

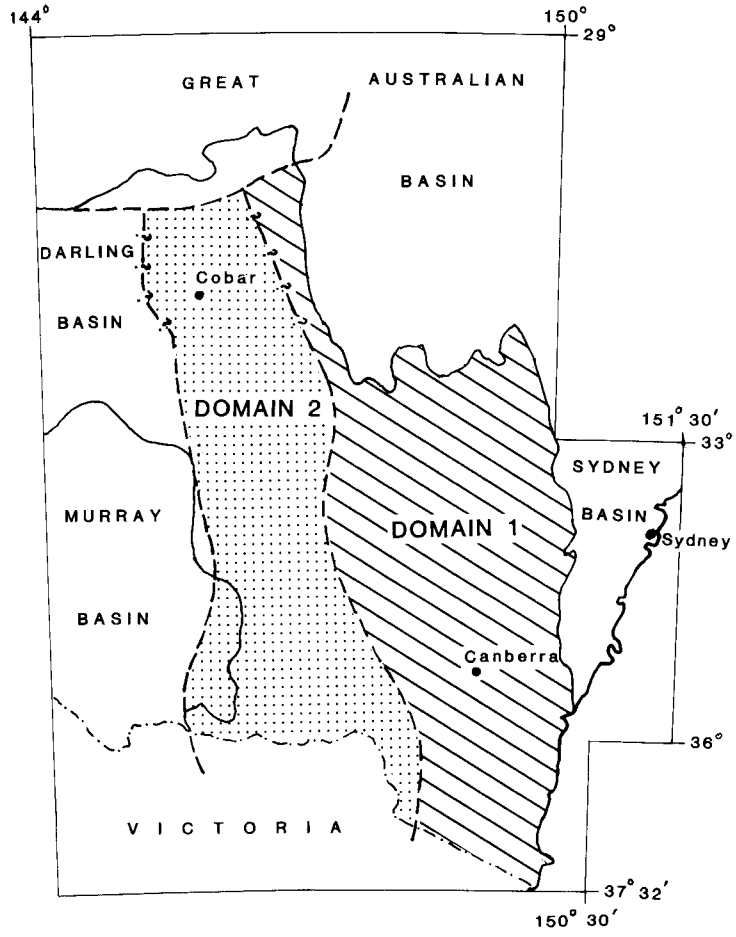

Fig 1 Locality map of the Lachlan Fold Belt.

The sampled area falls almost entirely within Domains 1 and 2 of Wyatt *et al.* (1980) (Fig. 1). Therefore, each of the 32 rock groups was subdivided into Domains 1 and 2.

Physical properties

One objective for analysing the database was to obtain typical values for physical properties of the various rock types samples, as they would be useful for any geophysical modelling investigations in the Lachlan Fold Belt. Some 240 stratigraphic units are represented in the database, and summary statistics have been obtained for each of these units for magnetic susceptibility (field and laboratory), remanence, dry density and grain density. However, because of the comparatively small sample size for most of these units, summary statistics for the major rock type groups are likely to be of more practical use.

Table 1 gives values for field magnetic susceptibility, remanence and grain density for the 32 selected rock types, subdivided where necessary into geophysical domains. These data show the contrast of values between rock types, and the magnetic data in particular show the difference between the two domains. The density data should be useful in gravity modelling.

The use of mean and standard deviation values for skewed distributions (such as magnetic properties) requires some care, and frequency histograms of the data on which the values in Table 1 are based are much better for practical use; however, space precludes their use here.

Correlation of geophysical and geochemical properties

Histogram plots of data sorted on several different variables, XY plots, and correlation analyses were carried out to see if, and to what extent, the geophysical and geochemical variables correlate. A general lack of correlation was evident in many of these analyses. This is interpreted as being due to different plutonic, volcanic and sedimentary rock suites, from various locations in the Fold Belt, being considered collectively under the 32 rock type groupings in Table 1.

