1980/39. Review of resistivity sounding interpretation - Winnaleah area

D.E. Leaman

INTRODUCTION

Five deep soundings were observed in the Winnaleah - Branxholm area during 1972 and reported by Leaman (1974). The soundings were undertaken on an experimental basis to evaluate the possible use of the technique for structural analysis of basalt-covered deep leads. It was found that large arrays were possible with the available equipment, but the interpretations offered were uncontrolled. Drilling of the five sites was recommended before any major application of the technique was considered. As each of the sites has now been drilled it is possible to provide a review of the interpretations and the effectiveness and penetration of the method.

REVIEW OF INTERPRETATION

Each sounding is discussed below using the notation of Leaman (1974). The revised interpretation has been undertaken using any interfaces suggested in the drilling log and any implications based on material type. Initial estimates have then been revised until a good match was obtained with the field data. The interpretation procedure used is multi-layer with no restrictions on the number of layers, although the minimum layer thickness possible is 0.1 m. It is based on the filter procedure of Ghosh (1971). This procedure offers good accuracy and reliability, and there is no need to interpolate groups of layers as required by the series expansion used for the earlier interpretation or graphical techniques.

SOUNDING 1

Location : Pioneer Back Road, Winnaleah
Borehole : Steele
Log summary :

Depth (m)	*Description*
0 - 1.2	soil
1.2- 3.6	basaltic clay
3.6- 7.5	weathered basalt
7.5- 9.0	basalt
9.0-11.0	clay, boulders
11.0-26.0	basalt
26.0-28.0	clay
28.0-40.0	basalt
40.0->57.0	clay, cemented sand

Interpretation :

The interpretations given below are equivalent. The original estimates for surface soil and clay are shown to be adequate and a representative resistivity was applied to the weathered rock (to 15 m). The controlled interpretation has identified some layering in the basalt (11-26 m) which becomes resistive, and probably massive, at about 17 m. The original interpretation is not at variance with this conclusion, but the series approach was insensitive to a series of positive contrasts.

Note that the overall penetration of the 600 m sounding is about 20 m, largely due to the overall conductive character of the terrain.

	Uncontrolled		*Controlled*	
Layer	*Resistivity (Ωm)*	*Depth (m)*	*Resistivity (Ωm)*	*Depth (m)*
1	200		140	
		1.2		1.3
2	15		30	
		2.7		3.6
3	150		90	
		9.0		7.5
4	180		1000	
		15.0		9.0
5	800		75	
		?		11.0
6	1000		150	
				13.0
7			750	
				15.0
8			250	
				17.0
9			2500	

SOUNDING 2

Location : Winnaleah by-pass road
Borehole : Shaw
Log summary :

Depth (m)	*Description*
0- 1	soil
1- 3	soil, boulders
3-20	basaltic clay, with boulders (weathered basalt)
20-24	basalt
24-26	clay
26-28	basalt
28-33	honeycombed basalt
33-61	massive basalt

Interpretation :

	Uncontrolled		*Controlled*	
Layer	*Resistivity (Ωm)*	*Depth (m)*	*Resistivity (Ωm)*	*Depth (m)*
1	300		300	
		7		13.0
2	5000?		<0.1	
		7.5		13.1
3	125		1500	
		8		
4	20		?	
		15	(∿150/200)	
5	5000			

The interpretations are in overall agreement. However, filter processing has indicated that the minor variations in the original interpretation between 7 and 8 m are probably not present. Both interpretations

suggest a termination of low resistivity values in the region of 13-15 m, which is described as weathered basalt in the log. However, analysis of the detailed character of the curve reveals a thin layer of almost perfect conductor marks the interface between basalt and debris. This effectively inhibits current flow and its addition to the model prevents further interpretation.

SOUNDING 3

Location : Rattrays Road, Winnaleah
Borehole : Lester
Log summary :

Depth (m)	*Description*
0- 1	soil
1- 8	clay, boulders
8-43	massive basalt
43-54	soft basalt
54-62	massive basalt

Interpretation :

	Uncontrolled		*Controlled*	
Layer	*Resistivity (Ωm)*	*Depth (m)*	*Resistivity (Ωm)*	*Depth (m)*
1	700		650	
		2.0		1.0
2	350		600	
		8.0		1.3
3	2000		250	
		17.0		4.0
4	100		900	
		110.0		6.2
5	2000		2000	
				9.5
6			100	
				11.0
7			50	
				15.0
8			600	

Both interpretations recognise the resistive layer at about nine metres - the top of the massive basalt. The uncontrolled version is in error due to smoothing and integration of many layers. The bulk resistivity estimates are justified however. The revised interpretation indicates a maximum penetration of about 30 m. The relatively low basalt resistivity implies that the rock is wet.

SOUNDING 4

Location : Tasman Highway, Legerwood junction
Borehole : Johnson
Log summary :

Depth (m)	*Description*
0-18	decomposed basalt
-	basalt - hole abandoned at 19 m.

Interpretation :

	Uncontrolled		*Controlled*	
Layer	*Resistivity (Ωm)*	*Depth (m)*	*Resistivity (Ωm)*	*Depth (m)*
1	1000		700	
		1		1
2	50		200	
		2		3
3	2000		5000	
		20		6
4	20000		25000	
		30		12
5	100,000		30000	
		60		13
6	300		600	

The 'controlled' sounding has benefited from improved modelling techniques and neither interpretation is supported by drilling information. Maximum penetration approximately 20 m.

SOUNDING 5

Location : Branxholm Back Road
Borehole : Brown
Log summary :

Depth (m)	*Description*
0- 1	soil
1- 2	clay, gravel
2-14	weathered basalt
14-23	basalt

Interpretation :

	Uncontrolled		*Controlled*	
Layer	*Resistivity (Ωm)*	*Depth (m)*	*Resistivity (Ωm)*	*Depth (m)*
1	750		770	
		1		0.6
2	200		500	
		5		1.2
3	100		100	
		40		14.0
4	1000		120	
		90		20.0
5	500		500	
		120		25.0
6	2000		350	

There is little correlation between the interpretations other than bulk equivalence of the upper materials (<25 m). The uncontrolled interpretation incorrectly identifies deep layers, since the maximum penetration is about 35-40 m. The basalt below 20-25 m is clearly saturated.

CONCLUSIONS

The original uncontrolled interpretations based on an often unreliable series calculation have yielded reasonable bulk estimates of resistivity values and layer thicknesses, but in some cases have inferred an unrealistic depth range. In the basalt terrain around Winnaleah, penetration and depth resolution of a 600 m half array spacing is generally less than 30 m. This surprisingly low penetration is related to the number of high contrast thin layers with some of very low resistivity. Massive and wet basalt are identifiable, approximately 2000+ Ωm compared to 500 Ωm. It may therefore be concluded that the method is of no structural value in this region, but could be used to trace shallow local boundaries or locate massive and probably dry, or moist rock. In either case the Wenner (a) or Schlumber (AB/2) value must exceed 400 m.

REFERENCES

GHOSH, D.P., 1971. Inverse filter coefficients for the computation of apparent resistivity standard curves for a horizontally stratified earth. *geophys.Prosp.* 19:769-775.

LEAMAN, D.E., 1974. Use of deep resistivity probes in basalt covered Tertiary basins. *Tech.Rep.Dep.Mines Tasm.* 17:65-72.

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