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9. Seismic survey at the Australian Commonwealth Carbide Company Works, Electrona.

W.R. Moore

A seismic survey was undertaken for a feasibility study for new furnaces and buildings at the Electrona works at the request of K. Steinman of Crooks Michell Peacock Stewart Pty Ltd, engineers, architects and planners of Chatswood, New South Wales.

Seven spreads and two weathering spreads were fired at the proposed site. The location of these spreads is shown in Figure 20. The geophone spacing was 7.6 m for the first five spreads but it was reduced to 3 m for the remaining two spreads owing to the close proximity of the office building. The two weathering spreads were 15 m in length.

The carbide works are situated on a promontory north of Snug village. Triassic sandstone crops out along the foreshore and low cliffs north of the Snug Rivulet. Grey and brown clays were exposed in two exploration pits near the south-western corner fence of the works. Some very deeply weathered Triassic mudstone and, or, Tertiary clay is partly exposed in a disused clay pit at the western end of the low cliff line.

GEOPHYSICAL WORK

The seismic results are summarised in Table 1. The area is a particularly difficult one for seismic interpretation as there are large areas of fill (limestone, furnace slag, etc.) which may or may not overlie clay and sand. The clay and sand are probably derived from the very deep weathering and decomposition of the underlying sandstone and mudstone of Triassic age, although the possible presence of Tertiary clay and sand cannot be overlooked.

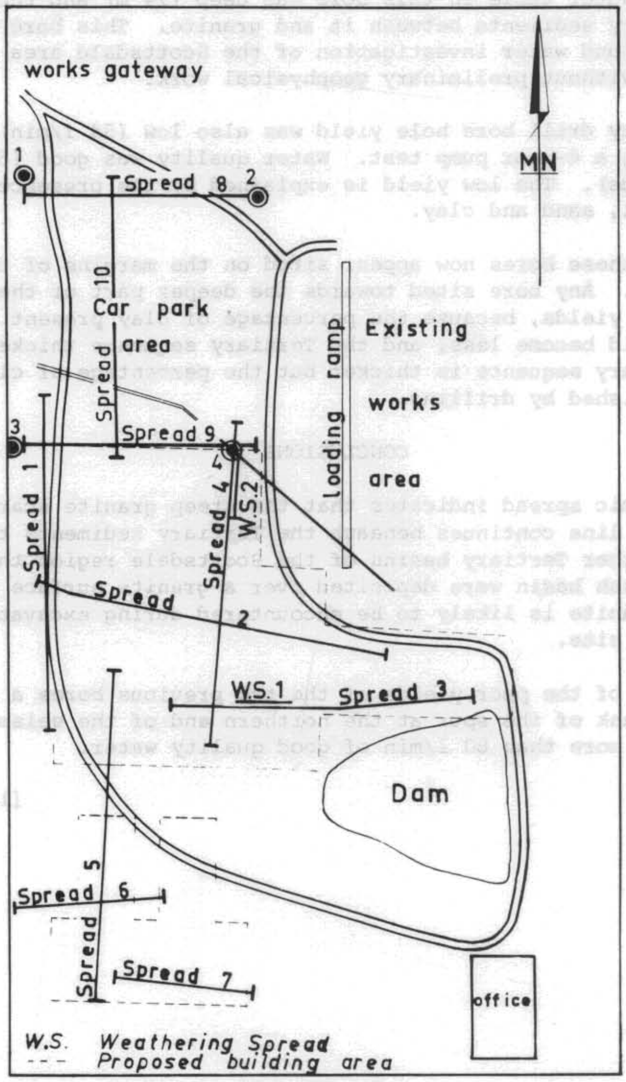
The clay and sand overlie deeply weathered Triassic sandstone and mudstone with a gradual transition to the unweathered parent rock. There is no precise boundary separating the various degrees of weathering in these sediments and consequently the interface between the seismic velocity layers is unlikely to coincide with weathering zones in the sandstone and mudstone. The slope of many of the interfaces leads to further imprecision in the calculation of seismic velocities and interface depths.

In the south-west corner of the site area the surface velocity layer (V_0) is the clay exposed in the two shallow clay pits. Its velocity (610 m/s) is the same as that recorded for the two weathering spreads which are located in areas of fill. Spread 1 was fired along the western boundary road of the works, and appears to be the only spread where the bedrock occurs at shallow depth. In all the other spreads the depth to bedrock is calculated as 10-18.3 m, where bedrock is defined as rock with a velocity of 1525 m/s or higher.

