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1986/20. Geophysical logging of the Edgell Cannery borehole

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Abstract

Logging of an exploratory groundwater bore at the Edgell Cannery, Ulverstone revealed a physically uniform lower zone most likely to be weathered rock. There is nothing in the logs to indicate that the bore would be unable to produce water but then again there is nothing to indicate that it would be capable of producing a large amount.

INTRODUCTION

Edgells contracted Gerald Spaulding Drillers to drill an exploratory groundwater bore on site at the Ulverstone Cannery. After drilling through what appeared to be fine sand the drillers retrieved gravel (or rock chips resembling gravel) from the drilling mud at a depth of roughly 60 metres. The drillers suspected that the gravel may have been coming from cavings higher up and wished to determine if this were the case or if the gravel was being drilled at the bottom of the hole. To assist them with this problem, Gerald Spaulding Drillers contacted the Department of Mines and requested that wireline logging of the hole be carried out. Following discussion, the contact geologist, W.L. Matthews, informed Gerald Spaulding Drillers that the logging would probably not conclusively distinguish between unknown sediments and very weathered rock of unknown type. Gerald Spaulding Drillers decided not to withdraw the logging request.

On 5 November 1985 the borehole was open to about 58 m and was logged for natural gamma and single point SP/resistivity. The drilling method was mud rotary and at no time did the hole appear in any danger of collapse. After the initial logging the hole was deepened to a logging depth of about 72.0 m and some fresh mud circulated. The previously run logs were repeated and a much better electric log was obtained, probably due to freshening and circulation of the mud. Caliper and gamma-gamma density logs were then run followed by long/short normal resistivity logs the following day.

Very little clay was observed by the drillers. The cuttings from the upper part of the hole were fine and gritty. The cuttings size coarsened downwards. In the bottom twenty or thirty metres of the hole the cuttings were two to four millimetres across and very angular.

OBSERVATIONS

All runs were recorded on both magnetic tape and paper chart. The natural gamma tool was raised from 58.1 m (run 1) and 71.5 m (run 2) at six metres per minute with time constant two seconds and full scale deflection 50 cps (196.8 API). The single point SP/resistivity was raised from 58.5 m (run 1) and 71.8 m (run 2) at about ten metres per minute with resistivity full scale deflection of 500 ohm metres (run 1) and 250 ohm metres (run 2) and SP zero offset with scale 100 mV per chart width. The caliper tool was raised from 71.8 m at about six metres per minute. The atypically straight section between 7.5 and 9.5 m is probably a boulder or a layer resistant to caving. It might possibly be caused by the caliper going out of range but the trace is not in quite the right place for this whereas

it does line up very well with the minimum cave parts of the rest of the trace.

The gamma-gamma density tool was run with no spacers and the larger bowspring. Cable speed was six metres per minute with time constant of 600 seconds. The tool was run between two and 67 metres. Two up and two down runs were carried out and both upward and downward runs recorded. The tool experienced a sticking problem at about 19.5 m on the second downward run. Full scale deflection was 25 000 CPS for the first downward run and 50 000 CPS for all other runs.

The LN/SN tool was run for LN/SN but not for SP, this having previously been run on the single point tool. The LN/SN was raised from 62.0 m at ten metres/second and considerable noise was observed on the LN channel with a lesser amount of noise on the SN channel. The tool was lowered again and it was found that the noise could be minimised by slowing the speed of the tool right down. The tool was raised from 62.0 m at speeds of four metres/second or slower and an acceptable record was obtained, the remaining noise spikes being sufficiently few to allow hand editing. This is thought to be an instrument problem.

#### RESULTS AND INTERPRETATION

The gamma variations are thought to reflect varying clay content in this hole. The higher gamma zone between 15 and 32 m would be less likely to yield water than the low reading zone which begins at 40 m and continues to the bottom of the hole. This lower zone has an encouragingly low gamma count. If this lower zone is unconsolidated sediment then it would be expected to be a good aquifer. If the lower zone is weathered rock then the potential of the rock to produce water would most likely depend primarily on the fracture porosity and permeability.

The repeated density results up and down the hole were very similar and confidence in the validity of the results is high. There is little variation in density throughout the hole, especially from 32 m to the bottom of the hole. The density is a little lower from 7 to 17 m and very slightly higher for a few metres around 25 m and from about five to seven metres. Above five metres the density is lower but this is common near the top of holes and is usually due partly to surface material of low density and partly to surface disturbance (e.g. washout) near the top of the hole. The density from 32 m to the bottom of the hole is about 2.15 g/cm<sup>3</sup> (the accuracy of this figure depends on the current validity of the test pit calibration carried out over a year ago). This value is on the low end of the range for consolidated clastic rocks and on the high end of the range for unconsolidated material. In engineering terms the material could be described as a 'gravel' without precluding it from being *in situ* weathered rock.

The caliper log shows material more resistant to caving over the depth intervals 7 to 9.5, 20 to 33, and 67 to 71.5 metres. The caliper straight line from zero to seven metres is the casing.

The single point resistivity trace indicates material of moderate resistivity, with resistivity increasing slowly with depth from about 17 m to the bottom of the hole. Deviations from the general trend are fairly small, the most significant being the interval 55 to 62 m which shows increased resistivity. The SN confirms the single point

trace and the LN shows that the deviations are relatively short intervals apart from the 55 to 62 m interval. At 17 m there is a rapid change to a lower but still moderate resistivity above this depth. In terms of water production the variations in the trace are not highly significant. The presence of moderate resistivities suggests the potential for moderate yields. The lack of an anomalously low resistivity zone suggests the absence of a good gravel aquifer of appreciable thickness.

