TR18_106_121

16. Groundwater investigations at Currie, King Island.

W.L. Matthews
W.C. Cromer

The King Island Council requested that further investigations into groundwater occurrences around Currie be undertaken as it is intended to increase the supply to the town. Areas had been suggested for investigation in previous reports and some of these were examined using seismic methods and shallow hand augering. The geology along the coastline was examined briefly and water samples from seepages along the coast and from boreholes were collected and tested for content of their dissolved solids.

GEOLOGY

The older or basement rocks are exposed mainly along the coastline and consist of metamorphosed sediments intruded by granite and basic igneous rocks.

The sediments are of Precambrian age and range from cleaved, banded siltstone where the bedding is plainly visible to light grey-green phyllite where the bedding is not obvious. The foliation strikes at about 140-160° (magnetic) and minor folds developed in the sediments have axes striking in about the same direction and usually plunge gently south. Quartz veining is relatively common and one vein rich in arsenopyrite occurs on the shoreline north of Currie.

The granite has been dated as Precambrian and also has a foliation which is strongly developed in some areas and is much weaker in others. The jointing is closely spaced in some outcrops and widely spaced in others. The granite contains blocks (up to several metres across) and small pieces (about 10 cm across) of indurated sediments. The contact of the granite with the main body of sediments appears to be almost parallel to the main foliation direction.

Small bodies of sheared basic igneous rock (amphibolite?) occur north of Currie, in Currie Harbour and to the south of Currie. The exposures north of Currie contain abundant small patches rich in epidote.

Some granite outcrops occur inland, *e.g.* along Camp Creek and to the south of the present water supply area. Several kilometres east of Currie Precambrian sediments are exposed in road cuttings.

The basement rocks are overlain by dominantly stabilised sand dunes of two ages. The 'Old Dunes' are mainly of silica sand whereas the younger or 'New Dunes' which overlie them are rich in carbonate. The Old Dunes form low rounded hills and contain layers of brown stained (vegetation derived?) and slightly cemented sand. Wood fragments were noted in this material near the mouth of Camp Creek. The New Dunes form sharp hills, have occasional blowouts and have a very distinct boundary on their inland side in most areas. Percolating water has dissolved and reprecipitated calcium carbonate contained in them resulting in some cementation, and excavations in the New Dunes often have faces which stand at high angles.

A narrow old marine terrace along the shoreline and about 3 m above sea level is made up of rounded boulders of basement rocks.

Table 1. RESULTS OF SEISMIC SURVEY

Spread No.	Altitude m	V_0 m/s	Thickness m	V_1 m/s	Thickness m	V_2 m/s	Depth to basement m	Possible depth to water table m	Possible thickness of saturated sand m
1	41	411	3.0-4.0	1830	1.0-6.7	3810	4.6-10.1	3.0-4.0	1.0-6.7?
2	41	274	2.4-3.0	1524	1.2-3.7	3048	3.0-6.1	2.4-3.0	1.5-3.4
3	41	488	3.0-3.4	1555	3.4-7.3	4175	6.4-10.7	3.0-3.4	3.4-7.3
4	41	457	3.0-3.7	1676	3.0-6.7	4419	5.5-9.1	3.0-3.7	3.0-6.7
5	41	427	3.0-3.7	1830	4.0-7.0	4572	7.0-10.1	3.0-3.7	4.0-7.0
6	41	244	1.2-2.1	1280	1.8-4.9	3597	4.0-6.4	1.2-2.1	1.8-4.9
7	27.5	305	3.0-4.3	1615	4.6-6.1	3719	7.3-10.4	3.0-4.3	4.6-6.1
8	27.5	305	2.7-3.7	1158	5.5-6.7	3292	8.5-9.8	2.7-3.7	5.5-6.7
9	33.5	381	2.7-3.4	762	8.8-12.2	3962	12.2-14.9		
10	33.5	213	1.5-1.8	686	8.5-10.7	3810	10.7-12.2		
11	45.5	305	1.8-2.4	610	12.2-13.7	5486	14.6-15.9		
12	45.5	335	2.1-2.4	579	10.7-11.6	4110	12.8-13.7		
13	38.0	396	2.7-3.7	610	7.9-9.8	4800	11.6-13.4		
14	33.5	381	1.8-4.0	823	7.6-13.1	3353	11.9-15.5		
15	43	305	2.4-3.4	1676	7.3-12.8	5106	10.4-15.6	2.4-3.4	7.3-12.8
16	65.5	244	1.5-2.1	1067	1.5-4.3	2347	3.7-6.4		
17	62.5	229	1.5	502	1.8-2.4	3231	3.4-4.0		
18	64	396	2.1-3.0	1067	5.8-9.1	4053	8.2-11.3		
19	64	244	1.5-2.7	1204	3.4-6.7	4267	6.0-8.5	1.5-2.1	3.4-6.7
20	61	274	1.1-1.8	746	2.1-5.5	3658	3.7-6.7		
21	61	351	2.7-3.4	914	4.0-10.4	4785	7.6-13.4		

Table 1. (continued)

Spread No.	Altitude m	V_0 m/s	Thickness m	V_1 m/s	Thickness m	V_2 m/s	Depth to basement m	Possible depth to water table m	Possible thickness of saturated sand m
22	61	182	1.5-1.8	914	1.2-10.1	2591	3.0-8.8		
23	61	411	3.0-4.0	1576	7.9-11.3	3810	11.9-14.6	3.0-4.0	7.9-11.3
24	27.5	282	2.1-2.7	457	7.0-7.9	4110	9.4-10.7		
25	24.5	367	3.0-4.6	1830	10.7-18.0	4358	7.9-21.0	3.0-4.6	10.7-18.0
26	21.0	274	1.5-2.1	1219	1.5-6.4?	1220	3.4-8.0	1.5-2.1	1.5-6.4?
27	21	229	1.5-2.4	1129	3.7-5.2	3658	6.1-7.0	1.5-2.4	3.7-5.2
28	47	411	2.4-3.0	762	6.7-9.8	1600	9.4-12.2	10.1-11.6	very thick
29	55	381	3.4-5.5	1524	15.2-19.8	6096	19.8-24.4	3.4-5.5	15.2-19.8
30	55	320	3.4-5.5	1280	12.8-21.3	6553	18.0-25.6	3.4-5.5	12.8-21.3
31	8	290	1.0-2.1	853	1.0-4.3	2286	3.0-5.8		
32	8	351	1.2-1.5	1494	4.0-6.1	3353	5.2-7.3	1.2-1.5	4.0-6.1
33	17	229	1.2-2.1	853	1.2-2.4	3353	3.4-4.3		
34	12	229	1.0-1.8	975	2.4-6.1	3658	4.3-7.0		
35	12	244	1.2-1.5	1463	2.4-3.7	3222	4.0-5.8	1.2-1.5	2.4-3.7
36	15	213	1.2-1.5	579	3.0-3.7	3962	4.6-5.2		

