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Mineral geophysics in Tasmania.

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Abstract

All reports relating to geophysical exploration performed for or by mining companies and submitted to the Department of Mines prior to 31 May 1978 have been reviewed to allow formulation of a policy that will result in a decreased cost-benefit ratio.

The reports indicate failure to select appropriate geophysical methods, poor field techniques and supervision, and almost total failure to perform data reduction in the field. Combined with neglect of geological and previous survey data, this has led to indefinite survey results accompanied by constant recommendations for additional field work. There has been no improvement in survey quality during the period under study.

This Department must continue to increase the catalogue of physical property and report data available and must tighten control on exploration companies by insisting on detailed proposals prior to surveys and prompt report submission. The Department must be able to reject a report as inadequate. Assistance in survey specification, inspection and supervision of field operations and limited interpretational advice must be offered. This may involve changes in licence granting and renewal procedures.

INTRODUCTION

A total of 182 individual reports covering geophysical surveys and filed on open-file or closed-file with the Department of Mines prior to 31 May 1978 were examined during compilation of this report. Reports prepared by the Bureau of Mineral Resources or this Department were excluded as being unrepresentative of current company and consultant practices. Closed file reports were used solely to provide a wider statistical base for consultant and technique usage.

A number of reports submitted by companies are single paragraphs within the body of an exploration licence report, or are deliberately obscure, and provide little indication as to the contractor, the technique used, the area covered by the survey and the interpretation of the observations. The level of non-submission of reports is unknown except for those compiled by Scintrex Pty Ltd, where at least 28% of the reports prepared by the consultant have not been submitted to this Department.

SURVEYS CONDUCTED

After an initial surge of activity with the first availability of electromagnetic and induced polarisation techniques (fig. 1), the use of geophysical surveys increased somewhat erratically from 1967 to 1975 and then appears to have decreased dramatically in the period 1976-1978. It is likely that this decrease is due to non-submission of reports rather than any fall-off in activity.

The usage of a particular method is often governed by technological changes and the salesmanship of the supplier.

Aeromagnetic surveys (fig. 2)

Aeromagnetic surveys conducted in the late 1950s were flown at relatively high altitudes using fluxgate magnetometers, often with poor positioning, and lacked the resolution required for good interpretation. Surveys flown after 1964 were at lower altitude and used proton magnetometers, better positioning techniques and frequently composed part of a suite of simultaneous measurements.

Airborne electromagnetic surveys (fig. 3)

The early surveys were conducted shortly after the first light-weight EM equipment was manufactured and no significant anomalies were detected. Promotion of the Turair and similar methods in the early 1970s produced an upturn in the number of surveys although interpretation and terrain corrections remain inadequate.

Ground electromagnetic surveys (fig. 4)

The distribution of the number of surveys is similar to that for airborne EM surveys, but the period of higher activity in the late 1960s results from the earlier development of Turam and similar techniques. Interpretation of data from a survey is virtually impossible because of topographic effects and varying weathering depths.

Induced polarisation surveys - Electrical and magnetic (fig. 5)

McPhar Geophysics introduced IP to Tasmania in the late 1950s but the large increase in the number of surveys performed since 1970 is almost entirely due to service marketing by Scintrex Pty Ltd. The initial enthusiasm shown for MIP in 1974 did not recur until 1977-1978 when several abortive surveys were carried out.

Self potential and resistivity surveys (fig. 6, 7)

These techniques, which may be carried out rapidly and relatively cheaply, show a major peak in activity between 1969 and 1972 when C.G.G. included resistivity soundings and SP measurements in routine IP surveys. The level of usage of SP at all survey stages is disappointingly low.

Gravity and ground magnetic surveys (fig. 8, 9)

Surveys using these methods show no explainable variations. Although costly, the gravity method has the potential, if performed correctly, to rapidly resolve the nature of anomalies detected using other techniques.

Minor methods

The minor techniques that have been used are:

- Applied potential - six surveys only, although the technique is cheap and rapid.
- Mercury sniffer - several non-productive surveys.
- Radiometrics - eight small-scale air and ground surveys and one large benchmark airborne survey.
- Seismic - four small surveys reported, although a number of others have been carried out.