The hole may now be divided conveniently into three zones. The upper zone above 17 m is a shallow zone where borehole effects and weathering are generally greatest. This zone has low to moderately low gamma, moderate resistivity, exhibits caving and is of moderately low density. This sort of depth is not usually of great interest in groundwater investigation and there is nothing in these results to suggest that this is an exception. The zone from 17 to 33 m has, compared with the lowest zone, higher gamma, slightly higher density, slightly lower resistivity, higher SP and does not cave so easily. This middle zone is expected to have a greater shale content and therefore be less permeable than the lowest zone. The middle zone must be viewed as having a lower water producing potential than the lowest zone.

The lowest zone, from 33 m to the bottom of the hole, is the most encouraging from a water exploration point of view. It exhibits minor caving, uniform moderately low gamma, uniform moderately low density, variable S.P. and variable moderate resistivity. The caving is absent from 67 to 71.5 m (the bottom of the hole) but no change is visible on the gamma; thus the bottom of hole material may be similar to but less weathered than that immediately above, in which case the density would be expected to increase below 67 metres. Unfortunately safety procedure precluded lowering the density tool below 67 metres.

The bottom thirty or so metres of the hole (the lowest zone) is probably the most prospective, the logs indicating a lower amount of shale than is expected in the middle zone. However, it is fairly uniform without any real indication of sedimentary structure. Between 50 and 60 m it may be marginally less 'shaly' than in the remainder of the zone, there being a marginal decrease in gamma, a definite increase in resistivity and decrease in S.P., and a slight increase in caving (there is no change in density).

It seems quite unlikely that the cuttings noted at 55-60 m indicated a gravel bed higher up not noticed by the drillers while drilling through it. The logs indicate no such gravel bed higher up but they do indicate that the cuttings observed while drilling the 55-60 m interval are most likely to have come from that interval.

As to whether the 33-70 m zone intersects fine gravel, weathered rock, or the *in situ* brecciation of a fault zone (a third possibility suggested by W.L. Matthews as worthy of consideration), the most likely answer is weathered rock, because the general physical uniformity of the material for over thirty metres makes it unlikely to be a brecciated fault zone and the moderate resistivity makes the material unlikely to be a gravel aquifer. Furthermore, the angularity of the cuttings poses something of an origin problem if it is assumed that the zone is a gravel bed with thickness in excess of thirty metres. There would appear to be no such objections to the material being weathered rock.

The water-producing potential of the bore would be rated as moderate because the logs are not indicative of material unable to produce water nor of material of high permeability.

ACKNOWLEDGEMENTS

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[4 February 1986]

