

## Section 2: Engineering Geology

TR 14-57-64

### 11. Geology of a dam site on Deep Creek

W. L. MATTHEWS

To augment present water supplies to Smithton, the Circular Head Council are considering building a dam across Deep Creek about  $1\frac{1}{2}$  miles S of the Bass Highway. An earth fill clay core dam about 25 ft high with a capacity of rather more than 600 million gallons is planned.

The valley of Deep Creek in the dam site area is wide and flat, but at the dam site itself there is a small hill in the middle of the valley which will form part of the proposed dam; despite this the length of the dam wall to be built will still be approximately 1700 ft. R. M. Foster and Associates, the Council's consulting engineers, requested an examination and report on the geological features of the area.

The investigation included geological mapping, a seismic survey and some shallow auger drilling.

#### GEOLOGY

The geology of the Smithton area has been described by Nye, Finucane and Blake (1934), Carey and Scott (1952) and Gulline (1959). The first survey did not cover the dam site area but dealt with a strip of country to the W; the second survey covered the western part of the dam site area and the survey by Gulline covered the whole of the dam site and surrounding areas.

The following general sequence of rocks for the Smithton district was given by Gulline:

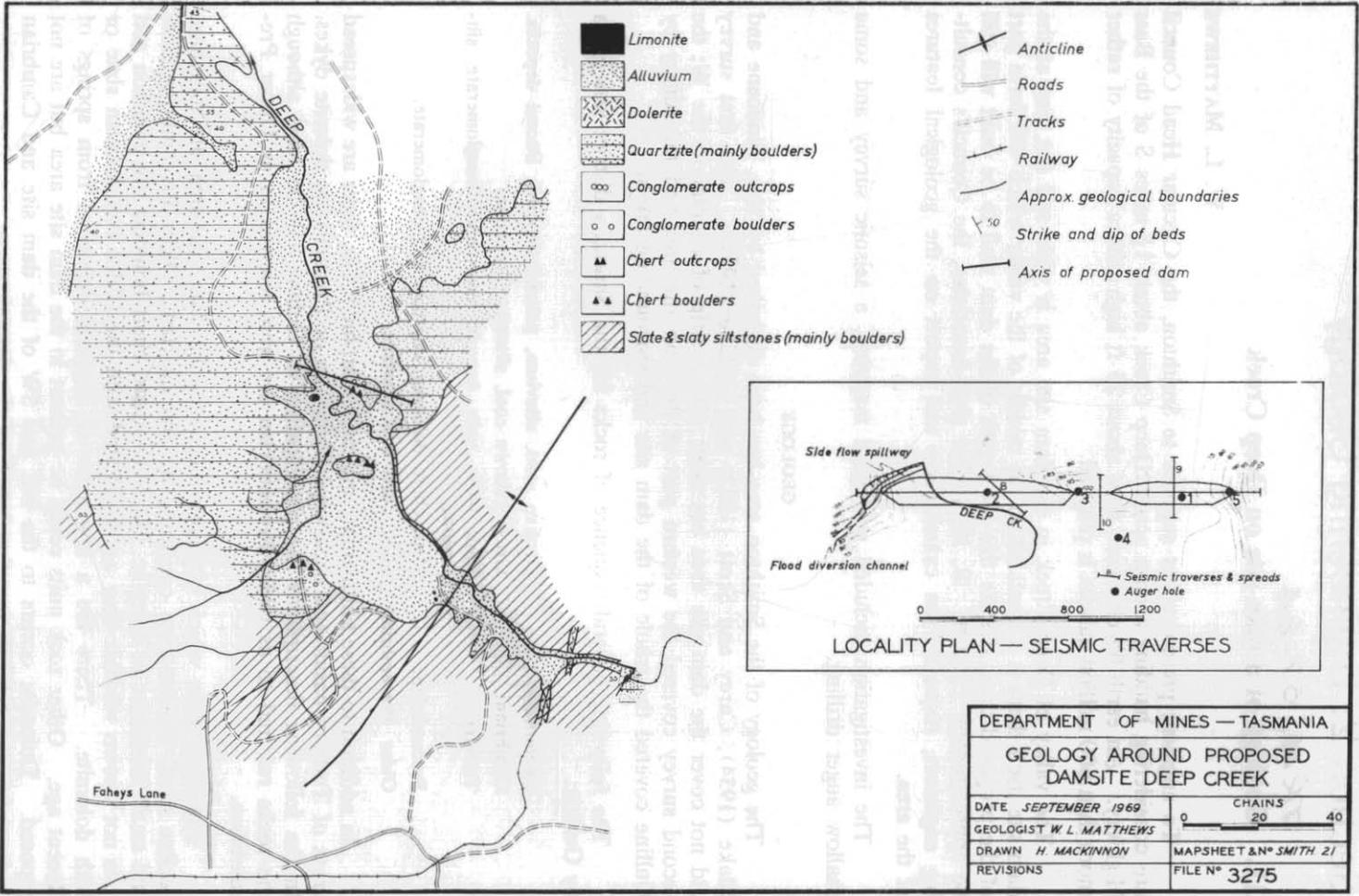
Quaternary:	Aeolian sand, alluvium, paludal deposits, littoral deposits.
Cambrian:	Gravel, brown coal, siltstone, limestone.
Tertiary:	Basic lavas, tuffs, breccia, greywacke, conglomerate, siltstone.
Precambrian:	Slate, chert, dolomite, quartzite and conglomerate.
Older Precambrian:	Slate, chert and quartzite.