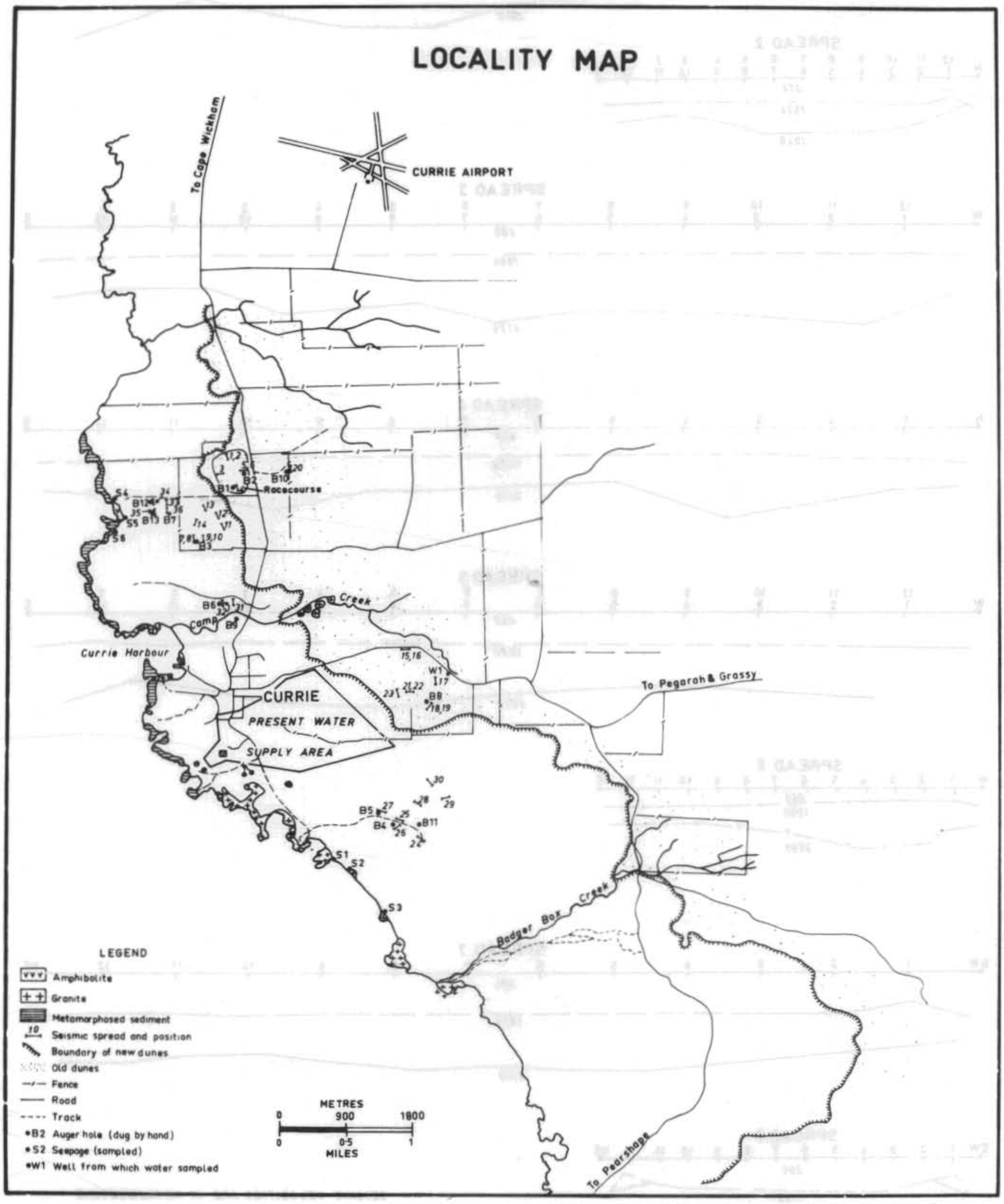

Figure 21.

