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28. Interim report on a groundwater survey of the Associated Pulp and Paper Mills clay pit area, Tonganah.

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The A.P.P.M. clay mining project at Tonganah requires about 230 *l*/min of high quality water. Although the Great Forester River is nearby its water is not suitable because of discolouration. The engineers were aware that considerable quantities of high quality groundwater had been discovered in the Tertiary sediments of the Scottsdale Basin, 3 km to the north. It was hoped that sufficient quantities would be available in the smaller Tonganah Basin which contained lithologically similar Tertiary sediments.

GEOLOGY

The Tonganah Basin is an intermontane sedimentary basin. Tertiary sand, gravel and clay underlie the areas of lower relief within the basin. The surrounding high rim of the basin is formed by two types of adamellites and a granodiorite which are collectively grouped in this report as granites. The east and west boundaries are formed by the N-S ridges of Kamona and Mt Stronach. The southern boundary is formed by the high plateau of Cuckoo Hill which has a conspicuous north-facing scarp. The northern boundary of the basin is formed by a low E-W ridge that extends eastward from Mt Stronach towards the Kamona ridge. The Tertiary sediments cover an area of about 30 km^2 and range in thickness from 1-100 m. The Tertiary sediments of the Tonganah Basin appear to be isolated from those of the Scottsdale Basin to the north-west and those of the Springfield Basin to the south-west.

HYDROLOGY

The Tonganah Basin has a rainfall of 1000 mm per year but the only two permanent streams, the Great Forester River and its tributary the Aaron River drain the granite plateau of Cuckoo Hill which has a rainfall of more than 1500 mm. The flow of these streams appears less than would be expected from the rainfall in this catchment area. The surface drainage may be compensated by considerable subsurface groundwater drainage as in the Scottsdale Basin. There are no operating stream gauges on the Great Forester River or its tributaries.

GEOHYDROLOGY

The Tonganah Basin was geologically mapped in 1969. Surface exposures within the Tertiary sediments were few. The sediments appeared to be less than 30 m in thickness. An exploration percussion hole was drilled near the centre of the basin in 1969 [EQ503427]. It penetrated to a depth of 40 m before hard granite was encountered. On pump testing, the bore yielded less than 8 *l*/min with a water quality of 75 ppm. In 1972 a rotary hole was drilled in Rocky Gully valley in the headwaters of the Aaron River [EQ421417] to check the bore yield of an earlier percussion hole which appeared very low. The rotary hole was drilled to 29.9 m of which only 6.1 m were in Tertiary sediments and the remainder of the hole was in weathered granite. The yield was 53 *l*/min with a water quality of 55 ppm.

This drilling appeared to confirm the impression gained from the surface mapping that the Tertiary sediments of the Tonganah Basin were thin. Because of the limited thickness of the sediments and the high percentage of clay contained in them their groundwater could be expected to be low. Although the Scottsdale and Tonganah Basins have a similar surface hydrology, and the lithology of their Tertiary sediments is comparable, a given thickness of Tertiary sediments in the Tonganah Basin yields much smaller quantities of groundwater. This apparent anomaly might be explained by postulating a groundwater flow in the granite of the Tonganah Basin.

PREVIOUS INVESTIGATIONS

Scottsdale Pine Industries requested the Department to undertake a foundation and groundwater survey of their proposed factory site area in 1974. One seismic spread was fired along the logging track to the railway line (fig. 90). This spread indicated a greater thickness of Tertiary sediments and weathered granite than had been indicated by the previous drilling and mapping. The seismic spread showed a steep slope to the north on the face of the underlying granite. About 75-90 m of Tertiary sediments and weathered granite were indicated at the northern end of the spread and 45-60 m at the southern end. Because of the increased thickness of Tertiary sediments and the possibility of a valley in the granite surface which channelled the subsurface drainage, yields of 90 *l*/min were forecast in this preliminary investigation.

A.P.P.M. drilled their first groundwater investigation bore without knowledge of the Scottsdale Pine Industries investigation. The bore was sited immediately north of their clay prospecting area. It penetrated 38 m of Tertiary sediments, appeared to bottom in a coarse gravel, and yielded 50 *l*/min. This bore (A.P.P.M. Bore 1) was drilled by a light cable tool drill by H. Stackpole.