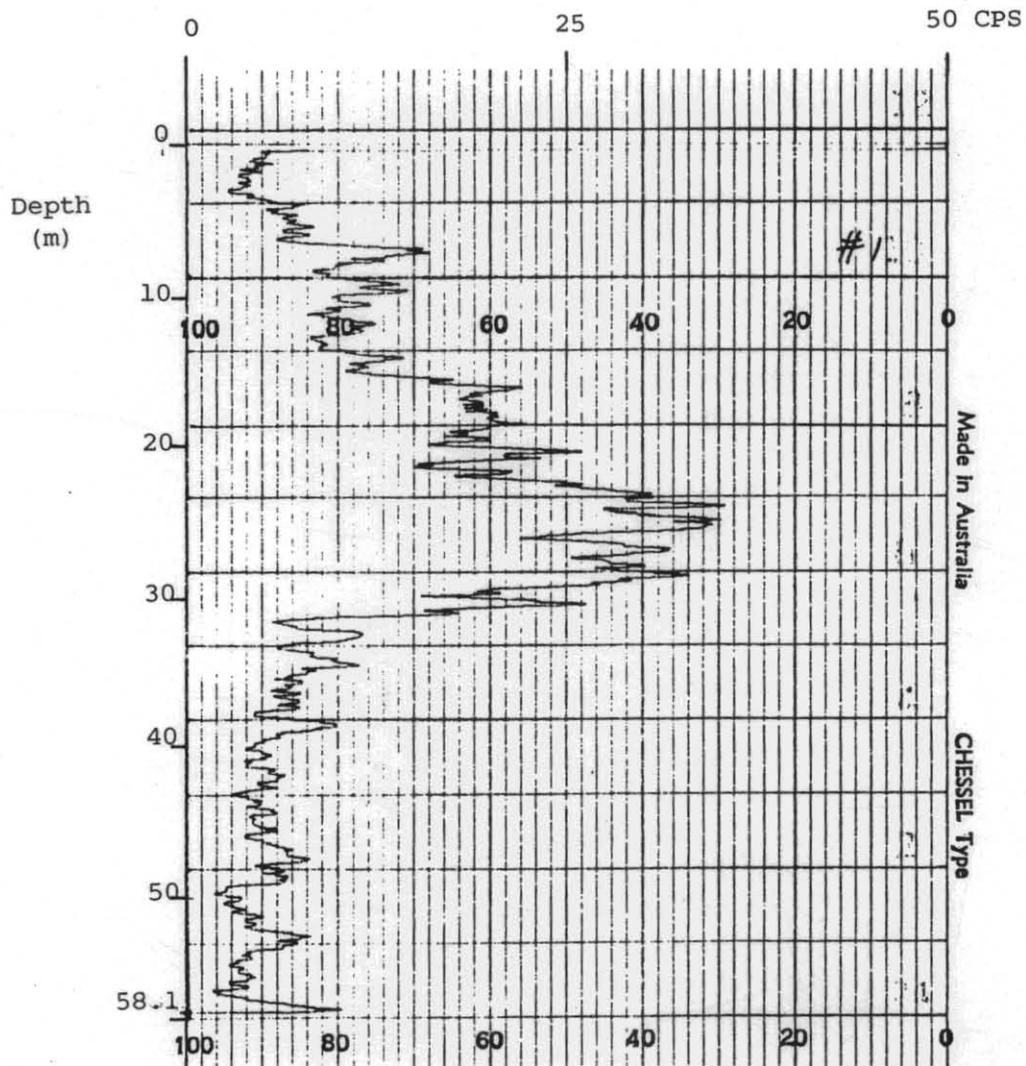


Figure 1. Natural gamma - Run 1

5 cm

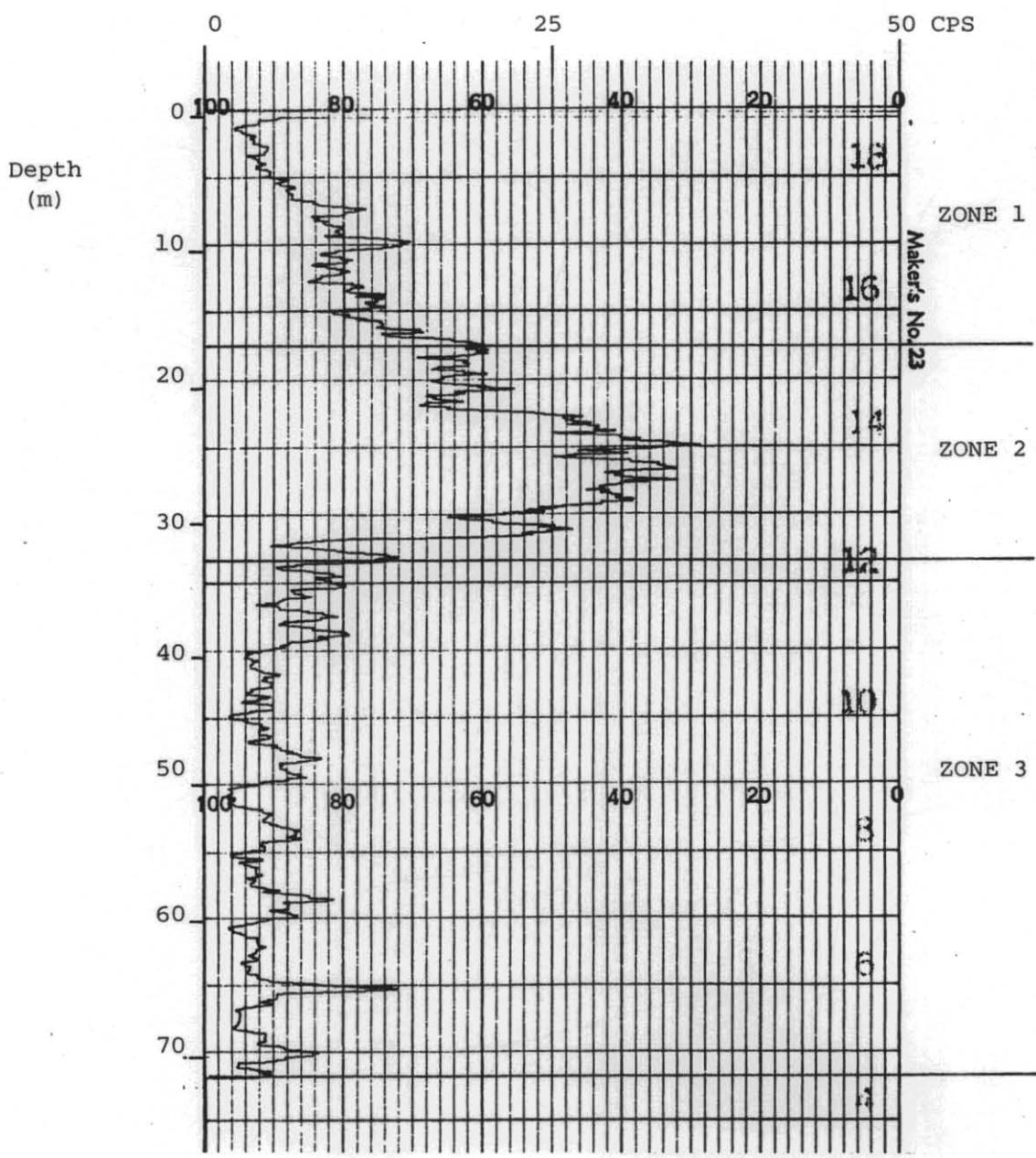


