Depot Records

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY

GEOPHYSICAL SECTION

REPORT ON OFFICIAL VISITS MADE DURING OVERSEAS TRIP

1963-1964

by

J. E. Webb
Senior Geophysicist

18/65

5th October, 1964

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INTRODUCTION

The author spent eleven months in the United States of America (September, 1963 to July, 1964) as an exchange visitor. He was engaged as party leader on a deep resistivity study of the earth's crust in Oregon and Washington States.

The work was later extended to cover the northern part of California. A report was written for the Office of Naval Research and Cambridge Research Laboratory of the Airforce, who funded the work.

This report was later combined with the work of the Bonneville Power Administration and submitted for publication to the Institute of Electrical and Electronic Engineers.

The author later spent three months touring the United States and Canada visiting companies of interest to geophysics.

This report covers the sections of this trip during which the author visited places and made inquiries on behalf of the Department. A total of 23 working days were involved.

The companies visited are listed each with a short commentary while several geophysical methods and other subjects are examined in more detail and include information gathered on the private sections of the trip.

Although all companies visited were helpful, they were reluctant to discuss the finer details of particular surveys.

INDUCED POLARIZATION

This method is now the major mineral exploration method in use in the U.S.A. and Canada.

McPhar, Geoscience and Huntec are the best known operators and equipment manufacturers and all operate in Australia. Heinrichs of Tucson and many others manufacture for sale and contract while every small mining company possess a set of their own making.

There is strong competition between time domain and frequency domain advocates. I consider this argument was summed up by Mr. McLaughlin of Newmont who after several years with McPhar (Frequency domain) changed to Newmont (Time domain). He stated that either equipment in the hands of an efficient operator would not locate more or less ore bodies than the other.

Now that the initial glamour has worn off, most operators are faced with the problem of deciding which anomalies are worth testing. Also having selected an anomaly for testing, how to design the test drilling programme.

I.P. anomalies are usually widespread in comparison with the target size and the shape can be such that the cause is not immediately under the highest reading. The best way is to plan for at least three holes for each anomaly. Where possible an electromagnetic survey will help sharpen the I.P. anomaly. Borehole I.P. is now receiving serious consideration as a test for near misses.

The author's work in Oregon showed the seriousness of electromagnetic coupling and this should be tested for over low resistivity areas.

Although they are not prepared as yet to make any claims; American Smelting and Refining of Salt Lake City consider that they have a clue in the search for a method to distinguish between sulphides and graphite clay etc. They use pulse equipment of their own manufacture which puts out a single pulse and

records the resultant decay curve on a pen recorder. A long tailed decay curve has been associated with sulphides while a shorter decay has been associated with non sulphides. A test programme along these lines is recommended as an adjunct to our normal surveys.

Both McPhar and Geoscience have developed high power (5 amp 800 volt) transmitters. Many others are producing light weight low power equipment which in general cannot be recommended for South Australian conditions.

GRAVITY

This method has not received the same attention for mineral location as it has in Australia. The higher cost and the success of magnetics alone in the search for iron are the most probable reasons.

Beard Instruments, the manufacturers of the World Wide gravity meter are now non existent as a company and should not be considered in the purchase of future gravity meters. Mr. Beard could notbe located in a four day search in Houston.

The quality of the products of D.J. Sharpe Instruments of Canada is such that consideration should be given to future quotations for meters from them.

MAGNETIC

The Jalandor and similar magnetometers manufactured by Sharpe & McPhar have superseded balance type instruments for all but the most accurate surveys.

Nuclear precession magnetometers are more accurate but the high cost of American made instruments and their extra bulk have limited their use. The Elsec was totally unknown apart from Dr. Wold in Wisconsin.

Vehicle installations have been tried by some using fluxgate magnetometers, but only one operator has had much success (Heinrichs Tucson). A lively interest was shown in the Department's installation.

AIRBORNE MAGNETIC

The techniques used are generally similar to the Department's on field operations and in the reduction of the results. Some mechanisation has been applied to scaling and digitisation is being considered seriously where very large volumes of results are being processed.

The use of second derivatives has been dropped by the U.S.G.S. This is a lengthy process and as it is an averaging process, it tends to conceal detail rather than add any information.