The choice of technique frequently appears to be made without reference to the site geology, terrain, vegetation, survey purpose and the results of previous surveys. (How many consultants come to this Department to examine open-file and Department of Mines reports before commencing a survey?).

Several examples of this include the use of ground magnetic surveys on basalt to look for possible slightly-magnetic or non-magnetic bodies under the basalt, airborne radiometric surveys in areas of heavy cover and the use of a mercury sniffer after a prolonged period of rain. A more complete range of techniques may frequently be performed for little more than the cost of the proposed technique, particularly if line preparation costs are high, yielding a lower cost-benefit ratio and a potentially less ambiguous interpretation.

Failure to perform physical property tests and orientation surveys has resulted in an unnecessarily high proportion of recommendations for resurveying using different techniques. The use of type surveys is totally misleading as the only body to give a 'type anomaly' will be the type body. An example of the problem caused by neglecting to perform an orientation survey is an airborne scintillometer survey to search for bauxite deposits in the basalt of north-west Tasmania (Close, 1970). No flight was made over a known bauxite deposit and the significance of readings 1.5 times background remains unknown.

The ultimate responsibility for choice of technique and adequacy of data and interpretation lies with the company requesting the survey, regardless of who performs the survey.

SURVEY REPORTS

The standard of reports is predominantly poor with a standard recommendation for the performance of an additional survey to fill gaps in the current survey. Conclusions within the body of the report and within the summary are often contradictory and although several physical parameters may have been measured, it is uncommon for more than one technique to be interpreted. There is a strong tendency amongst consultants to refer to anomaly sources as sulphides, apparently in an attempt to strengthen recommendations for further work. Examples are:

> 'The Bismark Creek Fault is well positioned by the EM results. This shows that the fault is mineralised.' (Webb, 1969).
>
> 'There are numerous zones of metallic mineralisation indicated' (Hallof and Burnside, 1970).
>
> 'The anomaly .... is large enough to suggest a large percentage of metallic mineralisation.' (Hallof, 1960).
>
> 'a definite induced polarisation anomaly associated with the feature indicating the presence of metallic minerals. The magnitude is great enough to suggest something more than just a few per cent disseminated sulphides.' (Hallof, 1959).

Many reported anomalies are readily explained by reference to the geology of the area, common examples being edge effects from basalt flows and IP anomalies due to black shale or clay zones. If all anomalies regarded as inferring sulphides were due to sulphides, as suggested by consultants, the top 30 m of the western Tasmanian crust would contain an average of at least 5% metallic sulphides.

The recommendations for additional field work arise from use of inappropriate methods and field techniques, failure to perform field reduction of the data to obtain a preliminary interpretation and lack of adequate field supervision. The latter is well illustrated by a gravity survey in which the gravity meter handling and positioning and the levelling quality were so poor that the final result had to be strongly amended by visual filtering (Sefton, 1960). The final interpretation, such as it is, frequently totally ignores the known geology and the results of previous work in the area, although both have been made available.

The standard of conduct and interpretation of surveys performed has shown no obvious improvement and has probably declined throughout the period covered by reports filed with this department. Survey costs, although available for only a small number of surveys, show a minimum loading of 50% over the charge for a comparable survey on the mainland exclusive of mobilisation costs.

RECOMMENDATIONS

To achieve the minimum cost-benefit ratio in geophysical mineral exploration the following procedure should be followed:

(*a*) An initial geological survey should be performed including descriptions of access, topography and vegetation. It may be decided not to invoke geophysics at this stage.

(*b*) If potential targets are located or supported by (*a*), the physical properties of materials in the area should be measured to enable computer simulation of anticipated anomalies and the evaluation of the applicability of available geophysical techniques.

(*c*) A survey of literature available on the area under survey, particularly that data held by this Department, should be thoroughly implemented to prevent repetition of previous surveys or more importantly, repetition of costly mistakes.