Even allowing for possible errors in the calculation of the seismic results there appears little doubt that much of the area is unsuitable for bearing heavy structures such as furnaces and will require further investigation.

CONCLUSIONS AND RECOMMENDATIONS

Even at this early stage of the feasibility study it appears that further drilling and geophysical investigation will be required for any site evaluation. It is recommended that two holes to a minimum depth of 15 m be drilled and cored. These holes should be located at the intersections of



Positions of seismic spreads, Electrona; for seismic profiles see Figure 20 (in pocket).

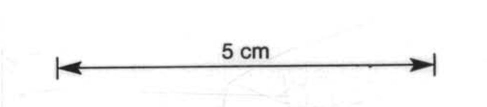


Table 1. SEISMIC RESULTS

Spread No.	Layer	Velocity (m/s)	Interface	Depth (m)	Slope	Geological interpretation of the velocity layers	Remarks
1	V_0	610				Fill and clay.	
			$\frac{V_0}{V_1}$	4.6-6.1	Nil		
	V_1	1830				Weathered Triassic sediments.	
2	V_0	610-915				Clay and fill.	The slope of the interface down to the east and differing velocity layering at the ends of the spread is possibly due to the infilling of the natural gullying combined with deeper weathering at the lower levels of the valley.
			$\frac{V_0}{V_1}$	4.6-7.6	8-10° to E.		
	West End V_1	1525				Weathered and decomposed Triassic sediments.	
			$\frac{V_1}{V_2}$	13.7-18.3	As above.		
	V_2	2135				Unweathered Triassic sediments.	
	East End V_1	2135				Unweathered but stained Triassic sediments.	
			$\frac{V_1}{V_2}$	24.4-26.0	Slope to E not as apparent as at W end.		
	V_2	3050				Consolidated Triassic sediments.	
3	V_0	915				Clay and, or, fill.	
			$\frac{V_0}{V_1}$	10.6-14.0	Slight slope to E.		
	V_1	1525-1830				Weathered Triassic sediments.	
			$\frac{V_1}{V_2}$	28.9-30.5	No apparent slope.		
	V_2	3660				Consolidated Triassic sediments.	
4	V_0	610				Fill	The level interfaces of this spread and depth to bedrock indicates a considerable amount of infilling.
			$\frac{V_0}{V_1}$	5.2-6.1	Nil		
	V_1	915-1220				Clay and deeply weathered and decomposed Triassic sediments.	
			$\frac{V_1}{V_2}$	12.2-13.7			
	V_2	1830-2135				Stained but unweathered Triassic sediments.	

Table 1. (continued)

Spread No.	Layer	Velocity (m/s)	Interface	Interface Depth (m)	Slope	Geological interpretation of the velocity layers	Remarks
5	V_0	610				Clay	Velocity interfaces are transitional.
			V_0/V_1	3.6–7.6	Slope to S.		
	V_1	1220–1525				Deeply weathered and decomposed Triassic sediments.	
			V_1/V_2	12.2–13.7	No apparent slope on lower interface.		
	V_2	3050				Unweathered and consolidated Triassic sediments.	
6	V_0	610				Clay.	Slope of the interface and absence of sharp velocity contrasts make depths only approximate.
			V_0/V_1	3.0–6.0	6° to W.		
	V_1	915				Sand and clay and, or decomposed and deeply weathered Triassic sediments.	
			V_1/V_2	10.4–11.3	Slight slope to W.		
	V_2	1830				Stained but unweathered Triassic sediments.	
7	V_0	610				Clay	Transitional V_0/V_1 velocities.
			V_0/V_1	2.1–3.7	Slight slope to W.		
	V_1	1220				Sand and clay and, or, decomposed Triassic sediments.	
			V_1/V_2	10.4–11.6			
	V_2	2135				Unweathered Triassic sediments.	
Weathering Spread 1	V_0	610					
	V_1	915–1067					
2	V_0	610					
	V_1	915					

seismic lines 2 and 4, and 5 and 6. These drill holes would allow for the seismic velocity layering to be compared with lithology. The holes could then be used as a control for a resistivity survey. The clay and rock fill should give differing apparent resistivity and it may be possible to draw resistivity contours by the use of resistivity sounding and traversing. This would enable further information to be secured at little cost before undertaking extensive drilling for a detailed site feasibility study.