Figure 2. Natural gamma - Run 2

5 cm

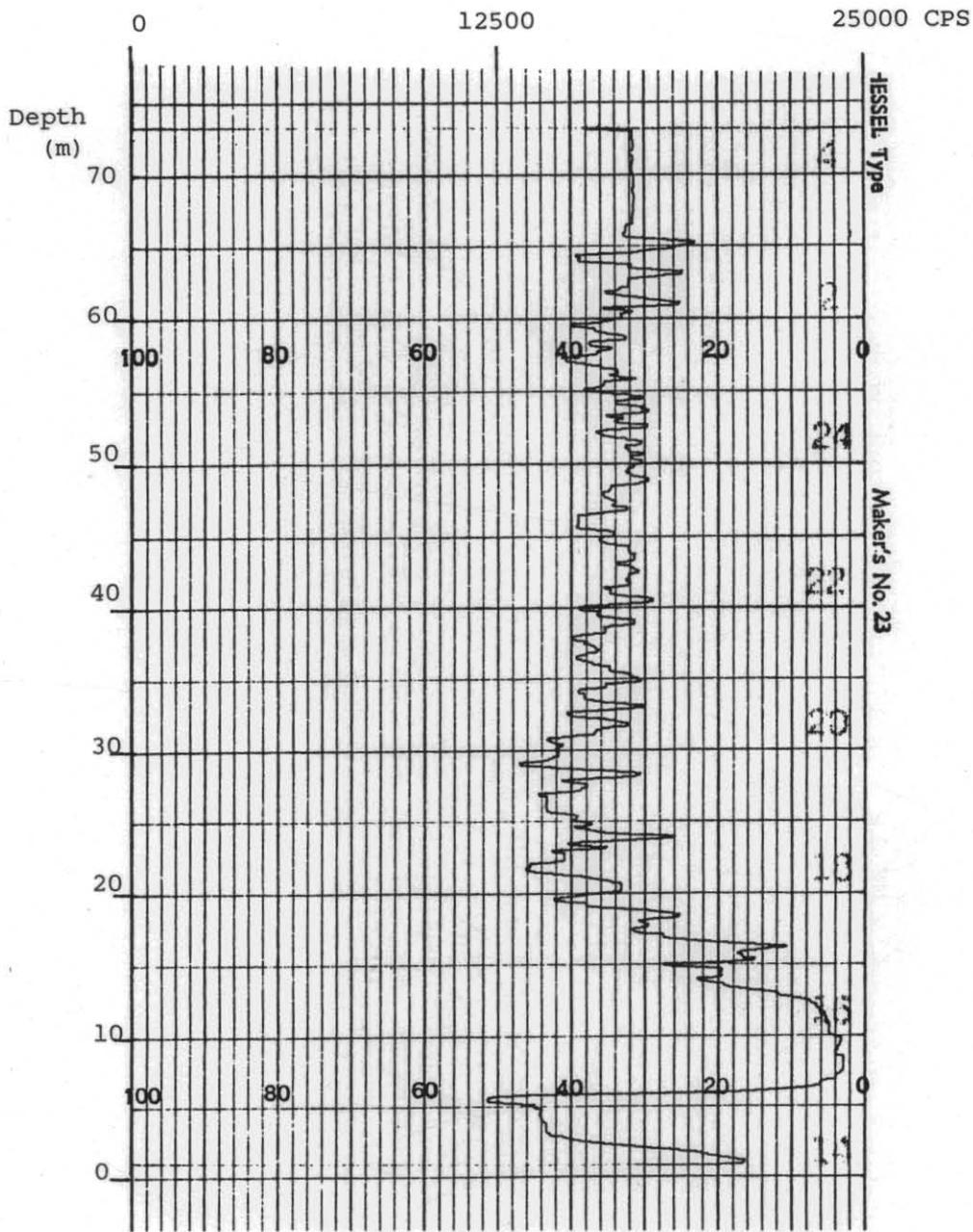


Figure 3.  $\gamma$ - $\gamma$  density - Run 1 (Downward)

