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APPLICATION OF GEOPHYSICAL TECHNIQUES IN OPAL PROSPECTING: YOWAH OPALFIELDS

by

R.D. Huber

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ABSTRACT

Magnetic and resistivity surveys on the Yowah Opal fields indicate the potential of geophysical methods in opal exploration. A reasonable magnetic susceptibility contrast between the ironstone nuts and the country rock was detected. Insufficient quantities of nut concentrations on the Yowah field hindered the effectiveness of the magnetic survey. Resistivity measurements about the Opal field succeeded in determining the thickness of the surface sandstone layer. Opalization is found within and at the interface of this layer and the lower mudstone layer.

INTRODUCTION

At the request of Economic Geology Section, consideration has been given to the applicability of geophysical techniques to the exploration for opal in Queensland. The consideration has been based on the fact that a majority of opalization in Queensland is associated with iron rich formations. It is suspected that these iron rich formations have physical parameters which may be measured by geophysical methods. B. Senior (personal communication) has indicated a fair degree of success using magnetics in locating iron boulder concentrations. Anomalies in the range from 20 to 50 gammas were measured. Based on his success a geophysical exploration program was mounted on the Yowah opal field.

LOCATION AND GEOLOGY

The Yowah opal field is located 106 km WNW of Cunnamulla. Access to the field is via a 72 km dirt road and track from the Eulo-Thargomindah road.

The field is situated on the Winton formation which has been described by B.R. Senior et al. (1969). They describe the Winton formation in the Yowah area as "selectively kaolinized, silicified and ferruginized sediments which are harder than the underlying unweathered material". The formation is flat lying and is reported to be approximately 91 metres thick over this area.

Two sedimentary layers exist on the Yowah field: the surface layer of sandstone, within which occur bands of clay or clay breccia, and a lower layer of mudstone.

Ingram (1968) describes the two common forms of precious opal. Boulder opal refers to precious opal occurring as thin veins and pockets within iron concretions. At Yowah, the iron concretions vary in size from a few millimetres to approximately 10 cm across. Larger concretions have been found on other fields. These smaller conctetions are referred to as "nuts" and concentrations of them as "nut bands". These nut bands are generally found in the sandstone. Sandstone opal is the other mode of occurrence. Sandstone opal occurs as thin horizontal veins in ironstone seams associated with the junction between the sandstone and the finer grained underlying mudstone. Opal may also be found immediately above and below this seam. This form has also been called "seam" or "banded" opal. Both forms of Opalization have been observed at Yowah.

The ironstone seams, with which the sandstone Opal is associated, is the more persistant formation, but mining has been confined to the nut bands within the sandstone layer.

METHOD AND PROCEDURE

The apparent success indicated by B.R. Senior has prompted further use of the magnetic method. Success of this method hinges on the presence of a susceptibility contrast between the nuts and the sandstone and a sufficient volume of nuts to generate a response which can be detected remotely from the surface. Owing to the small dimensions of the nut bands and the anticipated moderate susceptibility contrasts, small amplitude anomalies were expected, necessitating the use of accurate equipment and precise methods.

A MacPhar proton precession magnetometer with one gamma repeatability was used. Base stations were repeated at intervals of 15 to 60 minutes to enable diurnal corrections to the data.

A 200 m grid was surveyed over an area 2 km by 1 km. Profiles, 1 km long and running in a N-S direction, were run with a 10 m interval. The profiles were 200 m apart with intermediate (100 m apart) profiles placed to evaluate observed trends.

At selected locations D.C. resistivity soundings were conducted to assist in the interpretation. The Schlumberger configuration with a maximum $^{AB}/2$ spacing of 100 metres was used.

To further assist the interpretation and the planning of further work, measurements were made of the magnetic susceptibility and resistivity of the sandstone, mudstone and the iron concretions. The magnetic susceptibility of the samples was determined using a Soiltest susceptibility bridge. The resistivities were measured in situ using a Megger resistivity unit and a 1 metre Wenner configuration.