In addition to these sedimentary and metamorphic rocks, there are widespread areas of Tertiary basalt and occasional Cambrian or Precambrian dolerite dykes. In the following descriptions the classification of Gulline will be used although the rocks referred to as Older Precambrian are now referred to as Upper Precambrian.

The rock units which obviously occur in the dam site area are alluvium, aeolian sand, Precambrian conglomerate and quartzite, Older Precambrian slate and small intrusions of dolerite. In some areas, chert boulders are common and it is not known whether they are associated with the Older Precambrian slate or with dolomite. There are a few areas of limonite deposited from springs of Recent age. Other rock units could be present in the dam site area but are not exposed. Dolomite occurs to the NE and SW of the dam site and Cambrian rocks occur in a NE-SW trending belt E of the dam site area.

5 cm

FIGURE 15



Outcrops at and around the dam site are very rare and where they do occur (e.g., at about one mile N and at about one mile S of the dam site) the rocks are strongly folded. It is impossible to determine detailed rock structure at the dam site and only the regional structure determined from the few outcrops and from boulder distribution can be given. The boundaries of the hard rock units on the accompanying plan (fig. 15) were determined almost entirely from boulder distribution.

#### *Older Precambrian*

The Older Precambrian in the dam site area consists of siltstone and slate and is exposed in railway cuttings a little over one mile SE of the dam site. In other areas where this unit is shown on the plan, boulders only were seen. In some localities these sediments are banded light or dark grey and black in colour. The dark colour is probably due to the presence of finely disseminated pyrite; where the pyrite has been oxidised, the rock is often reddish brown in colour. Development of a slaty cleavage is more obvious in some localities than others and quartz veining is a common feature.

#### *Precambrian*

The basal member of this unit, a conglomerate of rounded quartzite boulders, can be seen exposed in a railway cutting SE of the dam site, where it overlies the Older Precambrian. A few boulders of conglomerate have been seen on the small hill in the middle of the proposed dam and also along the side of a hill about  $\frac{1}{2}$  mile S of the dam. The boulders may have weathered off outcrop and indicate that the conglomerate underlies these areas, or they may have a different origin.