GROUNDWATER SOURCES IN THE TONGANAH BASIN

Three possible sources for groundwater appeared to be available for the clay pit site.

(1) The Tertiary sediments of the Tonganah Basin.
(2) The granites beneath the Tertiary sediments and on the periphery of the Tonganah Basin.
(3) The alluvial flats of the Great Forester River.

Tertiary sediments

From the results of departmental investigations, the Tertiary sediments are considered to be the most reliable aquifer in north-eastern Tasmania. These sediments yield the highest quality groundwater but have the most variable yield, ranging from 40 *l*/min to 1680 *l*/min. The water quality ranges from 50-600 ppm but averages 150-200 ppm.

Although the Tertiary sediments of north-eastern Tasmania have a generally similar lithology the bore yields can vary within the same basin in which the same general drainage conditions appear to apply and only generalised principles can be applied in their prediction; anomalous results are quite common. The higher yielding bores appear to be associated with drainage channels in the Tertiary basins where the greatest thickness of Tertiary sediments occur. The absence of a deeply weathered layer of granite between the sediments and hard rock and the absence of any thick clay layer near the base of the Tertiary sequence appears to be a feature of these higher yielding bores.

From the A.P.P.M. Bore 1 and seismic and resistivity results these three favourable conditions appeared to be present at Tonganah, although a thick clay layer overlies the granite in the clay pit.

Another factor influencing the yield of Tertiary bores is likely to be the amount of clay mixed within the sand and gravel. No exploration technique has yet been developed during the groundwater investigation of north-eastern Tasmania to allow an appraisal of this factor. In the drilling methods used in this investigation much of this clay is washed out from the samples. Electrical logging of the bores has not produced any pattern from which yields can be anticipated before pumping. The percentage of clay mixed with the sand and gravel will be of prime importance in the Tonganah Basin where extensive clay deposits, primarily from the weathering of granite, have been found by A.P.P.M. in their exploration drilling. The Tonganah Basin appears to be too small to allow sufficient distance for the transport of weathered granite to enable complete sorting into quartz sand or gravel, and clay. A higher percentage of clay appears more likely in the Tertiary sediments of the smaller Tonganah Basin than in the larger Scottsdale Basin. Therefore yields from an equivalent thickness of sediments are likely to be lower in the Tonganah Basin.

Granite

The granites of the Tonganah area are well jointed; wide vertical and horizontal joints occur. Only one bore has been drilled in the granitic rocks during the groundwater investigation of north-eastern Tasmania. This hole [EQ560661] was drilled in porphyritic granite to a depth of 64 m and produced 454 *l*/min with a water quality of 715 ppm. The bore was only producing 5 *l*/min for most of its depth when drilled; but during the bottom 2 m of drilling the water yield increased dramatically and water rose in the hole with a pressure high enough to preclude coring. Consequently it is not known if bore crossed a joint or some contact (*e.g.* between granite and Mathinna sediments).

Although, as mentioned previously, groundwater flow in the granites is likely, yields cannot be predicted.

Alluvial flats of the Great Forester River

From visual observations no great increase in volume of water occurs in the Great Forester River as it flows through the Tonganah Basin. It is possible that the river has a zone of discharge beneath its alluvial flood plain. The extent of this zone will depend on the lithology of the alluvial sediments. If any extensive sand or gravel beds occur within the alluvial deposits these could be a possible source of groundwater.

PROPOSED INVESTIGATION PROGRAMME

In consultation with the A.P.P.M. engineers and management it was proposed to investigate all three groundwater sources. The second bore to be drilled by A.P.P.M. was to be sited on the edge of the Great Forester River alluvial flats near the Tasman Highway. A.P.P.M. Bores 1 and 2 were both sited at the same distance from the Scottsdale Pine Industries seismic line.

Bore 2 should test a greater thickness of the Tertiary sediments than A.P.P.M. Bore 1 which may not have reached their base. A.P.P.M. Bore 2 would also serve as a control for a proposed seismic grid. This seismic grid would be fired with the aim of finding the shape of the Tertiary basin and its drainage direction.