5 cm

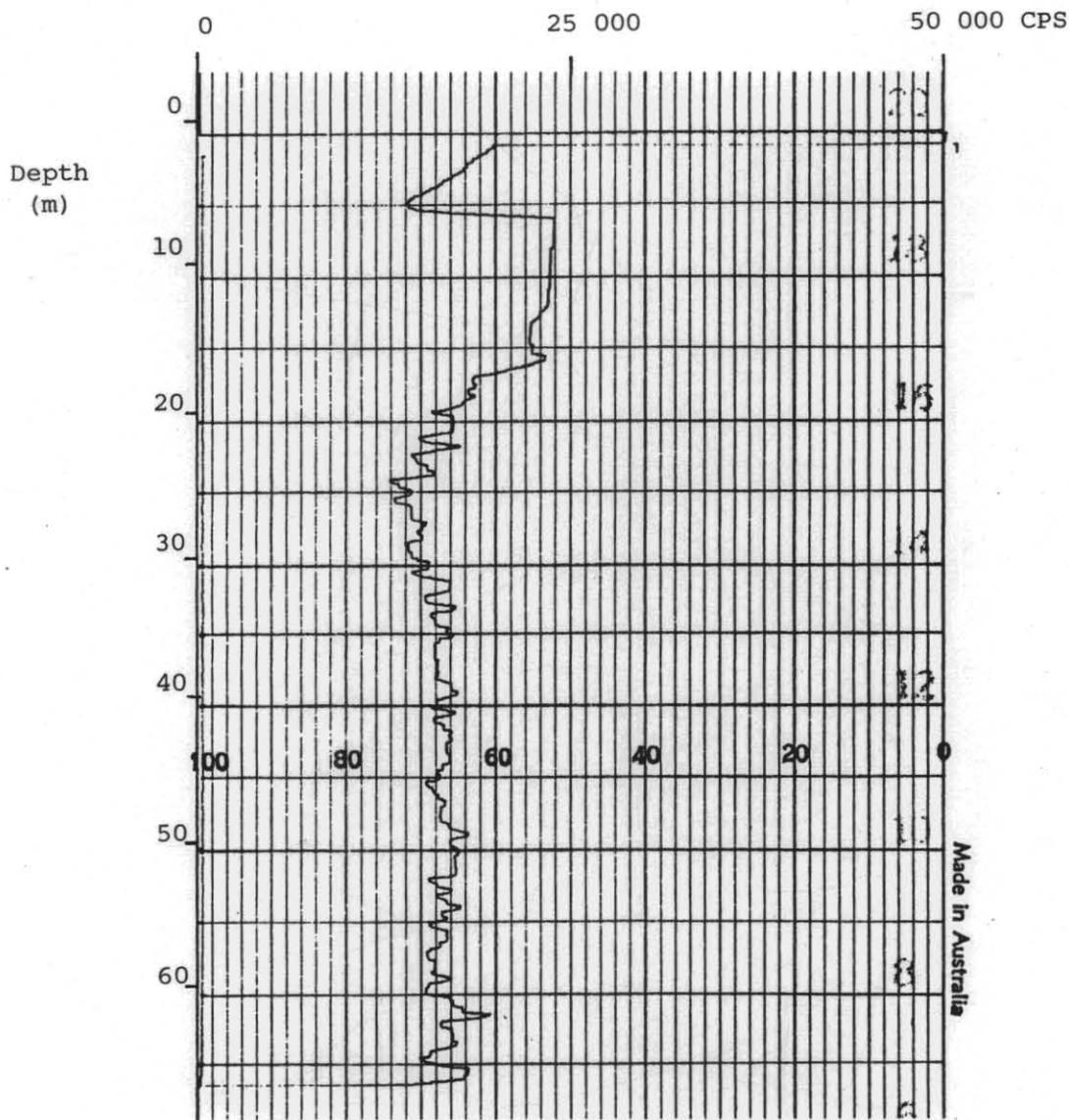


Figure 4.  $\gamma$ - $\gamma$  density - Run 1 (Upward)

5 cm

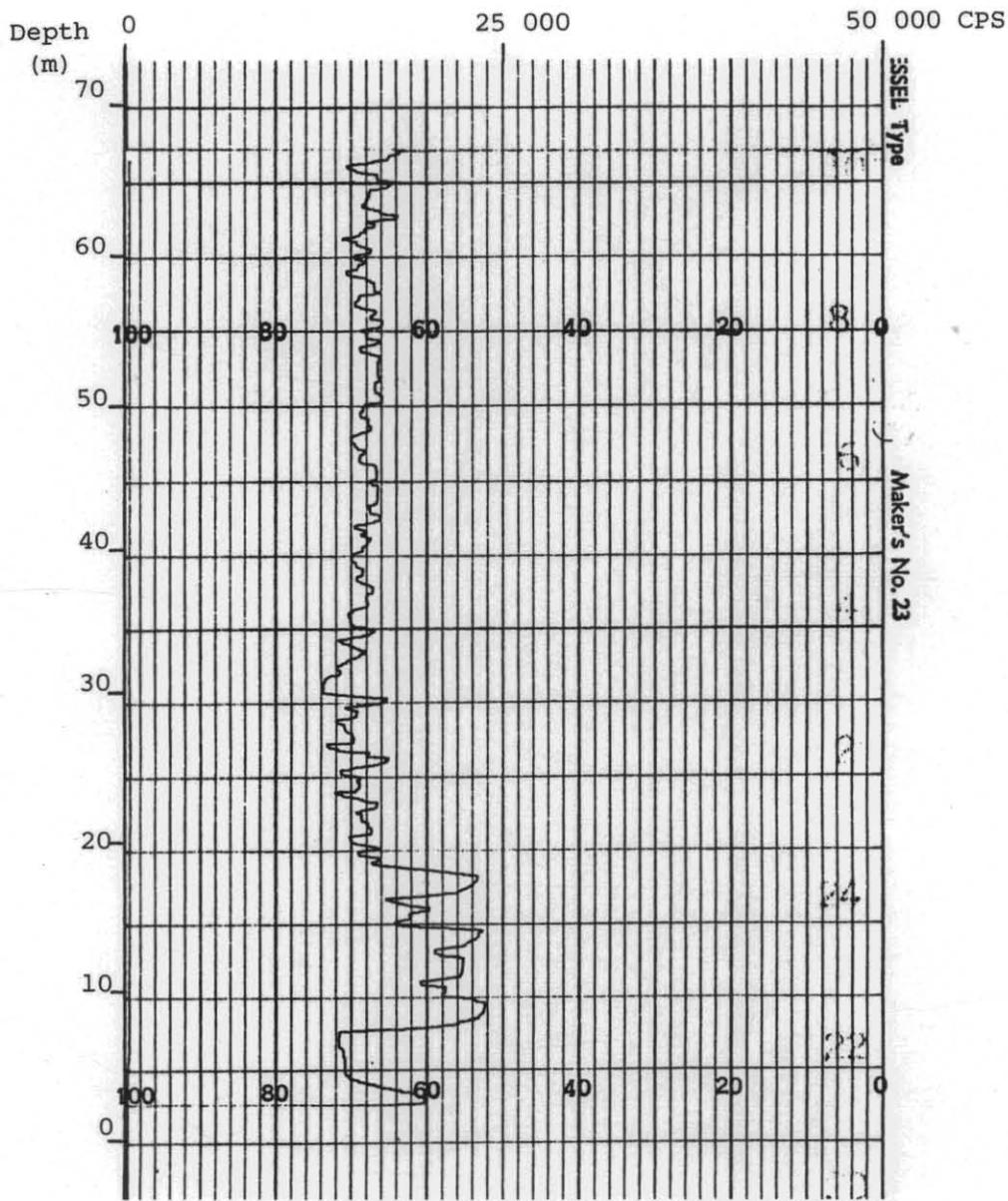


Figure 5.  $\gamma$ - $\gamma$  density - Run 2 (Downward)