5 cm

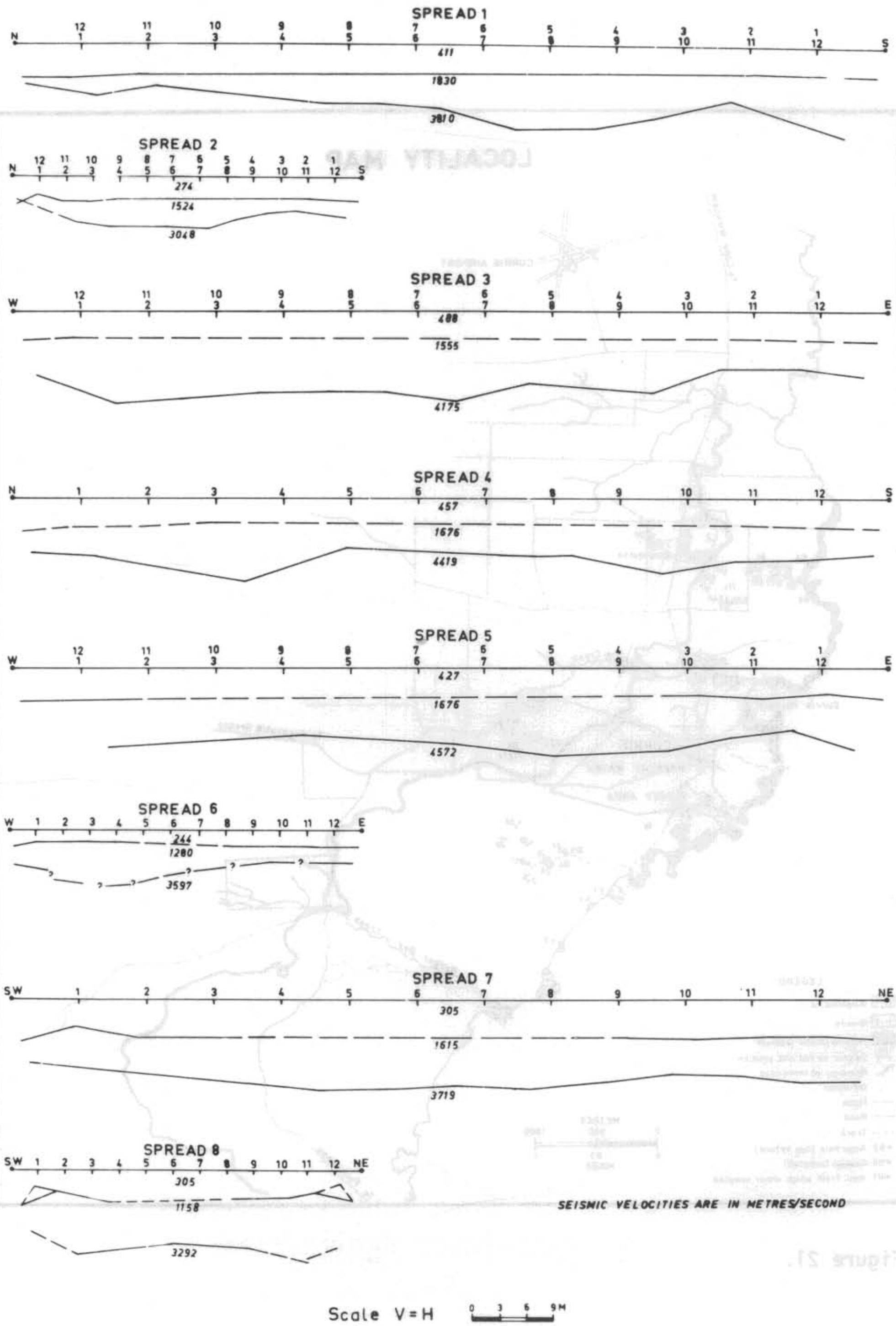

Figure 22. *Seismic spreads 1-8, Currie.*

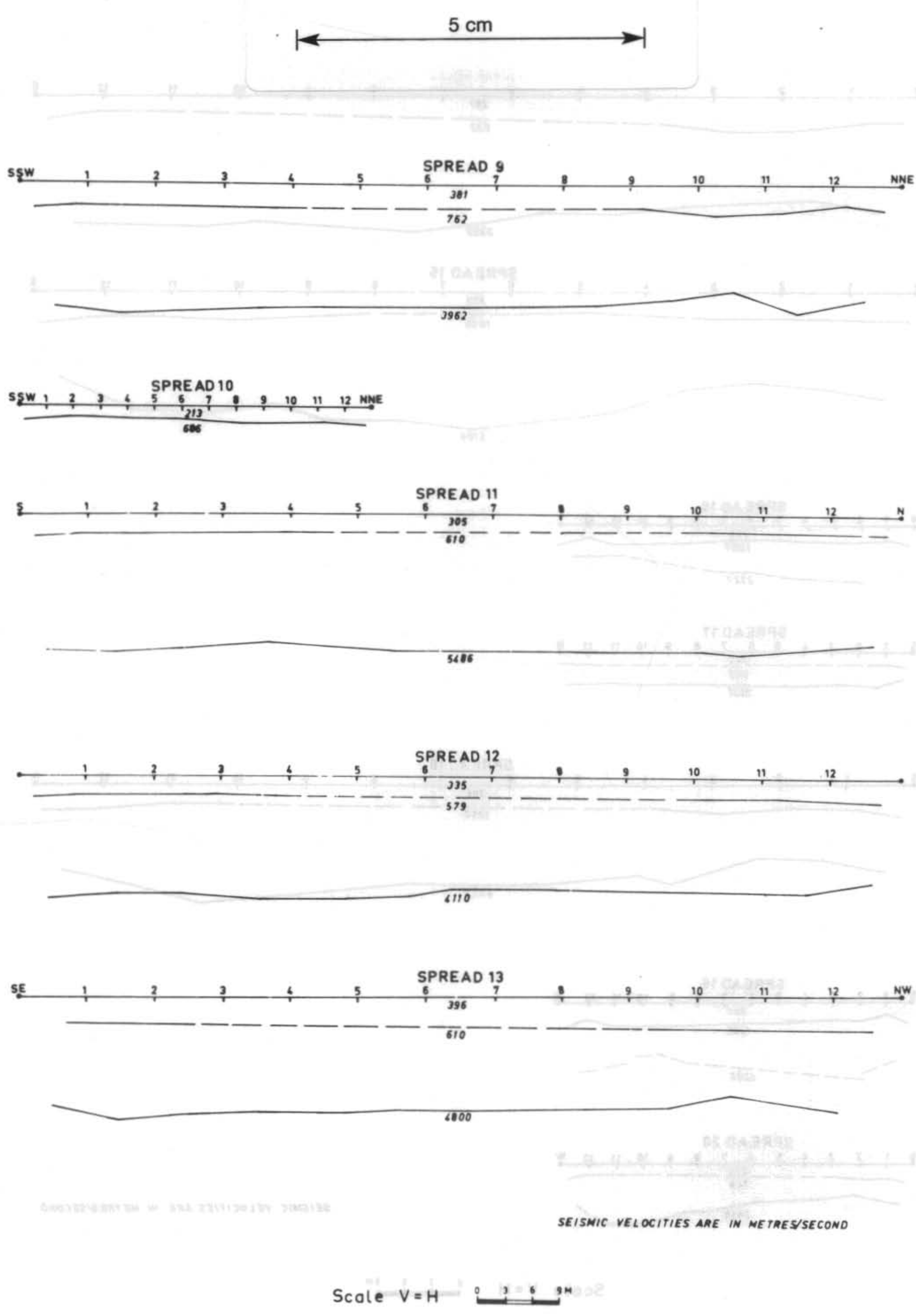

Figure 23. *Seismic spreads 9-13, Currie.*

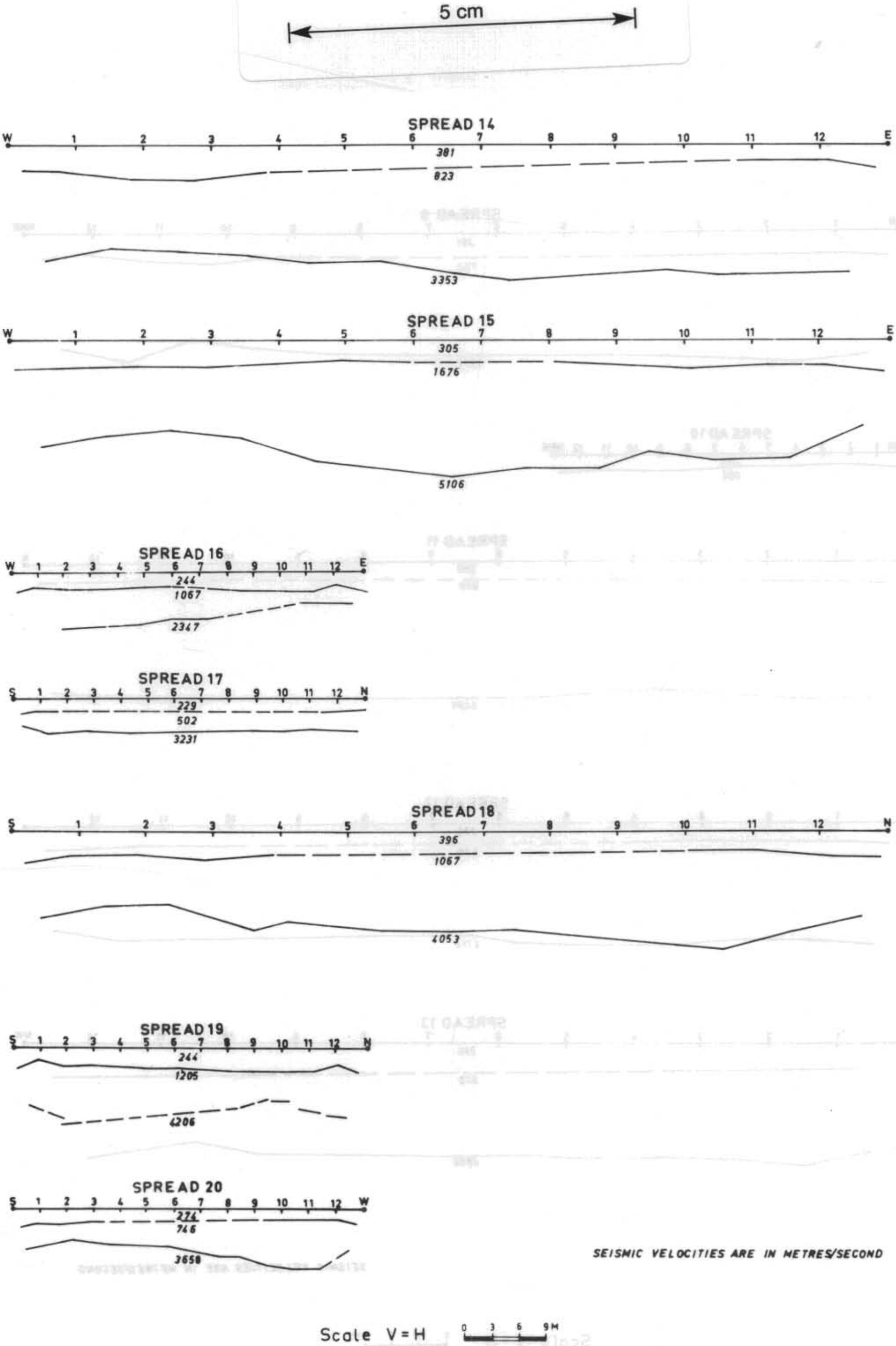

Figure 24. *Seismic spreads 14-20, Currie.*

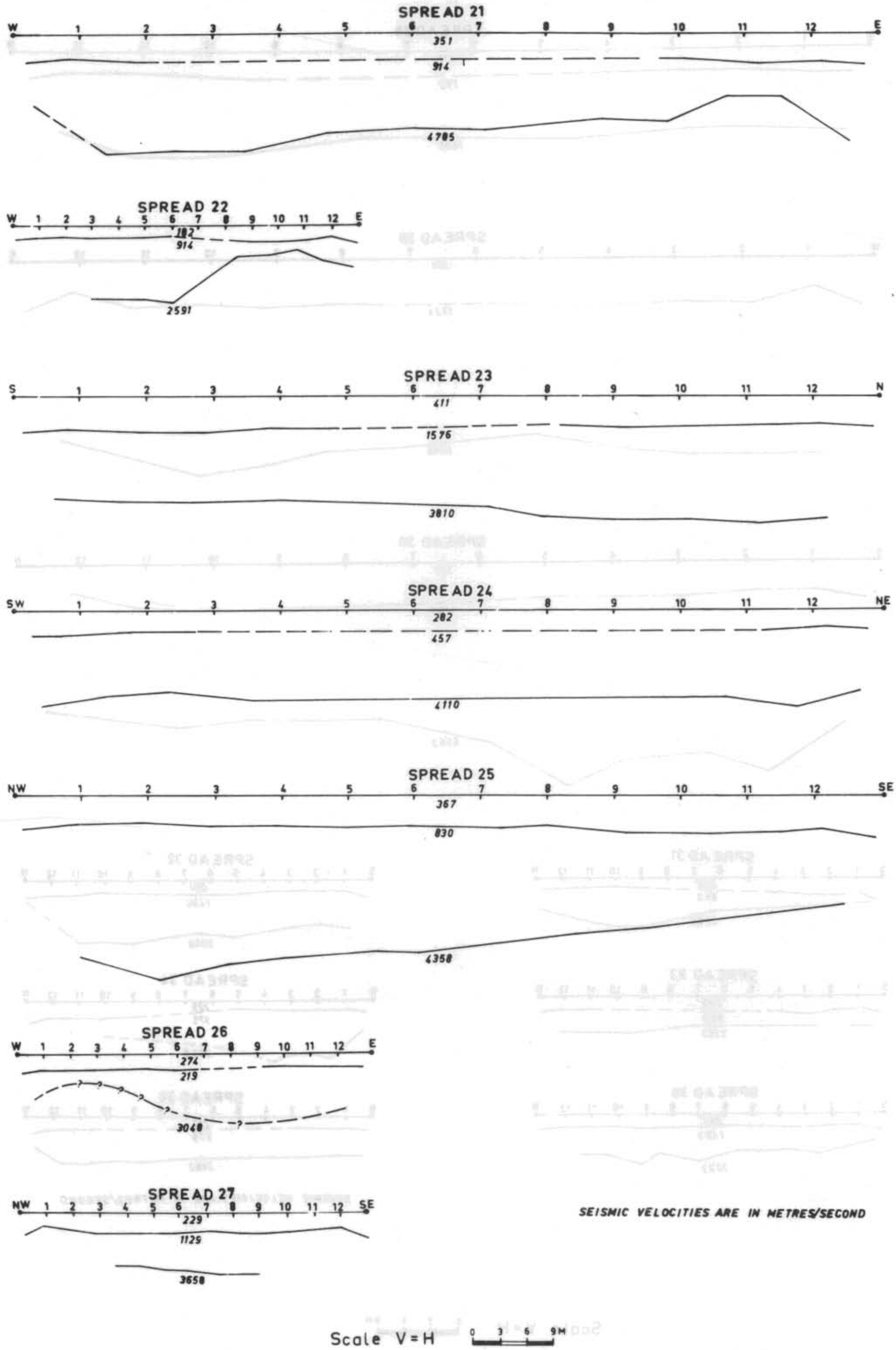

Figure 25. *Seismic spreads 21-27, Currie.*

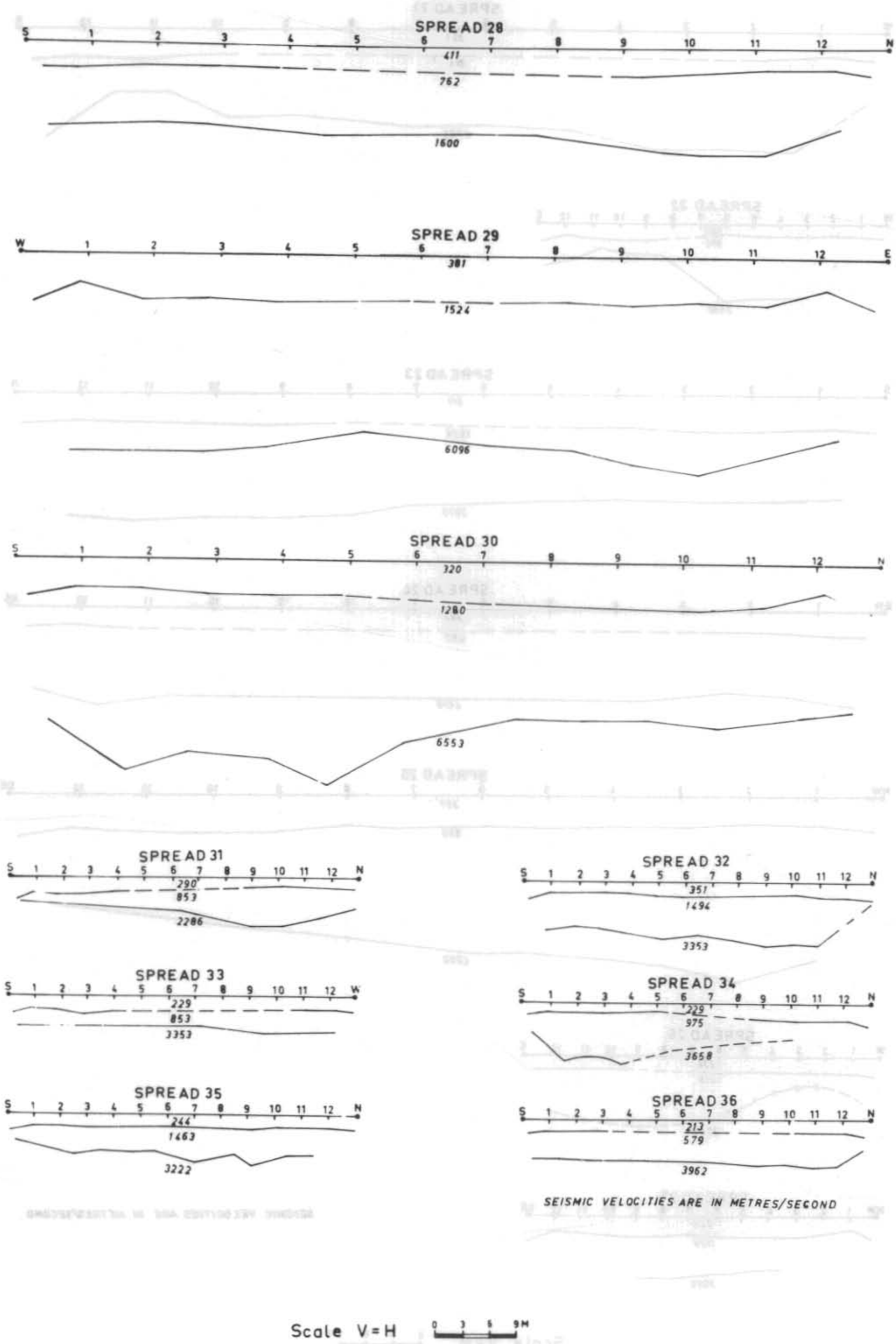

Figure 26. *Seismic spreads 28-36, Currie.*

SEISMIC SURVEY

The results of the seismic survey are summarised in Table 1 and interpreted sections are shown on Figures 22-26. In general, the lowest seismic velocity or top layer under each spread (250-450 m/s) probably represents soil and dry sand. The intermediate velocities *i.e.* seismic velocities which range from 450-1850 m/s and usually from 750-1850 m/s probably represent damp sand, clayey sand, saturated sand, clay and weathered rock. The spreads indicating seismic velocities of 1200-1800 m/s are in areas having good prospects for the occurrence of saturated sand. In some cases spreads where these velocities are not obvious could and probably do have thin layers of saturated sand which would occur above the bedrock. The highest seismic velocity in each spread (except for spread 28) is indicative of the presence of basement or hard rock. The variation in the seismic velocity exhibited by the basement is due to variation in weathering, jointing and perhaps rock type.

