- REPORT ON BOOLARRA GEOPHYSICAL TEST SURVEYS -

REPORT NO. 1942/19A.

A. Introduction.

Geophysical test surveys were made at Boolarra with the object of determining whether geophysical methods were suitable for the exploration of the bauxite deposits found in that district.

Field operations were carried out during the period 17th April to 15th May and consisted of the following:-

1. Open Cut Deposit.

   (a) Surface survey and examination of available sub-surface data.

   (b) Geophysical survey using the Resistivity method, over a small area adjacent to the open cut.

   (c) Geophysical survey using the Geomagnetic and Natural Earth Potential methods, on one transverse.

2. Orgill's Deposit.

   Surface Survey and examination of available sub-surface data.

3. Budgaree Deposit.

   Surface survey and examination of available sub-surface data. (Incomplete).

B. Geology and Nature of the Problem.

The general geological features of the Gippsland bauxite deposits have recently been studied by Dr. E.S. Hills of the University of Melbourne. Dr. Hills has supplied the following particulars. (Memo to Dr. Raggatt dated 26/6/42).

"1. The bauxite occurs in close association with the Older Basalt, either just beneath or just over it, according to the locality.

2. In most places it is interbedded with fluviatile sands and clays, though at Boolarra it rests in places on volcanic clays, which probably represent the decomposed scoriaceous and tuffaceous top of the Older Basalt.

3. The bauxite is itself bedded, and appears to represent water-laid pyroclastic material, though I do not think, from field evidence, that this was originally basaltic. ....

4. As one would expect with a deposit that is interbedded with fluviatile strata, the bauxite is, according to available data, lenticular. It certainly does not occur as a continuous sheet over the old land surface.

5. The varieties of bauxite are numerous, e.g. roughly "scoriaceous" en masse; containing sub-angular pebbles of hard bauxite in finer material; some contain rounded pellets of "silica", also irregular lenticles of hard clay; fine, soft, reddish bauxite; well-bedded, cream, yellow, and red bauxite; rouge-red bauxite resembling ferruginous sand; fine-grained cream and pinkish types; etc.

6. The bauxite has suffered considerable faulting and warping, so that it now occurs, even in the one district, e.g., Boolarra, over a wide range of elevations".

Some of the Boolarra bauxite deposits have been proved nes the fringes of the deposits, by means of open cuts and shafts. The type of section revealed is as follows:-

Tertiary deposits.	Sands, sandy clay and clay.	Up to 75' thick.
Bauxite.		Up to 20' thick.
Clay, probably decomposed Older Basalt.		To unknown depth.

Available information suggests that the bauxite rests directly on the basaltic clay at each of the Boolarra deposits mentioned above.

The attitude of the Open Cut bauxite deposit is revealed over a small area, by the data available from the open cut and adjacent prospecting shafts. This information has been used to draw the geological sections shown on Plan No.681. The top surface of the bauxite is shown to be fairly even, with slight undulations and slopes. The steepest slope exhibited is 11°. The surface of the basaltic clay on which the bauxite rests, is more undulating and high-spots occur on it which cause the bauxite thickness to be substantially reduced in certain parts.

The problem for geophysical work is to prove the extent of and depth to the bauxite.

C. Survey Results.

1. Open Cut Deposit.

Plan No.617 shows the structure contours on the bauxite, based on the information obtained in the open cut and prospecting shafts. It also shows the position of the traverses where geophysical observations were made.

The Wenner configuration or four-electrode system was used for the resistivity determinations. Tests for apparent resistivity were made in the open cut on a vertical section which included beds of sandy clay, clay and bauxite. Later work gave information concerning the apparent resistivity of thebasaltic clay bedrock. It was found that the average apparent resistivity of the formations concerned was as follows:-

Overburden	250 ohm. metre units.
Bauxite	439 ohm. metre units.
Basaltic Clay	100 ohm. metre units.

The apparent resistivity of the bauxite is thus appreciably higher than that of the underlying basaltic clay and to a lesser extent it is also higher than that of the overlying sandy clay and clay. In the latter case the ratio of resistivities is much less than in the former case, and m as will be described later, there is evidence at some observation stations of the presence of a sandy bed in the over-burden with resistivity much higher than that shown above for the bauxite. The resistivity ratio between overburden and bauxite is therefore likely to be inconsistent, but so far as is known at present the ratio for bauxite and basaltic clay bedrock is likely to be fairly consistent. Furthermore it seems likely that under <u>all</u> circumstances the apparent resistivity of the basaltic clay bedrock will be appreciably less than the overlying formation or formations.

Plan No, 680 shows resistivity curves obtained for the 31 stations at which observations were made. The most consistent feature of the curves is the tendency in them all towards relatively low resistivity values (of the order of 100 ohm. metre units) at the larger electrode separations. Presumably this is the effect of the basaltic clay bedrock.

The pronounced bulges present in some of the curves, are due to the presence of a relatively resistive formation of appreciable thickness, overlying the basaltic clay. These bulges may arise from either bauxite alone, combined effect of bauxite and overburden or overburden alone.