Some correlation of variables was displayed, however. For instance, the magnetic susceptibility of magnetized acid

	FIELD MAGNETIC SUSCEPTIBILITY (10^{-6} S.I. units)					REMANENCE (S.I. units)					GRAIN DENSITY (t/m^3)			
Rock type/domain	No. Obs.	Mean	S.D.	Min.	Max.	No. Obs.	Mean	S.D.	Min.	Max.	No. Obs.	Mean	S.D.	Range
ACID PLUTONIC ROCKS														
Adamellite/1	61	6770	7810	0	27400	62	354	919	0	6000	59	2.67	0.05	0.29
Adamellite/2	15	106	134	0	459	16	3	7	0	30	16	2.66	0.03	0.11
Aplite/2	5	531	843	0	2010	5	21	27	0	50	5	2.63	0.09	0.22
Diorite/1	6	18300	13100	3480	39900	9	3410	5347	50	16000	9	2.76	0.03	0.09
Diorite/2	1	2290	-	-	-	1	1100	-	-	-	1	2.80	-	-
Gneiss/1	1	376	-	-	-	1	50	-	-	-	1	2.63	-	-
Gneiss/2	1	23	-	-	-	3	3	4	0	7	3	2.70	0.06	0.11
Granite/1	24	2130	3800	0	13750	29	142	389	0	2000	25	2.64	0.08	0.34
Granite/2	25	54	85	0	289	36	9	33	0	190	32	2.66	0.03	0.26
Granodiorite/1	30	12500	14600	0	41750	37	954	2534	0	11500	32	2.71	0.04	0.17
Granodiorite/2	4	118	225	0	456	5	1	1	0	2	4	2.71	0.03	0.07
Granophyre/1	7	8310	12700	20	33300	9	816	1227	0	3100	8	2.68	0.12	0.31
Granophyre/2	5	521	1150	0	2590	6	2670	6539	0	16000	6	2.61	0.04	0.11
Greisen/1	1	0	-	-	-	1	1	-	-	-	1	2.84	-	-
Greisen/2	3	37	54	0	99	5	16	36	0	80	4	2.71	0.05	0.11
Microgranite/1	2	690	930	33	1350	2	50	71	0	100	2	2.63	0.08	0.12
Microgranite/2	1	196	-	-	-	2	5250	7425	0	10500	3	2.65	0.01	0.01
Monzonite/1	4	24800	20900	1010	45100	4	805	611	40	1500	3	2.71	0.08	0.20
VOLCANIC AND DYKE ROCKS														
Altered basalt/1	7	2610	18800	323	48600	7	915	1430	0	4000	7	2.86	0.09	0.29
Andesite/1	24	16900	14900	251	61700	27	4100	6280	0	22000	24	2.76	0.09	0.29
Andesite/2	5	10600	10500	63	24800	5	520	521	0	1200	5	2.86	0.14	0.37
*Basalt/1	33	18300	15900	376	52300	40	5520	14400	0	80000	38	2.89	0.13	0.82
Basalt/2	1	42400	-	-	-	1	61000	-	-	-	1	2.78	-	-
Dacite/1	9	3610	10200	0	30900	11	462	1050	0	3500	11	2.67	0.06	0.22
Dacite/2	2	5030	6220	634	9420	3	337	574	0	1000	3	2.73	0.01	0.02
Dolerite/1	6	11800	9500	1620	29000	9	126300	363300	0	1100000	8	2.92	0.07	0.22
Dolerite/2	1	1070	-	-	-	1	10	-	-	-	1	2.88	-	-
Ignimbrite/1	41	2410	6910	0	39600	51	448	2800	0	20000	46	2.70	0.05	0.26
Ignimbrite/2	28	2760	5600	0	18400	37	1870	7250	0	39000	35	2.67	0.06	0.30
Lamprophyre/1	3	11700	14400	1050	27000	3	890	1400	1	2500	3	2.95	0.16	0.31
Lamprophyre/2	1	13900	-	-	-	3	12100	14900	900	28100	3	3.18	0.16	0.37
Rhyolite/1	14	5940	16600	0	63100	17	421	1080	0	4500	15	2.62	0.05	0.17
Rhyolite/2	4	56	39	0	89	4	3	5	0	10	4	2.63	0.03	0.07
Trachyte/1	3	6610	2610	3680	9020	3	1980	1710	50	3250	3	2.60	0.05	0.09
Tuff/1	5	182	227	0	561	10	22	42	0	135	10	2.69	0.05	0.14
Tuff/2	7	122	179	0	456	9	4	10	0	30	5	2.63	0.16	0.41
SEDIMENTARY AND METASEDIMENTARY ROCKS														
Argillite/1	3	89	154	0	267	3	110	101	0	200	2	2.79	0.02	0.03
Chert/1	3	129	218	0	376	3	4	4	0	8	2	2.68	0.06	0.09
Chert/2	3	75	68	0	135	3	3	5	0	8	1	2.62	-	-
Conglomerate/1	2	385	354	134	635	2	5	6	0	9	1	2.68	-	-
Conglomerate/2	10	92	161	0	412	12	32	72	0	190	7	2.77	0.20	0.61
Greywacke/1	10	377	809	0	2590	11	22	60	0	200	10	2.70	0.06	0.22
Greywacke/2	10	214	288	0	960	12	3	3	0	10	12	2.68	0.04	0.15
Limestone/1	3	0	0	0	0	4	1	1	0	2	4	2.68	0.01	0.03
Mudstone/1	11	171	225	0	698	11	1	2	0	5	10	2.73	0.05	0.18
Mudstone/2	2	149	196	10	287	3	1	1	0	1	2	2.76	0.11	0.15
Phyllite/1	5	288	644	0	1440	8	12	22	0	60	5	2.73	0.04	0.09
Phyllite/2	1	225	-	-	-	1	0	-	-	-	0	-	-	-
Quartzite/1	22	698	1470	0	5030	32	82	441	0	2500	26	2.69	0.11	0.56
Quartzite/2	23	176	192	0	644	33	2	4	0	20	25	2.69	0.05	0.18
Sandstone/1	17	1940	5670	0	21900	20	87	238	0	1000	20	2.70	0.13	0.55
Sandstone/2	24	37	81	0	331	31	3	9	0	50	24	2.65	0.06	0.20
Shale/1	3	0	0	0	0	4	2	2	0	5	3	2.71	0.01	0.02
Shale/2	3	552	614	125	1260	3	0	0	0	0	0	-	-	-
Siltstone/1	17	122	146		452	22	751	3520	0	16500	16	2.72	0.09	0.41
Siltstone/2	7	251	199	0	565	13	3	7	0	25	6	2.73	0.04	0.10
Slate/1	20	470	1390	0	6160	22	2	9	0	40	9	2.69	0.10	0.33
Slate/2	14	1382	3380	0	12600	18	46	188	0	800	9	2.93	0.34	1.07