OTHER INVESTIGATIONS AND RESULTS

The following list of salinities are of samples of water from springs, drill holes and a well. The locations of the samples are shown in Figure 21.

Sample	*Total Dissolved Solids* *ppm*	*Sample*	*Total Dissolved Solids* *ppm*
S1	800	W1	600
S2	420	B4	500
S3	480	B8	500
S4	700	B9	1600
S5	550	B12	700
S6	500	B13	620

A sample taken from a borehole in Precambrian sediments on the east side of King Island had 500 ppm of dissolved solids. W1 and B8 samples were from the Old Dunes and both have a yellow colour. The amounts of total dissolved solids compare favourably with the salinity of the present water supply with the exception of B9.

The logs of drill holes are given below. The most significant information obtained from the drilling is the fact that the Old Dunes at the racecourse and near Spread 20 appear to be thin or virtually absent. They are probably much thicker around Spreads 18 and 19. Drilling on the swamp on the side of Camp Creek and north of Currie indicated considerable thicknesses of near-surface clay with thin sand bands. Although further deeper drilling would be required to prove it, the prospects of obtaining water from this area are not as good as previously thought.

HOLE B1

m	
0-1.5	Sand and sandy clay.
1.5-2.1	Gritty clay with mica (weathered granite?).
	No water but moist throughout.