Overlying the conglomerate in the railway cutting is a massive-bedded white to cream quartzite. Other outcrops of the quartzite can be seen in quarries NW of the dam site. Here the quartzite has been contorted and brecciated and much of it breaks up easily into irregularly-shaped fragments about one inch across. The fracture surfaces are usually stained brown probably due to water seeping down from the surface; the brown material being derived from the decomposition of vegetable matter. Contorted beds of brown mudstone are interbedded with the quartzite in the quarries. At other localities, only boulders of quartzite were seen in the dam site area.

#### *Dolerite*

Dolerite dykes are exposed at two places in the railway cutting SE of the dam site. The two exposures may be of the same dyke. The dykes are deeply weathered and brown in colour, although crystal outlines can still be seen. Boulders of dolerite were traced to the top of the hill on the N side of Deep Creek with boulders of slaty siltstone on either side. In the railway cutting, an almost vertical contact between the dolerite and the Older Precambrian sediments can be seen.

Gulline mapped a dolerite type intruding Cambrian rocks, about a mile E of the dolerite found in the railway cutting, which indicates that that particular dyke is younger than the surrounding Cambrian rocks.

#### *Quaternary*

The flats around Deep Creek are underlain by alluvium consisting of clay, sandy clay, sand and gravel. Near the surface, clay appears to underlie nearly

all of the flats in the storage area and also occurs for some distance N of the dam site. Sand, much of which is probably windblown, underlies most of the plain country further to the N and NE of the dam site.

There are at least three areas of accumulation of limonite; apparently deposited around springs. The largest of these is W of Deep Creek, just upstream of the dam site, and the other two are close together about  $\frac{3}{4}$ -mile S of the dam site; the most southerly occurrence still has water coming from it. All three areas are small mounds above the general level of the flood plain of Deep Creek.

#### STRUCTURE

From rock distribution and a knowledge of the sequence, a major anticline with a NE-SW axis can be inferred upstream from the dam site; the exact position of the crest is unknown because of the lack of outcrop. The anticline must plunge in both directions (i.e., forms a dome like structure where it crosses Deep Creek) since Gulline has mapped dolomite along its axis to the SW and NE. This may be due to cross folding, possibly in a NW-SE direction.

#### POSSIBLE DOLOMITE OCCURRENCE

There are three features which suggest that dolomite could be present within the dam site area:

- (1) The development of broad flats is common in country underlain by dolomite. The flat country around Deep Creek may indicate underlying dolomite but areas are known in the Smithton district, where Cambrian and Precambrian siltstones underlie similar flats.
- (2) Mound spring deposits ('blows') are common in dolomite areas but the material deposited from such springs is not usually limonite. Gulline recorded one limonite mound which was underlain by Cambrian rocks. The Older Precambrian slaty siltstones are sometimes rich in pyrite and the limonite could be derived from the oxidation of the pyrite.
- (3) There are areas of chert boulders in the dam site area and a massive chert outcrop had to be blasted in a drain excavation about 580 yd S of the dam site. Chert is commonly interbedded with the dolomite and can be massive in character. Gulline also found chert beds in Older Precambrian beds but one near Mengha was finely laminated.

The possibility of dolomite occurring in the dam site area cannot be discarded completely, but all the above features can be developed on other rock types. The presence of dolomite would require a much more complicated structure than that depicted. From the general distribution of the rocks around the dam site, it is thought that the slaty siltstone underlies much of the flat.

#### SEISMIC SURVEY

Because of the absence of rock exposure in the dam site area, it was thought that some seismic work would help in determining the depth to solid rock along the axis of the dam and also give some idea of the nature of the material overlying solid rock.

At the dam site 10 seismic spreads with a geophone spacing of 25 ft, making each spread 325 ft long (with the shot points), were fired from each end. Seven of these spreads were fired along the axis of the dam and the overlap between spreads was usually 25 ft. Three spreads, similarly laid out across the axis, were also fired. One spread was fired on top of one of the quarries NW of the dam site to get an idea of the seismic velocities of the quartzite for possible comparison with velocities in the dam site area.