When the basin was delimited seismically a third exploration bore would be drilled by A.P.P.M. provided the thickness of the Tertiary sediments appeared adequate and a channel well enough defined. If the yield of this bore from the Tertiary sediments was inadequate it was proposed to continue drilling into the granite. The granite would be cored at the contact beneath the

Tertiary sediments. If the core was jointed and the seismic velocities were low the granite would be drilled until the high seismic velocity granite layer (*c.* 5000 m/s) was reached. The hole would be rotary drilled, using slotted casing in the Tertiary sediments, followed by down-the-hole air hammer in the granite. It was proposed to try to core the granite at 15 m intervals.

In addition a fourth hole was to be drilled in the granite using an air hammer drill by the Department as part of their groundwater exploration programme. The hole is sited on Kamona adamellite close to outcrops where jointing is well exposed on and above the North Eastern Railway line (fig.90).

In addition two holes, 10-15 m deep, were to be drilled using a light cable tool drill on the flats of the Great Forester River to determine if any suitable aquifers were present in the alluvial sediments.

GEOPHYSICAL RESULTS

Twelve spreads of various lengths with a geophone spacing of 15 m were necessary to determine the basin bedrock configuration. Six of these spreads had to be repeated because of a fault which developed in the timing mechanism of the seismograph.

The velocity layers and depths to the interfaces in the twelve seismic spreads are shown in Table 1. The bedrock contours show that the Tonganah Basin is a narrow flat-bottomed basin with a gentle slope down to the north-east.

The bedrock (fig.90) is defined as a granite with a V_1/V_2 seismic velocity in excess of 2750 m/s. The contour datum is the collar height of A.P. P.M. Bore 2 (117 m).

Drilling results to date

A.P.P.M. Bore 2 was drilled to 77 m by Mono Pumps Ltd. The bore was gravel packed and solid casing and three drill screens were installed. Tertiary sediments were encountered to 72.5 m and hard granite at 76.2 m. The bore was tested using compressed air and yielded 55 *l*/min.

The next bore (A.P.P.M. Bore 3) to be drilled was sited at the intersection of seismic spreads 4 and 5. It was drilled to a depth of 109 m and the granite/Tertiary interface was encountered at 82 m. The bore initially produced 227 *l*/min on air testing but on further pumping stabilised after 4 hours at a reduced flow of 106 *l*/min. The driller reported that the Tertiary sediments were producing 90 *l*/min when the hole was being drilled. Recovery was rapid after pumping ceased.

No core was recovered from the granite or at the granite/Tertiary contact in this hole.

It was decided to deepen A.P.P.M. Bore 2 into the granite by approximately 30 m. This proved impossible because the footing on the screen was bent. A fourth hole (A.P.P.M. Bore 4) was then drilled by Mono Pumps. It penetrated over 85 m of Tertiary sediment and finished at 103 m and is reported to be producing 300 *l*/min.

Two shallow bores (A.P.P.M. 5, 6) have been drilled to 9 m in Quaternary alluvial silts, sand and minor gravel. The bores end in Tertiary clay and yielded 45 *l*/min with no apparent drawdown. They are now being pump tested at 230 *l*/min using larger capacity pumps and slotted casing, with little reported drawdown.

One of the two Department of Mines holes in the adamellite of the basin periphery (the observation hole) has been drilled to about 25 m in the hard granite after passing through 6 m of weathered and decomposed granite. It pumped 10 *l*/min. The other hole is now being drilled and was 52 m deep when last reported.

CONCLUSIONS

It appears that adequate groundwater supplies are present in the Tertiary basin. These could be supplemented by supplied from the granite beneath the basin. Further supplies are obtainable from the zone of discharge of the Great Forester River although this source requires further investigation by drilling stepping out at regular distances from the river.

Prolonged pump testing is required to test all exploration bores.

REFERENCES

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MOORE, W.R. 1977. The groundwater potential of north-eastern Tasmania. *Tech.Rep.Dep.Mines Tasm.* 20:249-251.