HOLE B2

No record preserved but weathered granite-like material encountered at about 2.5 m.
No water was obtained.

HOLE B3

0-3.0	Dry light brown sand.
3.0-4.6	Darker brown moist sand with some clay.
4.6	Clayey sand.
	No water struck to this depth.

HOLE B4

m	
0-1.5	Light brown sand.
	Water struck at 1.2 m.

HOLE B5

0-2.1	Light brown sand.
	Water struck at 2.1 m.

HOLE B6

0-1.8	Damp plastic clay.
1.8-2.0	Sandy clay.
2.1	Sand.
	Water struck in sand at 2.1 m.

HOLE B7

0-3.7	Light brown dry and moist sand.
	No water struck.

HOLE B8

0-1.4	Quartz sand.
	Water struck at 1 m.

HOLE B9

0-1.1	Sandy soil and clay.
1.1-1.2	Fairly clean quartz sand.
1.2-3.0	Clay and sandy clay with feldspar fragments.
3.0-3.5	Clayey sand.
3.5-3.7	Fairly clean sand.
3.7-3.8	Sandy clay.
	Water struck at 1.1 m. Standing water level 0.8 m.

HOLE B10

0-0.5	Whitish quartz sand.
0.5-0.6	Brown stained sand ('coffee rock').
0.6-1.2	Clay, a little sand.
1.2-1.8	Weathered granite? (quartz, feldspar and mica in clay).
	No water struck.

HOLE B11

0-1.2	Sand with dark brown to grey staining.
1.2-1.5	Carbonate concretion.
1.5-2.1	Brownish sand.
2.1-2.4	Quartz sand.
2.4-2.5	Orange-brown (iron oxide?)-cemented sand.
2.5-4.0	Light orange-brown quartz sand, some clay in final 1 m.
	No water struck.

HOLE B12

0-2.1	Light brown carbonate sand.
	Water at 2.1 m in coarse sand.

HOLE B13

0-1.2	Light brown carbonate sand.
	Water at 1.2 m.

HYDROLOGY

There are two possible sources of water *i.e.* basement rocks and the sand dunes.

Basement Rocks

In the immediate vicinity of Currie the basement probably consists of granite apart from a narrow strip of metamorphosed sediment along the coast. The presence of water in granite in sufficient quantities to supply bores will depend on there being a close, interconnected open joint system. It would be difficult to locate zones with these properties away from the shoreline as there is a sand cover of up to about 25 m. Seismic velocities in such zones would be lower, but lower indicated velocities could also be due to deeper weathering or sharp changes in the thickness of overlying sand. Closely jointed areas occur along the coastline and no doubt occur underneath the dunes also.

The quality of water contained in the granite would probably be better than that in the carbonate dunes. If water in sufficient quantities is found in the basement rocks, it would be a comparatively easy matter to set up production bores as the overlying unconsolidated material could be cased off. Because of the variation of joint intensity that can be expected, one unsuccessful hole would not prove the absence of water in the basement rocks. At least two or three holes into basement rocks would be required to adequately test this source.