5 cm

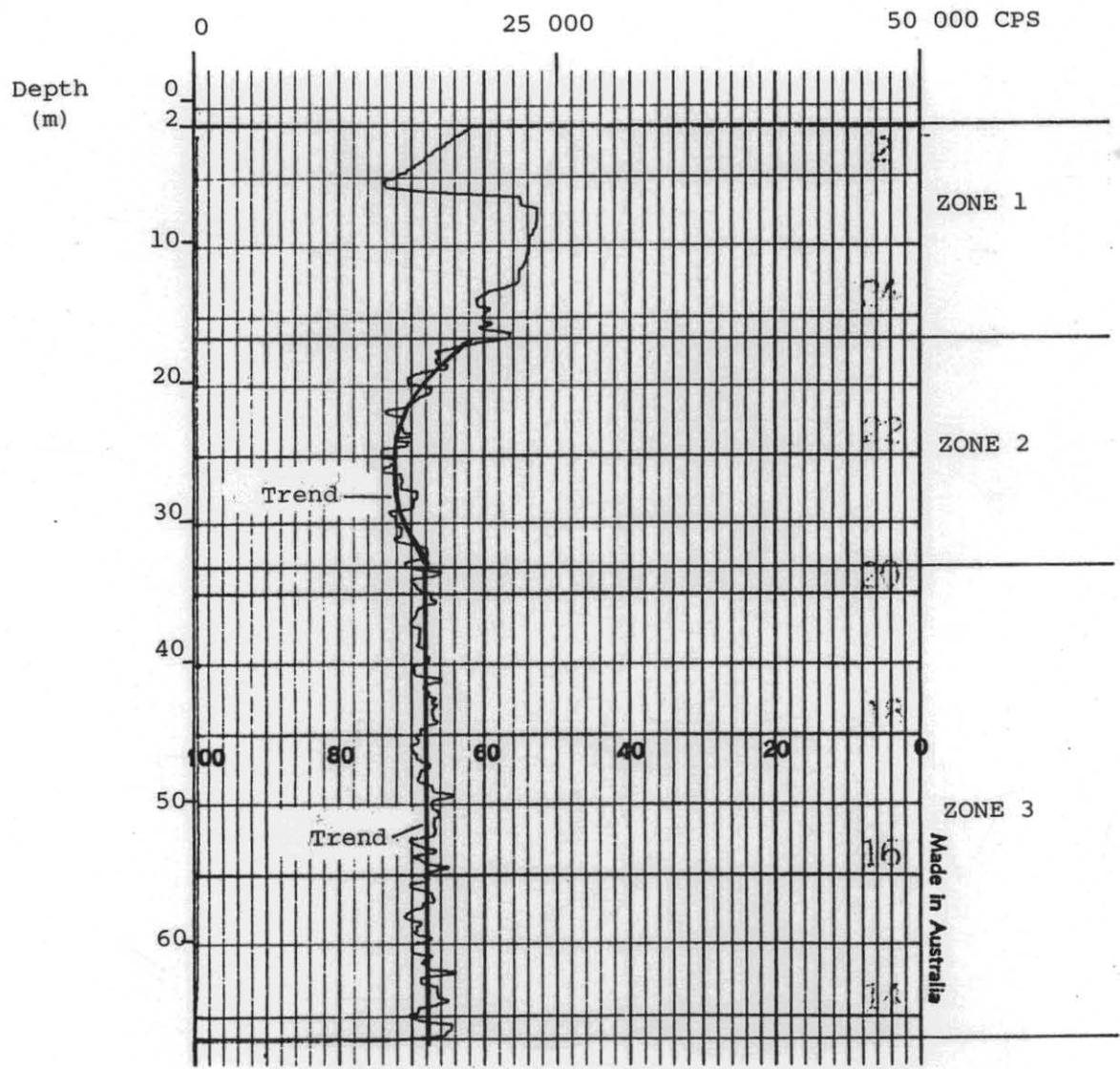


Figure 6.  $\gamma$ - $\gamma$  density - Run 2 (Upward)