* This group includes some Tertiary basalts.

Table 1 Summary statistics for values of field magnetic susceptibility, remanence and grain density for rock types in the Lachlan Fold Belt.

plutonic rocks decreases with increasing SiO_2 content, while there is no discernible pattern for the analysed lavas and tuffs. Also, an increase in K_2O content of magnetic plutonic rocks is accompanied by a decrease in susceptibility, whereas in the analysed felsic volcanics an increase in K_2O content is accompanied by an increase in susceptibility. The latter could be due to oxidation of ferromagnesian minerals to opaque oxides (including magnetite) in ignimbrites, and to the rhyolites in Domain 1 being magnetic (Table 1).

The analytical values of K_2O and Th were compared with those determined from field gammaspectrometric readings, while for uranium a high detection limit (3 p.p.m.) in the analytical data precluded a valid correlation. Good agreement was found with Th in all rock types, while with K_2O, the igneous rocks correlated much better than the more variable sediments and metasediments.

Future work

The analyses and correlations described here are a selection from the work carried out on the database so far. Many correlations have also been made between the geochemical variables, but there is still much more analysis to be carried out on the database. Most of the work on the database so far has concentrated on a general overview of correlations to evaluate its possible use for more specific investigations. Further analysis of the database may be of significant use in:

(1) providing information on the physical properties of rocks for use in geophysical modelling;
(2) possible delineation of metallogenic provinces;
(3) correlating physical and/or chemical properties as an aid to the location of ore environments—for example, the use of gamma-ray spectrometry in prospecting for tin and tungsten granites (Yeates *et al.* 1982);
(4) providing geochemical correlations which can assist in deciphering the evolution of rocks in the Lachlan Fold Belt.

References

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Acknowledgments

The BMR authors acknowledge with thanks the permission of the Director, BMR to publish material in this paper.

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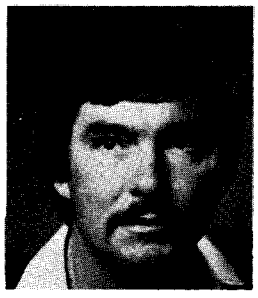

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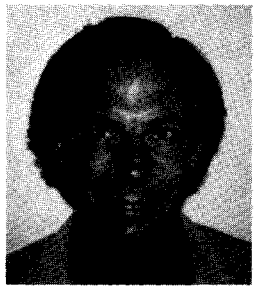

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