Sand Dunes

Considerable quantities of water must occur in the dunes because of the absence of surface streams and the abundance and size of seepages along the coastline. The New Dunes appear to be the best prospect because they are much thicker than the Old Dunes in most areas except perhaps around Spreads 18 and 19. The total dissolved solids content of the Old Dunes could be expected to be less than in the New Dunes because of composition differences but the water from the Old Dunes often has a yellow colour which might be difficult to remove.

It is likely that any additional water required by Currie in the foreseeable future could be obtained from the area of dunes from 2 km north of the town to 5 km south (*i.e.* to Badger Box Creek). Between the catchment area of the present scheme and Badger Box Creek the New Dunes extend further inland and the catchment and storage areas are therefore more extensive. Although larger quantities of water are expected to occur in the southern area, valuable additional quantities could be expected north of Currie.

METHOD OF WATER EXTRACTION

Although the seismic spreads suggest there are probably thick layers of saturated sand under some areas, drilling would be required to prove this as other materials such as clay and weathered rock could display similar seismic velocities. The first procedure is to locate areas suitable for extraction of water by exploratory drilling and pump testing.

The method of extraction depends on whether the water is shallow or deep. For shallow water the use of spear bores as used in the present scheme is probably the best as well as the simplest system to install. For deeper water, a screened bore with gravel packing would probably be the best method.

Two samples of sand from the Old Dunes and one from the New Dunes have been sized and the results are plotted on Figure 27. The size range gives an indication of the range of sizes that can be expected in the dunes but there will be some variation from area to area and also with depth. The graphs indicate the small average grain size and the low uniformity coefficients both of which are factors supporting the use of gravel packing around a screen. In addition water from the New Dunes would give rise to serious encrustation of the screen, so that small screen openings would close more quickly than a screen with larger openings where a gravel pack is used. The size range of a possible gravel pack is shown on Figure 5 and a screen is usually selected to retain about 90% of the gravel pack. For this gravel pack the screen openings should be about 700 μm. If a gravel pack is not used a screen with openings of 150-200 μm should be used.

METHOD OF INVESTIGATION

Auger drilling to 8-10 metres could be used in selecting areas suitable for spear bore systems and shallow bores. The use of a Proline or Gemco drill would be the most mobile and economical method of investigation. The depth to the water table and the thickness of saturated sand could be determined.

For areas where the water is deeper and where there are probably thicker layers of saturated sand either a percussion or rotary drill would be the most suitable. In using a rotary drill, bentonite mud is used to hold open the bore particularly below the water table and the removal of this mud after the casing is installed may sometimes present a problem.

If screens are unavailable, then slotted casing might be suitable for use, provided the slots are very narrow. If thick saturated sections are lined with casing having an open area of 6-9% then an approximate estimate of the potential of any hole should be obtainable from pump tests.

It is likely that the investigation stage and installation of production bores in the sand will be difficult to combine. A knowledge of the grain size of the sand is essential so that screens and gravel packing, if used, can be determined. The thickness of saturated sand and the depth to water are important in planning a production bore. In addition the possible output should be known as the size of casing might limit the size of the pump that can be installed and thus restrict output. These factors can only be determined with certainty by drilling, sampling and pump testing.

RECOMMENDATIONS

A hole on the racecourse to about 45 m would test the potential of the basement rocks in this area.

A hole in the vicinity of Spreads 7 and 8 would test whether thick saturated sand occurs at this point. The hole could be extended into basement for 30-40 m to test its potential in this area.

One or two holes at or near Spreads 29 and 30 would test possible thick saturated sand beds. Again the hole could be extended into bedrock for 30-40 m.

If at any stage in the above investigation significant quantities of water are obtained, a further hole should be drilled nearby as an observation hole for pump test purposes.

CONCLUSIONS

It is possible that reasonable quantities of water will be obtainable from basement rocks. It should be possible to convert test bores to production bores in basement rocks if sufficient water is located. The water quality will probably be better than that in the dunes.

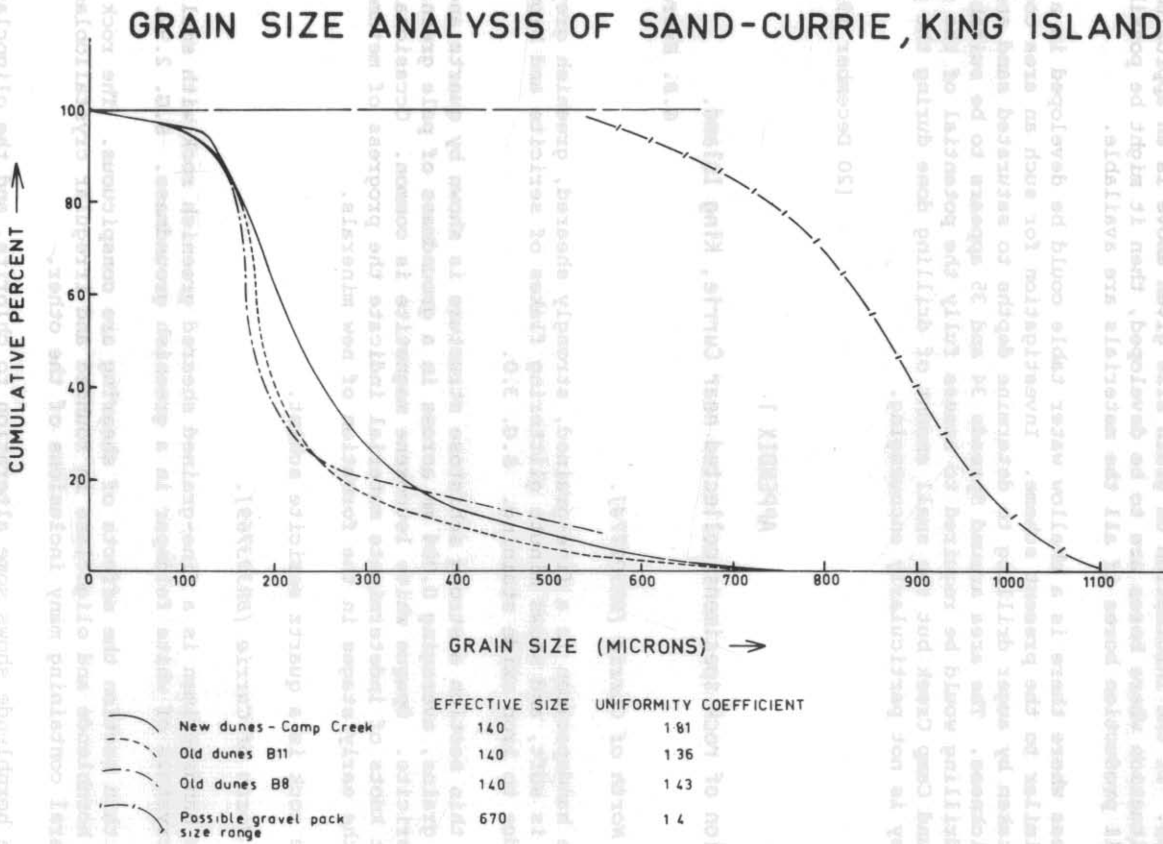
GRAIN SIZE ANALYSIS OF SAND-CURRIE, KING ISLAND
CUMULATIVE PERCENT
100
80
60
40
20
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
GRAIN SIZE (MICRONS)
EFFECTIVE SIZE
UNIFORMITY COEFFICIENT
New dunes - Camp Creek
140
1·81
Old dunes B11
140
1·36
Old dunes B8
140
1·43
Possible gravel pack size range
670
1·4