5 cm

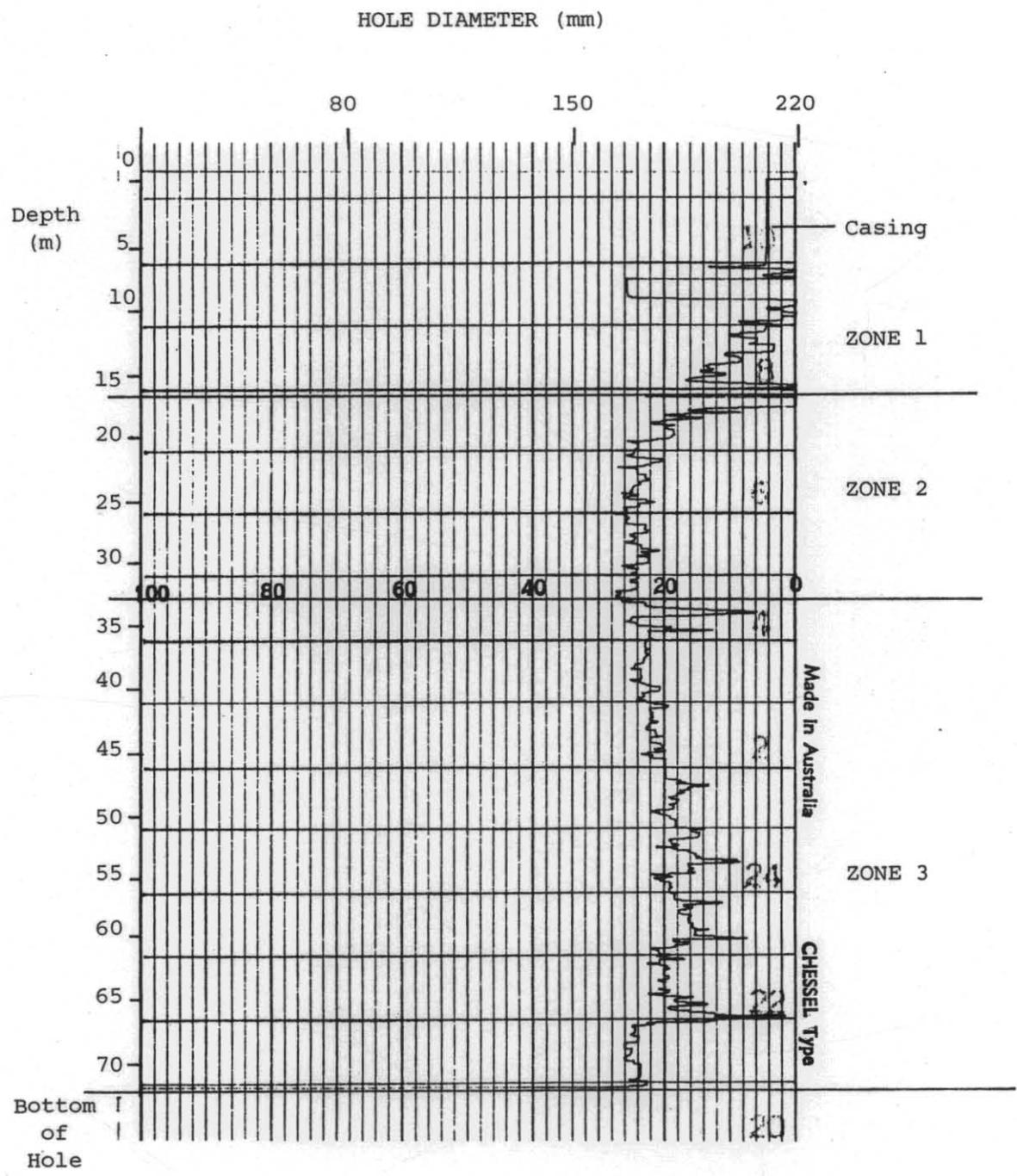


Figure 7. Caliper

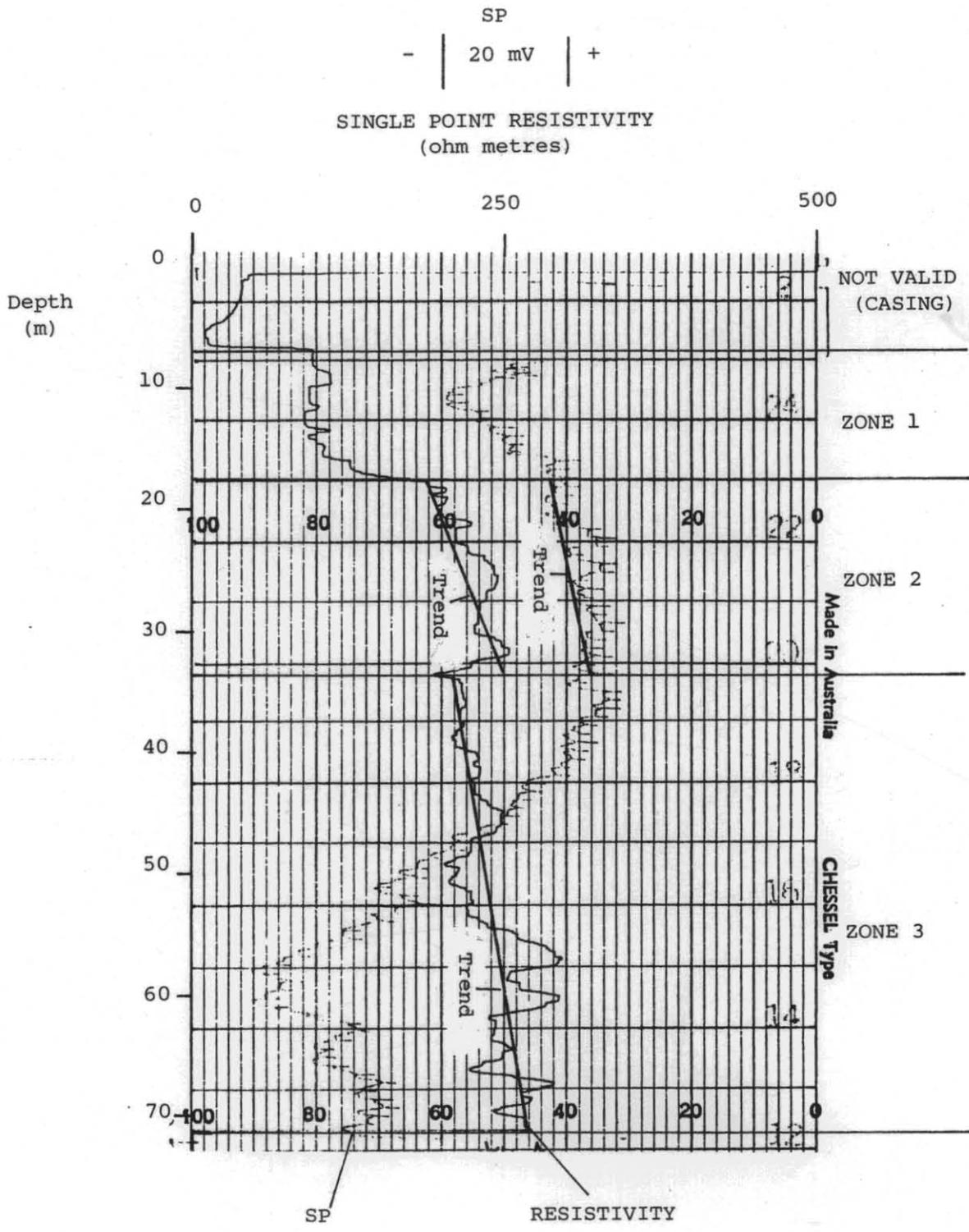