Many small companies are using Jalander type magnetometers in light aircraft with and without recorders. McPhar have mounted a fluxgate on an aircraft artificial horizon. The trend here is to avoid the high cost of large aircraft. The nuclear precession magnetometer gives high accuracy without weight but as it gives readings at intervals, there is a loss of detail at high speeds.

Airborne electromagnetic is being used extensively as a prospecting tool and has had some success, however careful consideration must be given before using the method in Australia, because of subsurface saline water. The INPUT system developed by Barringer for Selco may have special merit.

STAFF

There is an acute shortage of mineral geophysicists and a lack of students for geophysical education. Much of this shortage is due to the lack of security in the profession and to the lack of promotion above the level of field geophysicists.

The salaries of all scientific personnel however are high so that they could not be induced to seek employment in Australia.

Radio technicians are freely available in the major cities. However the standard is low in comparison with Australian technicians. The trend is towards specialization in a very narrow field of electronics.

COMPANIES VISITED

Geoscience Boston

(Dr. T. Cantwell, Dr. D. Maddern)

Several discussions were had with Dr. Cantwell on I.P. equipment, field methods and interpretation. Ediacara results were discussed in particular and some of his remarks have been previously reported by letter.

The location of the source of an I.P. anomaly is a major problem of the method, often necessitating a series of test holes or where possible the sharpening of the indication by another method such as E.M. This problem has been discussed under a separate heading.

Dr. Cantwell has produced a 5 amp transmitting unit and also a pulse technique set. A comparison of the resistivity pulse techniques has been given under a separate heading.

Geoscience are specialising on resistivity surveys of a general research nature. They also have an active team on computer programming for research purposes.

Several visits were made to the Massachusetts Institute of Technology. Although they have an active geophysics school it is not at all concerned with exploration work and is tending more and more to space science.

Texas Gulf Sulphur

(Mr. Donohoo) Houston and New York.

Texas Gulf are the owners of the Timmons sulphide discovery in Canada. This discovery was made initially by airborne electromagnetic surveys and then confirmed by ground I.P. surveys. It has also been a trial for other methods.

Mr. Donohoo stressed the importance of endurance. Something of the order of 50 anomalies were investigated in the Canadian Shield before the discovery hole at Timmons.

Texas Gulf use contractors, but employ a small staff of geophysicists to supervise the results.

Dr. Holyk, the exploration manager in New York, emphasised the potential of the Timmons discovery.

Union Carbide New York

All the geophysical team was absent, so inquiries were directed toward the use of batteries in equipment.

South-Western Industrial Electronics Houston

This is one of the major seismic equipment manufacturers and the main competitor of Texas Instruments.

The Department possesses an S.I.E. twelve channel refraction unit.

The main project here is the development of digital processing of seismic records. A normal magnetic tape recording is made in the field and digitised in the headquarters office before routine processing for normally marked detail. This system differs from the Texas Instruments equipment, which records digitally on magnetic tape in the field.

S.I.E. also manufacture complete processing equipment for magnetically recorded seismic records and have recently sold a system to the Bureau of Mineral Resources.

Lane Wells Houston

Lane Wells is an associate company of S.I.D. under the Dresser Industries Group.

Although not as large as Schlumbergor they are a major logging operator.

They provide a full logging service of all available electrical and sundry logs, but are specialising on radioactive logging using artificial sources. From radioactive logs they hope to be able to obtain all data now obtained by a multitude of electrical logs.

Seismic Services Corporation (Tulsa) are working along parallel lines to produce all information from sonic logs.

From the researches of these two companies it may be possible to dispense with electrical logs entirely and use non contact methods.

Utah Construction San Francisco

Dr. Hansen is the Chief Geophysicist. Utah was originally interested only in iron but have now directed their interest towards the location of base metal deposits.

They have a large back log of airborne magnetic records which were used for iron location and were not properly reduced. These records are now being reprocessed for use in the base metal search.

They use McPhar under contract to do their induced polarization surveys. They have used Heinrichs of Tucson Arizona but consider McPhar superior. Dr. Hansen is considering the purchase of a battery operated pulse unit.

Dr. Hansen seemed reluctant to discuss field data.