[21 May 1975]

Table 1. RESULTS OF SEISMIC SPREADS, TONGANAH

Spread and direction	Length (m)	Seismic velocities (m/s)	Depth of interface (m)	Character of velocity curve	Slope of interface	Remarks
1 N-S	343	V_0 910-1520 V_1 3050-3350	V_1/V_2 48-75	Strongly assymetrical	V_0 layer thickens to N. Slope down to N.	Some V_2 of >6100 m/s seen from extended shots but slope of interface so steep that calculations are not realistic.
2 N-S	411	*North end* V_0 1520-1830 V_1 3050 V_2 4570 *South end* V_0 1520 V_1 3050-4570	V_0/V_1 76-79 V_1/V_2 88-104 V_0/V_1 73-79	Strongly assymetrical	V_0 layer thickens to N. Slope down to N.	Small amount of 3050 m/s of V_2 layer present from south end in the extended shots. This 3050 m/s layer only present for 2 geophones, replaced by 4570 m/s velocity.
3 N-S	396	V_0 1520 V_1 3050 V_2 4570	V_0/V_1 49-82 V_1/V_2 >76 at north end	Assymetrical	V_0 layer shallows towards N.	
4 E-W	411	*West end* V_0 1520 V_1 2290 V_2 2740-3050	V_0/V_1 35-42 V_1/V_2 64-70	Slightly assymetrical	Deepens gradually to E.	Some 4570 m/s velocities calculated for east end at a depth of 104-197 m. East end on a topographic ridge.

Table 1. (continued)

Spread and direction	Length (m)	Seismic velocities (m/s)	Depth of interface (m)	Character of velocity curve	Slope of interface	Remarks
4 E-W		*East end*				
		V_0 1520				
		V_1 2290	V_0/V_1 29-34			
		V_2 3810	V_1/V_2 76-79			
5 N-S	549	V_0 1520-1830		Assymetrical		
			V_0/V_1 79-88		Deepens to N.	
		V_1 3050	V_1/V_2 104-125			V_1/V_2 layer material shallows at both ends.
		V_2 5180-6100				
6 N-S	457	*North end*				
		V_0 1520		Strongly assymetrical.		Steep slope to north making velocity correlation at both ends difficult. Errors of depth at shot points very likely.
			V_0/V_1 63-66		All three layers deepen to N.	
		V_1 3050				
			V_1/V_2 104-110			
		V_2 5180				
		South end				
		V_0 910				
		V_1 1830	V_0/V_1 29-31			
		V_2 3050	V_1/V_2 64-67			
7 E-W	442	*West end*				
		V_0 1680-1830		Strongly assymetrical		Thicker lens of V_1 = 2290 m/s appearing at east end. This layer present at west end but appears to lens out rapidly in this direction. Any error in thickness of the V_1 layer overdeepens the V_1/V_2 interface.
			V_0/V_1 38-43		Deepens to E.	
		V_1 2290	V_1/V_2 >91			
		V_2 4570-6100				
		East end				
		V_0 1520				
		V_1 2290	V_0/V_1 43-51			
		V_2 4570-6100	V_1/V_2 94-99			

Table 1. (continued).

Spread and direction	Length (m)	Seismic velocities (m/s)	Depth of interface (m)	Character of velocity curve	Slope of interface	Remarks
8 E-W	396	V_0 1680 V_1 3050	V_0/V_1 69-85	Symmetrical		Slight shallowing at east end shot point end and the calculated west shot point was over 9 m deep compared with drilling at this location.
9 E-W	Because of malfunctioning of the seismograph this spread was not refired. Seismic velocities were similar to Spread 8, but the V_0/V_1 interface was considerably shallower.					
10 N-S	457	*North end* V_0 1520 V_1 2900-3050* V_2 6100* *South end* V_0 1520† V_1 6100†	V_0/V_1 34-37 V_1/V_2 66-70 V_0/V_1 52-56	Assymetrical		Spread fired over an area of considerable topographic relief. The south shot point fired in valley with geophone line above V_0 3050 m/s velocity seen and V_2 velocities too high so slope not true.
11 N-S	411	*North end* V_0 910 V_1 1830 V_2 3050 *South end* V_0 910 V_1 1830§ V_2 6100§	V_0/V_1 29-31 V_1/V_2 76-85 V_0/V_1 21-23 V_1/V_2 80-91	Strongly assymetrical	Slopes down to N. V_0 layer thicker at north end. V_1/V_2 interface slopes down to N.	Northern shot fired in valley floor with geophone line along the ridge.

* † § Average used in calculations: 4570 m/s.