[4 October 1974]

APPENDIX 1

Second seismic survey.

At the request of the consulting engineers further seismic investigation was carried out at the Electrona works on 6-8 March. The investigation was made in the car park area, north of the area previously investigated.

GEOPHYSICAL WORK

Two E-W spreads (8 and 9) were to be fired between four proposed drill holes with a N-S cross spread (10). The geophone interval for all spreads was 6.1 m. The distance which shots could be extended from the geophone line was restricted and the amount of explosive which could be used was limited because of the amount of fly-rock occurring on firing. The fly-rock was mainly of limestone boulders which formed a thick surface layer to the car park. Even when the shot holes were 4 m deep and penetrated to the underlying clay the limestone boulders still flew to a distance of up to 30 m. Even using blast mats this survey was very difficult to execute because of danger to personnel and close proximity to buildings.

The results of these three further spreads are summarised in Table 2. As indicated in the previous survey no 'hard bed' was found close to the surface on which the blast furnaces could be sited. The seismic velocities and layering indicated that beneath the surface layer of fill was a thick layer of clay, sand and soft sandstone of Tertiary age overlying soft, deeply weathered, Triassic sandstone and mudstone. Bedrock of unweathered Triassic sandstone and mudstone with seismic velocities in excess of 3 000 m/s was not found, and must occur below depths of 16-21 m.

DRILLING

Subsequent drilling on the site by Davies and Moore, foundation investigation engineers, confirmed the seismic results. Eight holes were drilled using a Gemco auger and diamond rig and a Failing 800 rotary rig. The location of four of these is known to the writer who has seen briefly the core of some of them. The core from Bore 4, which was completed before the seismic work was finished was examined at greater length.

Bore 4 encountered a top layer, 3.5 m thick, consisting of fill, sand and sandy clay with one cemented band; a Permian mudstone boulder was also found. Soft Tertiary sand and sandstone continued to a depth of 14.3 m. No core was recovered between 14.3 and 14.9 m. Below 14.9 m to a depth of 20 m white graphitic and micaceous well bedded Triassic sandstone was encountered. The sandstone was soft, deeply weathered and stained, and had a bedding dip of 10°.

Bore 1 followed a similar sequence of fill, Tertiary sand and clay and white Triassic sandstone with similar depths as Bore 4.

In Bore 2 the Triassic sediments consisted of carbonaceous mudstone with minor sandstone (Cygnet Coal Measures) and occurred between 18-21 m.

Bore 3 Tertiary sediments continued to 18 m and no Triassic sediments were encountered.

The only other core seen was from Bore 8A which was drilled to 7.3 m in Tertiary sand and clayey sandstone.