Figure 27.

The area of dunes from 2 km north of Currie to 5 km south are expected to have the capability of supplying the town's water needs in the foreseeable future. Investigation drilling will be required to select the best areas to develop. The area south of the present scheme has the greatest potential. Screened bores with gravel packing are regarded as the best system for extraction of the water. Slotted casing might be an alternative if the slots are very narrow and the open area amounts to 6-9%. Gravel packing again around the slotted casing would be an advantage. It is difficult to combine the investigation stage and production bore installation stage when dealing with sands. If the information on grain size given above is an approximation of the situation where bores are to be developed, then it might be possible to install production bores if all the materials are available.

Areas where there is a shallow water table could be developed in a manner similar to the present scheme. Investigation for such an area could be undertaken by auger drilling to determine depths to saturated sand and their thickness. The area around Spreads 34 and 35 appears to be suitable. Further drilling would be required to assess fully the potential of the swamp area around Camp Creek but the small amount of drilling done during the present survey is not particularly encouraging.

[20 December 1973]

APPENDIX 1

Description of rock specimens collected near Currie, King Island.

G.B. Everard

72-687. North of Currie [BR302774].

The handspecimen is a fine-grained, strongly sheared, greenish grey rock; it is soft, and shows minute glittering flakes of sericite and brown streaks due to iron oxide staining. S.G. 3.0.

In thin section a strong schistose structure is shown by quartz and feldspar grains, averaging 0.004 mm across in a groundmass of pale greenish yellow sericite. Opaque white leucoxene magnetite is common. Occasional incipient knots of indeterminate material indicate the progress of metamorphism and the early stages in the formation of new minerals.

The rock is a quartz sericite schist.

73-888. North of Currie [BR303769].

The handspecimen is a fine-grained sheared greenish rock with small irregular crystals of white feldspar in a greenish groundmass. S.G. 2.97.

In thin section the effects of shearing are conspicuous. The rock consists of hornblende and oligoclase in rounded and irregular crystalloblasts, each mineral containing many inclusions of the other.

The hornblende shows some alteration to chlorite, and the oligoclase exhibits simple and lamellar twinning and contains inclusions of clinozoisite in aggregates of minute grains and some larger irregular crystals. Ilmenite and magnetite are largely altered to leucoxene and limonite.

The rock is an amphibolite.

73-689. Boulder on beach, north of Currie [BR301760].

The handspecimen is a medium- to fine-grained greenish rock with equidimensional crystals of hornblende and interstitial laths of feldspar. S.G. 2.97.

In thin section the texture is hypidiomorphic and sub-ophitic consisting of interlocking crystals of hornblende with interstitial laths of feldspar averaging 0.5 mm in length, some of which penetrate the hornblende crystals. The hornblende is rather pale coloured with pleochroic scheme X = pale green, Y = pale yellowish green, Z = pale brown, and absorption $Z>Y>X$. The plagioclase is oligoclase showing simple and compound twinning.

Ilmenite and sphene are accessory minerals.

The rock is an amphibolite.

73-690. South of Currie [BR320731].

The handspecimen is a very fine-grained greenish grey rock with irregular opaque white knots which stand out on the weathered surface.

In thin section the rock is of maculose structure consisting of white opaque knots of very fine-grained compound texture in a matrix of similar texture but consisting of much isotropic material and minute pieces of flaky minerals. Some small twinned plagioclase crystals are also present, so that the rock has a porphyroclastic texture in places. Small grains and aggregates of clinozoisite are also present.

The section also contains fine-grained veinlets of quartz and the handspecimen contains a larger inclusion of sericite schist.

The rock is a knotenschiefer.

73-691. South of Currie [BR323729].

The handspecimen is a fine-grained, dense, dark greenish grey rock, but containing narrow laths of feldspar up to 5 mm long.

In thin section the rock is holocrystalline, consisting of ragged hornblende crystals stained brown by alteration, laths of oligoclase showing carlsbad, albite, and pericline twinning and a felted mass of clinozoisite needles and some yellowish green prisms of epidote.

The rock is an amphibolite.

73-692. South of Currie [BR332719].

The handspecimen is a fine- to medium-grained silver grey rock with sparkling flakes of white mica, white grains of feldspar and glassy grains of quartz up to one millimetre across and minute black flakes of mica.

In thin section the rock consists of irregular but equidimensional grains of quartz and feldspar averaging 0.5 mm across in a finer grained matrix of muscovite, biotite and quartzo-feldspathic material. The crystals of quartz and feldspar show irregular twinning, undulose extinction and some recrystallisation.

The rock is a hornfels.

[21 December 1973]