Self potential and ground magnetic surveys, if expected to assist in the location of anticipated targets, should be carried out by the company to provide cheap and rapid reconnaissance data. Great care must be taken to ensure a complete coverage and reliable readings. Interpretation of these results may lead to the cessation of geophysical activities or the choice of a different method.

(*d*) A brief orientation survey should be carried out immediately prior to any major survey and action taken to amend or cancel the main survey in the event of an indeterminate result. By arranging the orientation and main surveys sequentially, only one set of mobilisation charges must be met.

(*e*) For companies performing their own geophysical surveys, the data from stages (*a*) to (*d*) and from previous work should be considered and the appropriate methods and field techniques chosen. Reduction of data and close supervision during the field survey will allow detection of instrument faults or of high background noise levels and the detailing of anomalies that might otherwise be insufficiently delineated. If necessary, the survey may be abandoned or the technique may be adapted to minimise the problem if any possible anomalies would be obscured by background or instrument noise.

Consultants should be supplied with the data from stages (*a*) to (*d*) and previous reports and asked to submit details of the techniques proposed together with the reason for the choices. The client must closely supervise the field work to ensure that the consultant engaged will perform field data reduction as outlined above, will supply capable and qualified personnel and will acquire the data the client needs to evaluate any anomalies. Where possible, the client should specify the survey techniques to his own satisfaction.

(*f*) Detailed reports containing an integrated interpretation should be supplied shortly after the survey and consultants recommendations for additional work viewed with extreme caution. The major proportion of any consulting fee should be withheld pending the submission of a report satisfactory both to the client and the Department of Mines. A copy of the report should be submitted to the Department of Mines as soon as it is available to allow time for comment.

This Department must be prepared to evaluate all survey reports and to assist companies, especially those without specialist personnel, during stages (*b*) to (*f*). Where possible, this assistance should be limited to interpretational advice, assistance in survey specification, brief inspection of field operations and small orientation surveys in areas of exceptionally difficult geologic conditions. A catalogue of physical properties and unusual methods adapted to Tasmanian conditions should be available to all companies.

The Department should exert pressure on companies to submit advance details of surveys to allow field assessment and to promptly submit all reports to allow rapid feed-back from the department to the company.

REFERENCES

CLOSE, S.E. 1970. Scintillometer search for bauxite, northwest Tasmania. *Unpubl.Rep.C.R.A.Explorations Pty Ltd.* (Open file Q37/14).

HALLOF, P.G. 1959. Report on Moore's Valley induced polarisation. *Unpubl. Rep.McPhar Geophysics Ltd.* (Q72/21)

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HALLOF, P.G.; BURNSIDE, E. 1970. Report on the induced polarisation and resistivity survey on the Trial Harbour grid Zeehan area, Tasmania for Electrolytic Zinc Company of Australasia Limited. *Unpubl.Rep.McPhar Geophysics Pty Ltd.* (Q50/53).

SEFTON, I.V. 1960. Report on Moore's Valley gravity and magnetic surveys Nov./Dec. 1959. *Unpubl.Rep.L.A.Richardson and Assoc.* (Q72/17).

WEBB, J.E. 1969. Second progress report. Staverton geophysical results (Moina Sheets 1, 2) for Mt Lyell Mining and Railway Co. Ltd. *Unpubl. Rep.Austral Exploration Services Pty Ltd.* (Q37/24).

[18 July 1978]