A number of the curves can be subjected to analytical interpretation by standard methods, giving the depth to interfaces between various formations responsible for the features of the curve.

The best example of such a curve is the one measured at the point A/250E. This curve is the type due to three layers, each of different resistivity. The calculated depths to the two interfaces in this case are 5' and 17', the latter figure being depth to the interface formed by the basaltic clay bedrock. In the case of this curve the resistive formation overlying the bedrock and responsible for the bulge in the curve, could be either bauxite or overburden.

The curve at A/175E is another good example of a 3 layer curve, with slight modifications. In this case the resistive formation responsible for the pronounced bulge is considered to be a sand layer, presumably about 10' thick at this point. The effects of this layer are also present in the curves at A/200E, A/150E, A/100E, 00/50S, 00/100S and 55W/100S. At the point A/175E it is possible that bauxite is present between the sand layer and bedrock.

The curve at 55W/200N can be regarded as a 2 layer curve (neglecting the top two points). The interface between the two layers is calculated to be about 30' and presumably that figure represents the approximate depth to the basaltic clay bedrock at this point. The formation overlying the bedrock, i.e. the top layer, has an apparent resistivity value of about 400 ohm. metre units and therefore could be either bauxite or overburden, on the basis of the tests in the open cut. However, on the basis of other curves measured it is considered that no bauxite is present.

The curve at 00/290N is a complex type and little confidence can be had in the interpretation of such a curve.

The curves at 00/100N and 00/150N are of a special interest. The former suggests that bedrock is at a depth of about 60 feet and the presence of a very appreciable thickness of bauxite is suggested. At 00/150 the same order of depth to bedrock is indicated but the resistivity of the overlying formation is much less than at 00/100N. It is considered that bauxite is largely responsible for the resistive conditions at 00/100N and in that case there would probably be little, if any bauxite at 00/150N because of the absence of similar conditions in the curve at that point.

The basis for the determination of the presence or otherwise of bauxite by the resistivity method, is not very strong and further field work is required to confirm the matter. It is considered that the most reliable interpretative data obtained from the curves under consideration is that concerning the depth to the lower interface, i.e., the top of the basaltic clay. The figures derived for the depth to this interface are shown on the various curves (Plan No.680) and the same figures are plotted at their respective positions on the geological sections (Plan No. 681). These depths are represented on Plan No. 680 by small circles and a study of this plan will show the comparison between geophysical depth determinations and known conditions based on the structure contour plan. Particulars are given on Plan No. 680 regarding the probable presence or otherwise of an appreciable thickness of bauxite.

The Geomagnetic method was applied only on traverse 00. Using a vertical force variometer, readings were taken between 200S and 400N. A change occurs at about 300N. South of this point conditions are little disturbed but anomaly up to 100 gammas in magnitude is present between 300 and 400N. This may be due to basaltic boulders in the overburden or to undecomposed basalt in situ. There is no anomaly associated with the bauxite.

The Natural Earth Potential method was also applied on traverse 00, between 300S and 350N. There seems to be no recognisable anomaly related to the bauxite.

2. <u>Orgill's Deposit</u>.

Plan No. 619 shows the results of the surface survey and the examination of the available sub-surface data. The information is considered to be too scattered to allow for the satisfactory drawing of structure lines. No sections have been drawn for the same reason.

3. Budgaree Deposit.

Plan No. 682 shows the results of the Budgaree surveys. Due to interruptions by rain these are incomplete and for the same reason no geophysical tests were completed at Budgaree.

D. Conclusions.

The Boolarra bauxite deposits overlie a clay which is a decomposed Older Basalt. It is considered that by geophysical methods the depth to this bedrock clay can be determined with reasonable accuracy. The known structural behaviour of the bauxite shows that the surface of the bedrock clay is far from regular and it seems probable that depth determinations to it would at least aid the selection of drill sites for a drilling campaign designed to prove ore reserves.

In addition to determining depth to the clay bedrock, it is possible that geophysical methods would furnish information concerning the presence or otherwise of appreciable thickness of bauxite overlying the clay bedrock.

It is not known to what extent the resistivity method would give useful information regarding the behaviour of the bauxite in the following cases because no tests have been made under these conditions:

1. Bauxite deposits above the Older Basalt but interbedded with fluviatile sands and clays and therefore not necessarily closely related to the basaltic clay surface.

2. Bauxite deposits occurring just beneath the Older Basalt.

The ground conditions present at Boolarra at the time of the test survey were very favourable for resistivity work and under similar circumstances the speed of the work on a large scale would be satisfactory.

Should the interpretation outlined in this report prove to be substantially correct it is considered that geophysical surveys applied in conjunction with and as a control for drilling, would expedite the exploration of the Boolarra bauxite deposits.

It is desired to express appreciation for the complete co-operation and useful assistance rendered by Mr. R.E. Cochrane (Manager for Sulphates Pty. Ltd.) during the course of the geophysical survey.

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GEOPHYSICIST.