Western Geothermal, Inc. San Francisco

Mr. D.E. Robertson was met as a result of a lunch invitation by Dr. Hanson of Utah. This company is interested in the development of the geothermal areas of California for steam supplies for power generation.

Surprisingly they have found A.F.M.A.G. to be a useful tool in the tracing of buried structures. Other operators advocate the use of resistivity.

California Bureau of Mines San Francisco

Mr. R.H. Chapman, senior geophysicist.

The geophysics section has been in existence for two years only.

They have concentrated on gravity surveys and have made an extensive survey in the bay area to the east of San Francisco for underground water particularly to locate ridges in the basin. A network of gravity stations is being set up throughout the state at known bench marks. Like all federal and state surveys they are practically forbidden to undertake mineral exploration.

Although geophysics has not been employed, the survey is very interested in the exploitation of the geothermal areas.

University of California San Francisco

Dr. Ward, professor of Geophysics.

Dr. Ward has recently taken up duties and has a small but active group of graduate and post graduate students. This is the most active group the author saw in the country.

Dr. Ward was originally with McPhar and developed their electromagnetic and A.F.M.A.G. equipment. He is at present compiling a comprehensive review of the whole induced polarization field.

Their experiments are directed towards induced polarization effects in samples.

Bear Creek Mining Co. Denver

This is the prospecting subsidiary of Kennicott Copper. Dr. Halmer is the exploration manager and Mr. McDougall the geophysicist. They are at present without a chief geophysicist.

This is an active section with induced polarisation equipment of their own manufacture. They use airborne magnetic and electromagnetic with extensive ground follow up.

They also have facilities for electromagnetic modelling as an aid to interpretation.

Geochemistry is also used extensively.

U.S. Geological Survey Denver

Mr. Anderson of the crustal studies Section was a participant in the Oregon resistivity tests. This Section is concerned with seismic and deep resistivity tests. They have a vehicle mounted battery of 1200 volts capable of supplying 200 amps for a few seconds at a time.

The Survey also has induced polarisation equipment but is not permitted to do extensive mineral surveys. Borehole logging forms part of the crustal studies.

Colorado School of Mines Denver

This institution has a geophysical school of world standing with Mr. J. Hollister at its head.

The author was surprised at the small amount of equipment owned by the school. This illustrates that it is possible to produce trained personnel without a large investment.

Like most geophysical schools, this one is having difficulty recruiting sufficient students.

University of Wisconsin Madison Wis.

Dr. Richard Weld has six Disec nuclear precession magnetometers as airborne and fixed station units.

For airborne work these are used in a tail stinger with compensating coils or in a "bird" trailed on a nylon sheathed cable. A Rustrak recorder is used.

Dr. Weld has experienced the same head troubles as we have, that is heating and loss of the alcohol on continuous reading.

He is well satisfied with the Disec's performance.

Texas Instruments Houston

This is one of the largest electronic manufacturing companies in the U.S.A.

The Houston factory is concerned mainly with geophysical equipment.

An inspection was made of their range of gravity meters and it is considered that they are a big improvement over the earlier model bought some years ago. A counter type dial has replaced the divided drum which caused so much confusion.

Their main project is the development of equipment for processing digitised seismic records. The record is taken on narrow tape (about 2" wide) in the field in a digitised form and returned to the office for processing. The processing set is a simplified version of a digital computor and costs would be in the region of £200,000.

The digital method of recording was also discussed with Mr. A. Rainey of G.S.I. in Dallas and he considers it the only way of handling a large mass of data.

Texas also produce high quality seismic equipment and pen recorders in Houston.

Barringer Research Ltd. Toronto

Barringer Research developed the mobile (air and vehicle) INPUT electromagnetic system for Selco. These units are at present operating in Australia for Australian Selection Company. A back mounted unit is being developed.

Barringer has established an Australian subsidiary in

association with John Newman late of B.H.R.

They manufacture a nuclear precession magnetometer, which although efficient costs more than our Elsec.

They are using a mercury content method of geochemical prospecting. This method is also being used by American Smelting and Refining of Salt Lake City.

Selco Exploration Co. Ltd. Toronto

Mr. Tom Parkes the manager had just returned from Australia at the time of our meeting.