DISCUSSION

Values of magnetic susceptibiltiy-measured on samples from Yowah are as follows:

1) nuts - 168 x 10^{-6} cgs units
2) sandstone - 34 x 10^{-6} cgs units
3) mudstone - 18 x 10^{-6} cgs units

These measurements indicate a reasonable contrast between the ironstone nuts and surrounding country rock. The success of the magnetic method depends on whether the nut bands are of sufficient size to be resolvable by the magnetic method.

Measurements in situ of the resistivities of the formations from Yowah gave the following values:-

1) nuts (single) - very high resistivity
2) sandstone - 4.8 to 6.3 ohm-m
3) mudstone - 1.3 to 2.4 ohm-m

These measurements indicate that the resistivity decreases with depth with the lower mudstone having the lowest resistivity. The very high resistivity of the individual nuts may cause the nut bands to have a higher resistivity than the country rock.

The magnetic profiles are shown in Plate 1. Most of the large amplitude responses correlate with observed man made surface and subsurface features; for example the dipole observed near 12S 2W can be attributed to a hole with metallic garbage in it. Other dipole anomalies not associated with man made objects occur and may be caused by nut concentrations. Examples occur at 12S 7W, 9S 8W, and 8.5S 9W. The low near 16S 14W coincides with an underground excavation. Similar situations occur on lines 10W, 9W, 7W and 6W.

Another interesting feature is the change of the prevailing magnetic field level along a profile. An example occurs on plate 1 line 14W. The apparent changeover between high and low zones is 55 310 gammas. An interpretation of these features suggests that they reflect changes in the thickness of the ferruginous sandstone. Thin sandstone sequences occur where the magnetic values are less than 55 310 and thicker sequences where the field is greater than 55 310 gammas.

Resisitivity soundings at six locations on the field are shown on plate 2 and their location on plate 1. The curves are consistent with the underground observations. They bottom in a low resistivity layer (1-3 ohm m) which is the mudstone. No other layer is detected below this. Some scattering of the data for large AB/2 spacings occurs and is probably related to resistivity variations near the surface (sandstone/clay boundary near the surface near Daniels upper claim).

CONCLUSIONS

The magnetic susceptibility measurements indicate a reasonable contrast between the nuts and the country rock. Unfortunately the nuts do not appear to be present in sufficient quantities to be resolved from the surface by magnetics. The profiles do indicate different magnetic zones which may be related to varying thicknesses of ferruginous sandstone. Although the susceptibility contrast between sandstone and mudstone is small the volumetric changes due to varying thicknesses of the sediments may be sufficient to be detected by the magnetic method. Several localized dipole anomalies occur which may be related to nut concentrations.

Resistivity measurements indicate that the technique can be used to map the thickness of the sandstone. The resistivity contrast appears to be sufficient to define the depth of the mudstone.

REFERENCES

INGRAM, J.A., 1968: Notes on opalization in southwestern Queensland. Rec. Bur. Miner. Resour. Geol. Geophys. Aust. 1968/47

SENIOR B.R., INGRAM, J.A, THOMAS, B.M., and SENIOR, D., 1969: The geology of the Quilpie, Charleville, Toompine, Wyandra, Eulo, and Cunnamulla 1:250 000 Sheet areas, Queensland. Rec. Bur. Miner. Resour. Geol. Geophys. Aust. 1969/13.

APPENDIX

Operational Statistics

Personnel

Geophysicist	R.D. Huber
Field Assistant	B. Stockill

Equipment

- 1 MacPhar Model GP-70 Proton Magnetometer
- 1 GEOTEST DC Bridge Compensator D102 and Power Supply D200 and cables
- 1 Megger Earth Tester unit
- 1 LWB Landrover

Survey History

Field work commenced	2 July, 1975
Field work completed	15 July, 1975

Statistics

Total length of Magnetic profiling	28 km
Total number of vertical electrical soundings	7