Figure 8. Single point resistivity and self potential

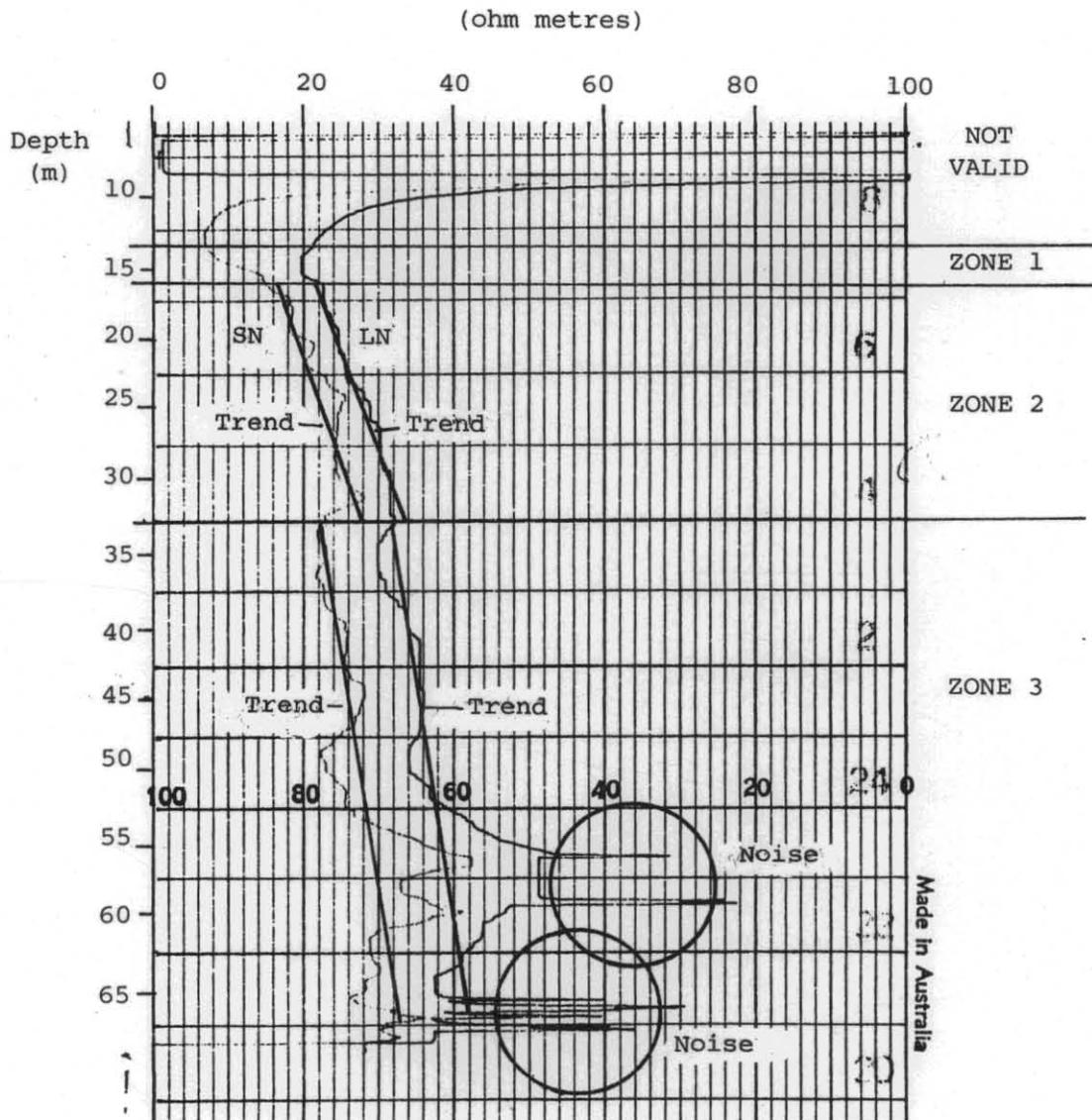


Figure 9. LN/SN resistivity