Table 1. (continued)

Spread and direction	Length (m)	Seismic velocities (m/s)	Depth of interface (m)	Character of velocity curve	Slope of interface	Remarks
12 E-W	472	*West end*				
		V_0 1220		Strongly assymetrical		
			V_0/V_1 27-35			
		V_1 1830			Surface layer thickens and V_1/V_2 deepens to W.	
			V_1/V_2 68-71			
		V_2 3660				
		East end				
		V_0 1520				
			V_0/V_1 61-64			
		V_1 3050				
			V_1/V_2 78-96			
		V_2 4570				

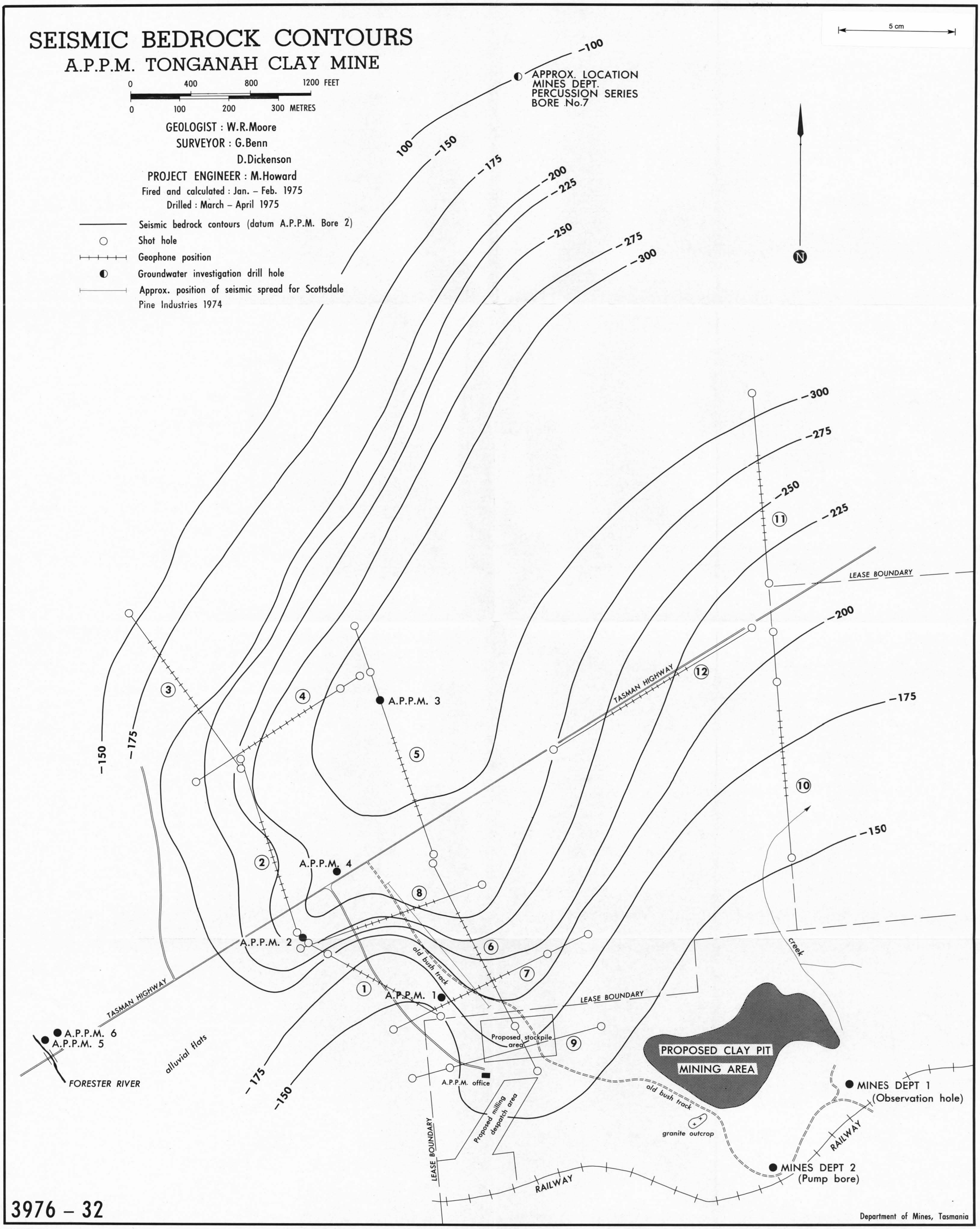

FIGURE 90

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