They are having staff troubles in Australia and have been unable to retain geophysical staff.

The author gathered that they are experiencing equipment difficulties and have not as yet started an aggressive exploration effort in Australia.

McPhar Geophysics Toronto Canada

Here Induced polarization interpretation was discussed with Mr. D. Sutherland and equipment with Mr. J. Sevenhausen.

McPhar are the largest induced polarization operator in America if not the world. Geoscience Inc. is their only serious rival.

Most of the discussion with Mr. Sutherland concerned the location of the source of an induced polarization anomaly. This has become the major problem of the mining industry. Now that the glamour of early successes has worn off it is apparent that many anomalies do not have a discrete source and that the size of the anomaly does not indicate the value of the source. This will be enlarged on.

McPhar has produced a high power I.P. transmitter giving 5 amps at 800 volts.

They produce a group of electromagnetic equipment and of interest to our Mining Branch a non destructive wire rope tester.

Edgar Sharpe & Associates Ltd. Toronto, Canada

This is a small Company operated by Edgar Sharpe, the founder of E.J. Sharpe Instruments of Canada. It manufactures personal magnetometers and cable reels at present but hopes to expand to a full range of geophysical instruments.

E.J. Sharpe Instruments of Canada Toronto

This company manufactures a wide range of geophysical equipment including gravity meters, magnetometers, susceptibility meters.

Although the author has been cautious in the past on the products of this company, it is now considered that their instruments can be purchased with confidence. Mr. H.O. Seigel, a pioneer of pulse method I.P. has recently taken charge as managing director.

Canadian Aero Services Ltd. Ottawa, Canada

This is a geophysical company of world wide standing specialising in airborne methods but with facilities for ground methods.

Results from several surveys including an extensive one of the British Isles were examined.

In particular several samples of herringbone (zigzagging of contours due to heading errors etc.) were outstanding. In ten years the author has not had serious herringbone in any surveys.

They use a plotting machine which the Department could well copy to reduce the time of scaling records.

A visit was also made to Aero Services at Philadelphia where in particular attention was drawn to the use of colour film in aerial photography.

Huntec Toronto

This is a new company formed as a subsidiary of Hunting Survey Corporation to undertake ground geophysics.

Although they conduct all types of geophysical surveys they emphasise the importance of Induced Polarization. They use the pulse technique.

They are distributors and users of "peg and hammer" seismic equipment. The direct plotting D.S.I. set could be a very useful tool for engineering projects.

Patino Mining Corporation Toronto

The author was referred to this company by Mr. Seigel of E.J. Sharpe Instruments as they are interested in Australia.

Patino have a tin smelting plant in Sydney and are interested in Mt. Bischoff in Tasmania. Dr. Ogryzlo expressed an interest in Bawsley and indicated his intention of writing to Mr. Barnes.

They have been unable to employ geologists or geophysicists in Australia.

Canadian Geological Survey Ottawa, Canada

Dr. Morley discussed geophysics generally and then passed me over to several members of his staff.

They conduct airborne magnetic surveys using fluxgate magnetometers designed in their laboratories. Their systems of reduction and publishing are similar to our own. The sheets are published for use by private enterprise without interpretation. The Department obtained samples of their work several years ago.

They also have an interest in engineering geophysics using resistivity and refraction equipment. In particular they have developed a low frequency resistivity meter using sine wave signals in place of the more usual square wave. Dr. Morley promised to forward a circuit diagram when it became available.

Like the U.S.G.S. they are required to avoid direct competition with private enterprise.

CONCLUSIONS AND RECOMMENDATIONS

Although advances have been made in the handling of large volumes of data, the author considers that the Department's Exploration Geophysics Section is able to compete with overseas operators on normal operations. During many of the interviews as much information and advice was given as received.

Very little is known of Australia and on many occasions it was necessary to convince senior members of mining companies, that Australia was not a socialistic country and was a safe place for the investment of money. During all visits the assistance available from the Department was stressed.

As a result of these visits the following recommendations are made:-

1. That junior members of the Geophysical Sections be attached to American companies for periods of one year for experience.

2. That consideration be given to the appointment of a Public Relations Officer to circularise and visit overseas companies to correct wrong impressions of Australia.

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JBW:AGK
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