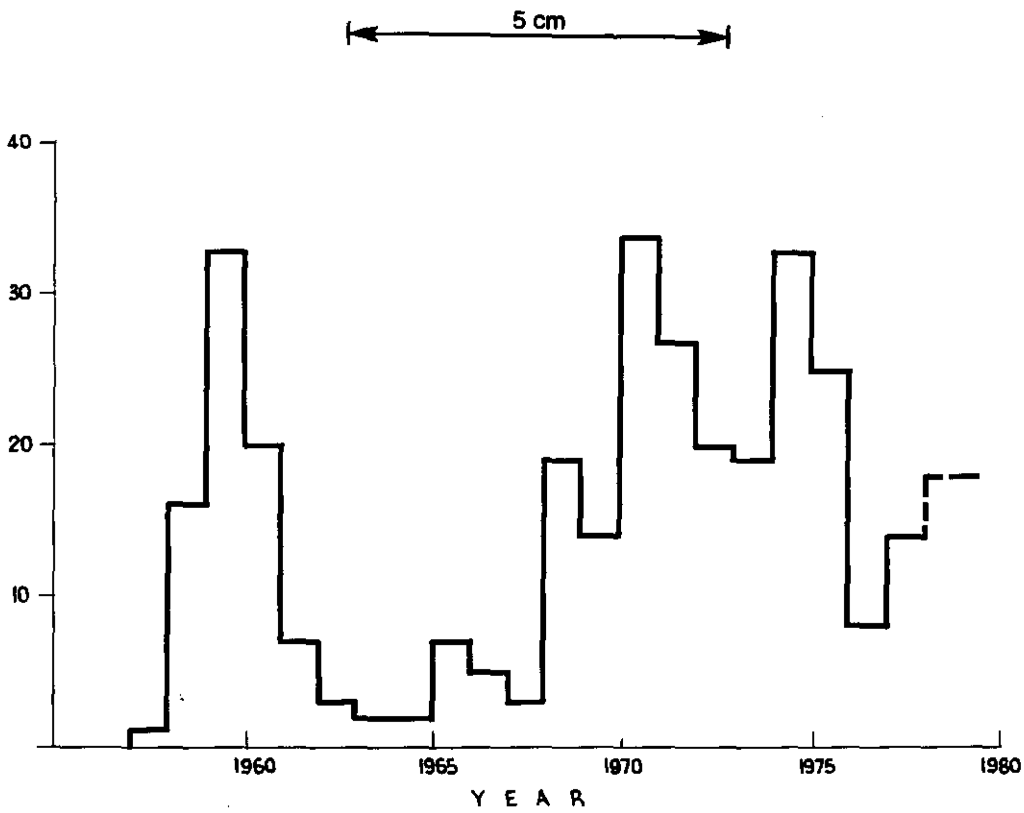

Figure 1. *Total number of surveys to 30 May 1978.*

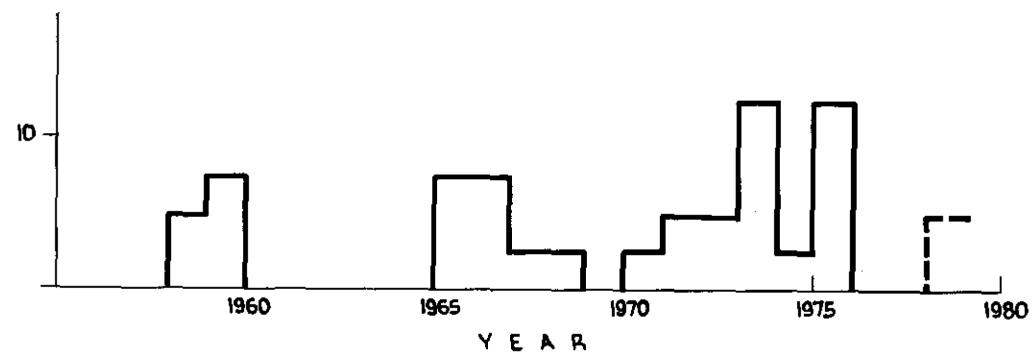

Figure 2. *Airmag surveys to 30 May 1978.*

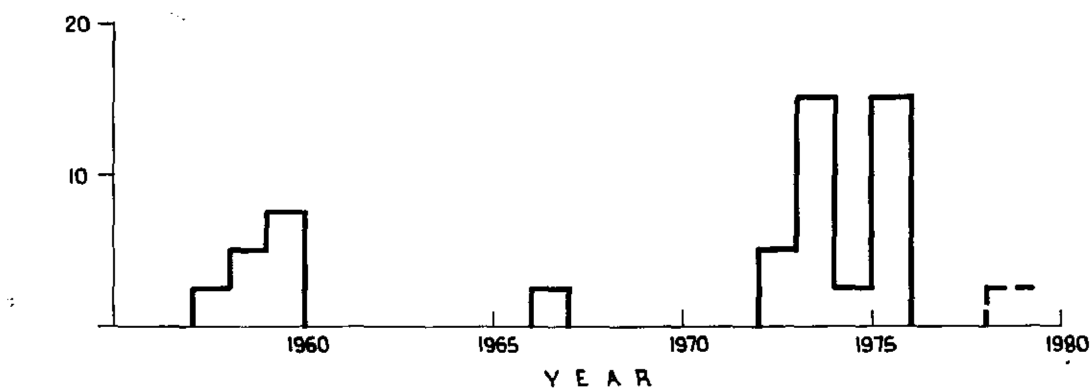

Figure 3. *Airborne EM surveys to 30 May 1978*

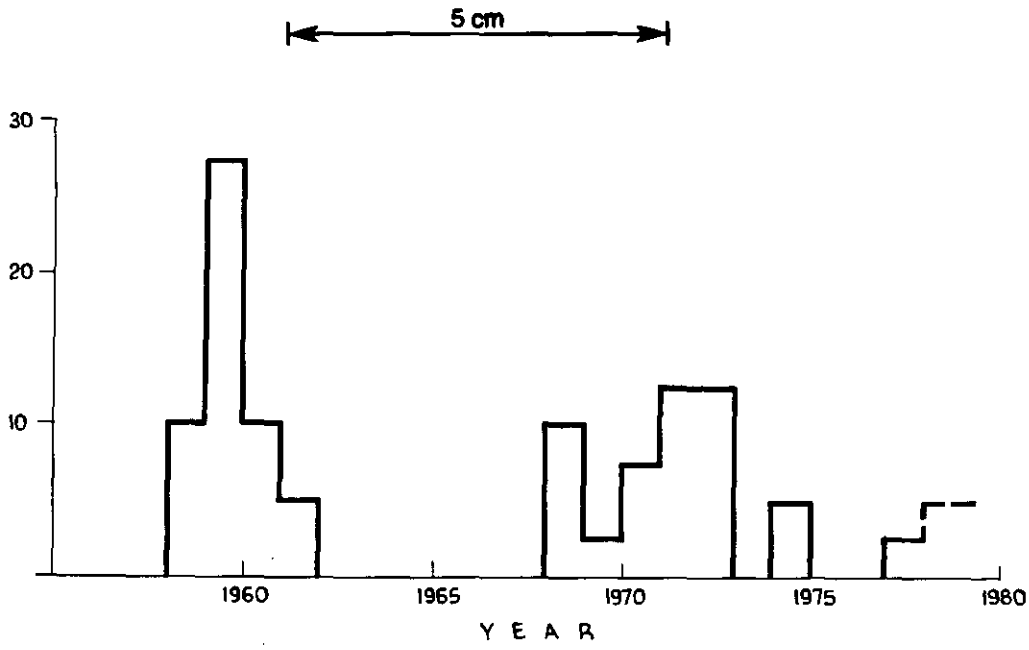

Figure 4. *Ground EM surveys to 30 May 1978.*

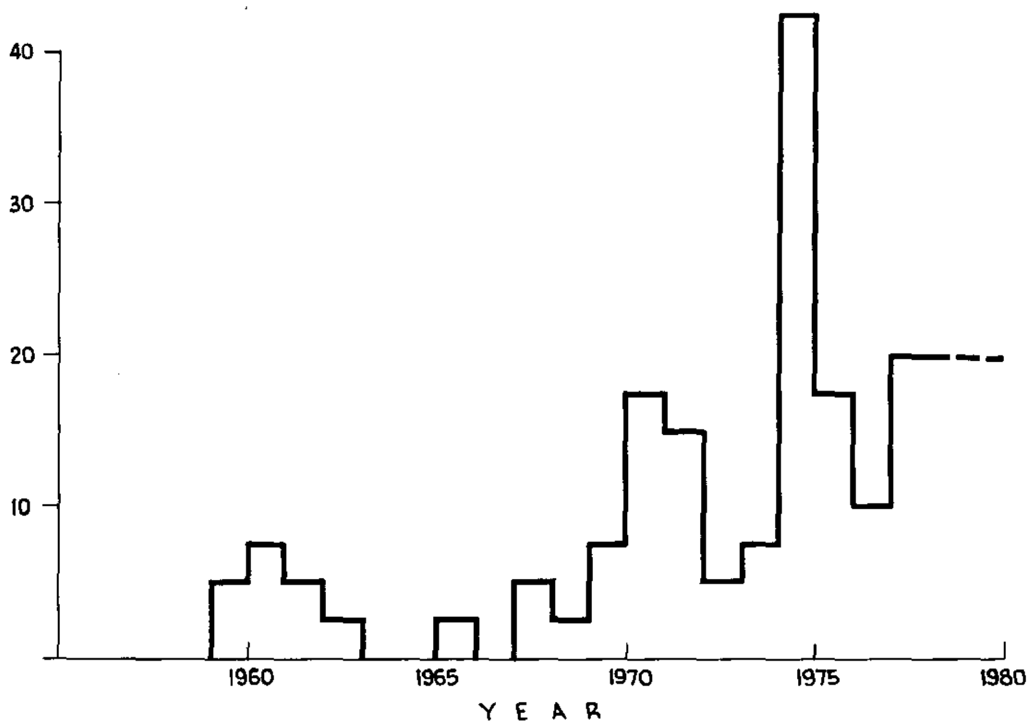

Figure 5. *IP and MIP surveys to 30 May 1978.*