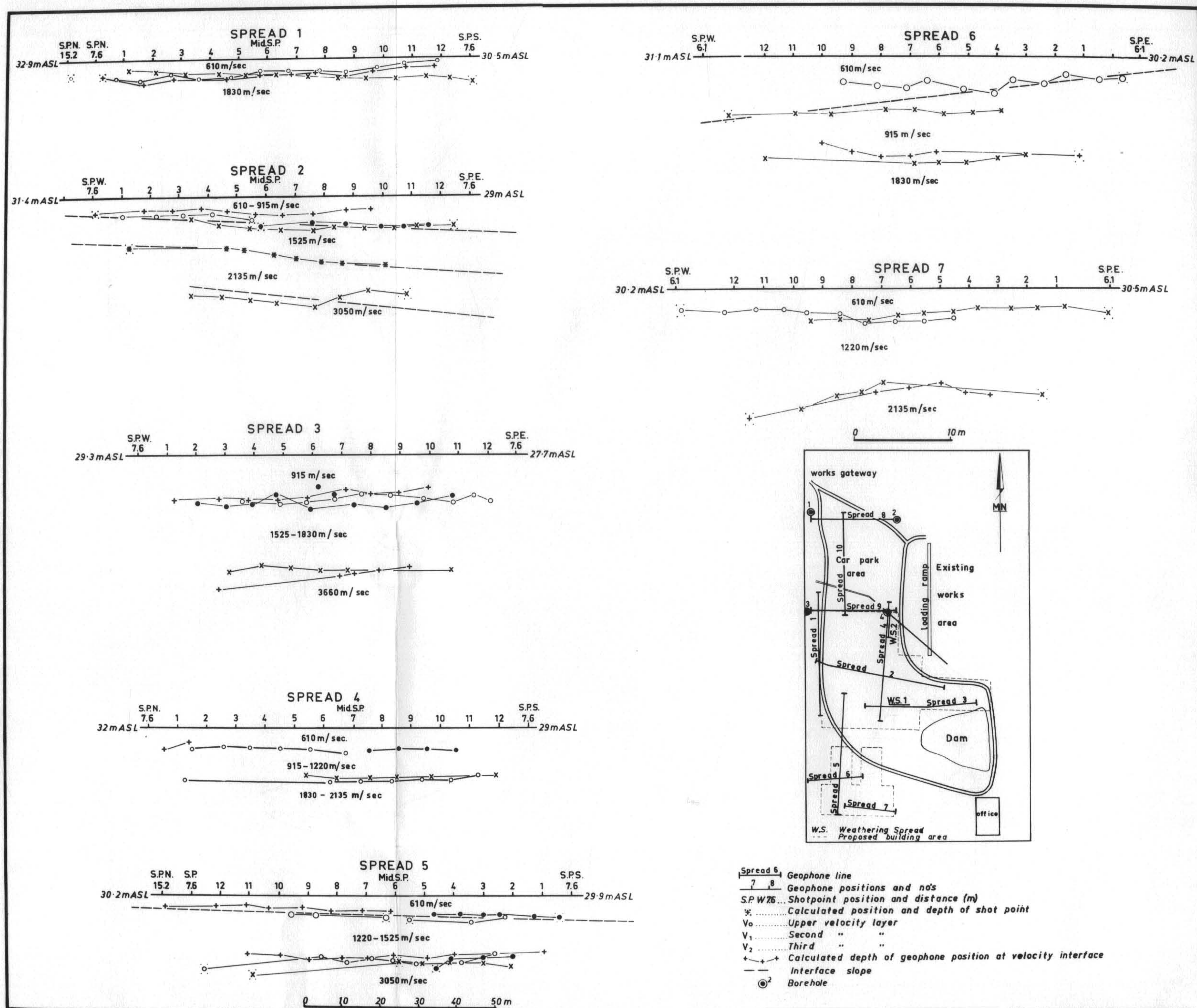
CONCLUSIONS

The drilling confirmed the presence of a Tertiary valley that traversed the Electrona works area. In this valley are Tertiary sand and clay which were probably overlain by basalt that has since been removed by erosion leaving only the silcrete boulders on the surface, one of which was encountered within one metre of the surface in Bore 8 causing the hole to be abandoned. This Tertiary valley was eroded into Triassic sandstone and mudstone which are soft and deeply weathered. This weathering probably occurred during Tertiary times.

[20 June 1975]

Table 2. RESULTS OF SECOND SEISMIC SURVEY

Spread No.	Length (m)	Velocity (m/s)	Interface Depth (m)	Slope	Geological interpretation of the velocity layers	Remarks
8 (E-W)	116	*West End*				
		V_0 915			Fill and clay.	No hard bedrock. No seismic velocities >3000 m/s detected in the spread. No bedrock anticipated before 16 m.
		V_1 1525-2135	V_0/V_1 9.1-13.7	Upper layer thickens to W.	Tertiary and soft, deeply weathered Triassic sediments.	
		East End				
		V_0 1065				
		V_1 2290-3000	V_0/V_1 7.6-10.7	Stepped.		
9 (E-W)	128	*West End*				
		V_0 1065	V_0 6.1-9.1	No slope	Fill and clay.	With flyrock likely to fall on the existing works the eastern shot point was located in drill hole 2 at a depth of 5 m. This reduced the calculated thickness of the surface layer and the depth to the underlying layers. No bedrock anticipated at depths of <16-18 m.
		V_1 1525-1830			Tertiary and soft, deeply weathered Triassic sediments.	
		East End				
		V_0 1065				
		V_1 1525-1830	V_0/V_1 6.8-8.5			
		V_2 2440-3050	V_1/V_2 14.6-15.8		Weathered Triassic sediments.	
10 (N-S)	128	V_0 1065-1220			Fill and clay.	No bedrock detected. Depth to bedrock layer is probably more than 21 m.
		V_1 1830-2130	V_0/V_1 9.1-10.9	No slope.	Tertiary and soft, deeply weathered Triassic sediments.	



5 cm

Figure 20. *Electrona seismic survey.*

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