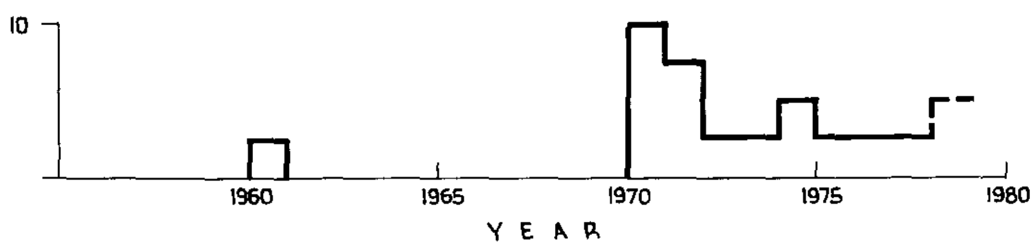

Figure 6. *Resistivity surveys to 30 May 1978.*

5 cm

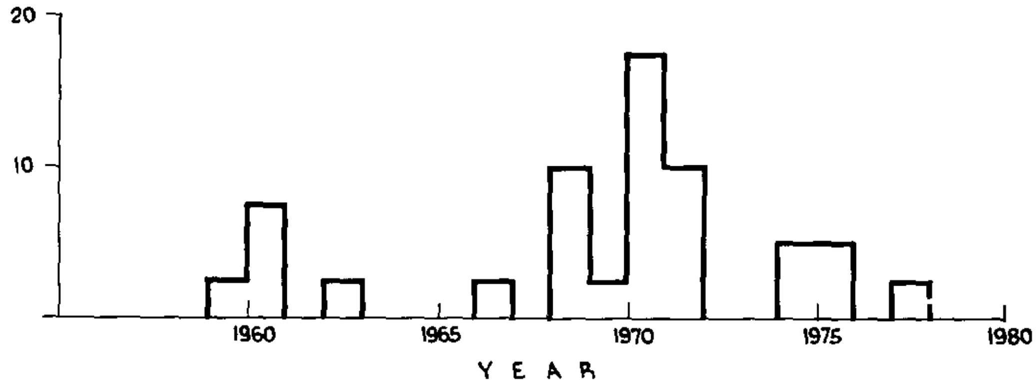

Figure 7. *SP surveys to 30 May 1978.*

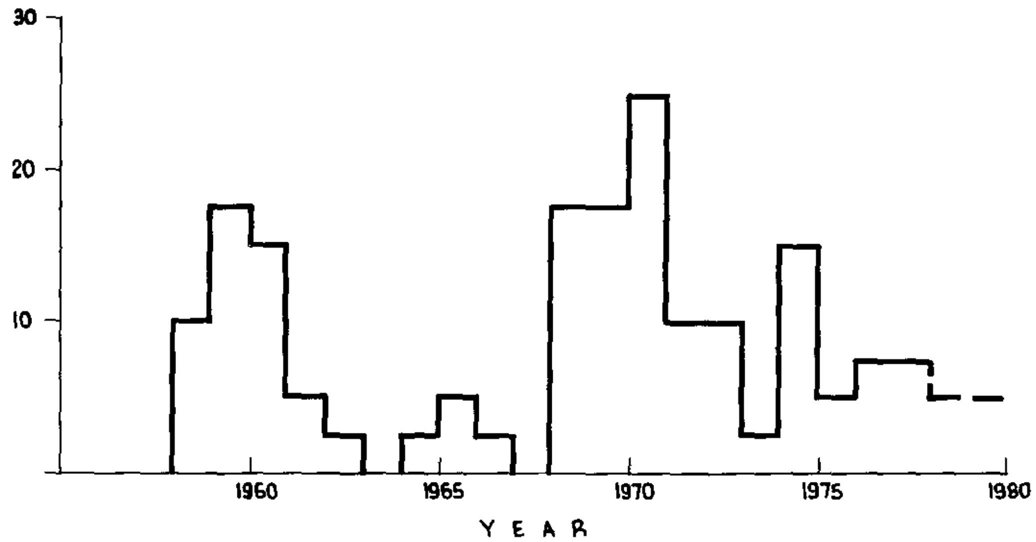

Figure 8. *Ground magnetic surveys to 30 May 1978.*

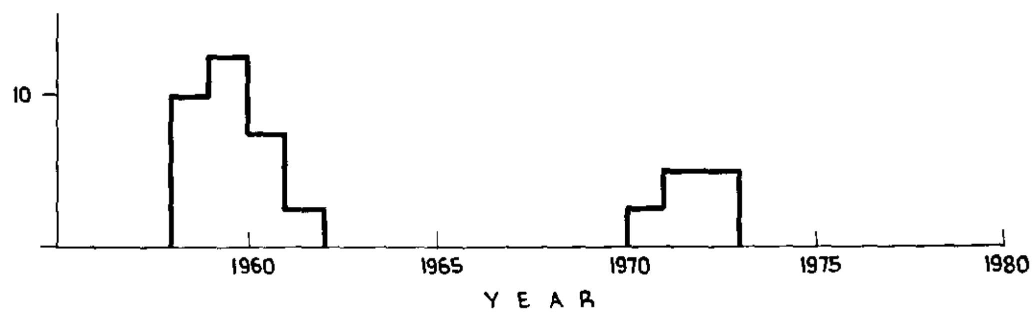

Figure 9. *Gravity surveys to 30 May 1978.*

APPENDIX 1

Summary of geophysical surveys and consultants

SURVEY SUMMARY

Survey	*Number performed*
Aeromagnetic	31
Applied potential	6
Airborne electromagnetic	23
Ground electromagnetic	44
Gravity	18
Induced polarisation	70
Ground magnetics	73
Magnetic induced polarisation	7
Mercury sniffer	Approximately 3
Airborne radiometrics	7
Ground radiometrics	2
Resistivity	17
Seismic	4
Self potential	27

GEOPHYSICAL CONSULTANTS

Consultant	*Number of surveys*
Adastra Hunting Geophysics Pty Ltd	4
Aero Service	2
A.M.E.G.	3
Austral Exploration Services Pty Ltd	6
C.G.G.	8
GEA Laboratories	1
Geoex Pty Ltd (includes McPhar Geophysics)	24
Geophoto Resources Consultants	9
Geophysical Research Pty Ltd	3
Geo-Sensing Systems	1
Geosurveys of Australia Pty Ltd	1
Geoterrex Pty Ltd	1
Golder Associates	1
Hall, Relph and Associates	1
Hunting Survey Corporation Ltd	1
JEDS Pty Ltd	2
L.A. Richardson and Associates	3
Scintrex Pty Ltd (including Seigel Associates)	40
Private Consultants (closed-file)	6