The results of the seismic work at the dam site are shown in the sections (fig. 16). The velocities shown are only average velocities and there could be sharp variations over short horizontal distances. It can be seen that there is a surface layer of material with a seismic velocity of about 1000 ft/sec with a thickness of up to 15 ft and probably averaging about 7 ft. With such a low velocity, this material could be expected to be loose and unconsolidated. Underlying this surface material is a layer with an average seismic velocity of 5000 ft/sec. This has a variable thickness from about 20 ft to greater than 100 ft. It is expected that open-jointed quartzite or weather siltstone could have a velocity of 5000 ft/sec. Below this layer is material with an average velocity of about 12,000 ft/sec. It is probable that both quartzite with closed joints and unweathered siltstone could have seismic velocities of this order.

The trial spread at the quarry suggested seismic velocities of 1000, 5000 and 10,000-12,000 ft/sec. The material with a velocity of 1000 ft/sec appears to be about 5-8 ft thick and that with 5000 ft/sec 50-70 ft thick. These layers may correspond to loose surface material and open jointed quartzite with the higher velocity material being quartzite with closed joints.

#### DRILLING

Five auger holes were drilled, in the positions shown on the plan, so that material underlying the dam site area could be examined. The results of drilling were as follows:

##### Hole 1

ft	in	ft	in	
0	0	1	6	Crumby brown soil
1	6	8	0	Light brown clay
8	0	9	0	Gravel (angular chert fragments)
9	0	10	0	Red clay with some chert fragments and a few limonite fragments.

The hole collapsed at about 8 feet after drilling. Standing water level was 10 in from the surface and the hole was cased with clay from the water level to the surface and filled with water. Water loss with the 10-inch head was about 2½ gallons in 40 seconds.

##### Hole 2

ft	in	ft	in	
0	0	2	6	Crumby dark brown soil
2	6	6	0	Light brown clay
6	0	8	0	Hard sandy material with a few quartzite and chert pebbles.

Standing water level was 2 ft below the surface. Similar measures were taken as in Hole 1 for pressure testing. There was only a small amount of water loss.

#### Hole 3

ft	in	ft	in	
0	0	5	0	Gravel and sand
5	0	6	6	Sandy clay
6	6	10	0	Clayey sand.

No water was struck. The hole was filled with water to within 1 foot of the surface. Water level fell 1 ft 4 in in 10 minutes.

#### Hole 4

ft	in	ft	in	
0	0	8	0	Clay
8	0	9	0	Gravelly clayey sand (gravel fragments mainly black chert).

Standing water level: 8 inches from surface. Water loss with 8-inch head: 3½ gallons in 1½ minutes.

#### Hole 5

ft	in	ft	in	
0	0	3	0	Dark brown soil and clay
3	0	6	0	Light brown clay
6	0	6	6	Hard sandy clay with quartz crystals (weathered rock?).

No water was struck. There was very little water loss when tested.

Samples from each hole were tested for properties of dispersion with water from Deep Creek and distilled water using the method as described by Reilly (1962). The water remained clear in all cases, suggesting that this material is likely to be stable if used in the construction of the dam.

#### CONCLUSIONS

(1) The only hard rocks likely to occur in the dam site and storage area are quartzite, conglomerate, dolerite and slate with some chert, although the possibility of the presence of dolomite cannot be completely ruled out.

(2) Where the quartzite is exposed, as in the quarries NW of the dam site, it is strongly jointed and brecciated and could be expected to allow considerable water loss if similar material occurs at the dam site. Weathered slate on the other hand should be fairly watertight.

(3) The unconsolidated material drilled to shallow depths with an auger showed considerable water loss in two holes. The material which allowed most of the water loss in each case was presumably the gravel beds. These beds may occur over wide areas including the storage area and to the N of the dam site: if they also intersect the surface in the storage area (e.g., in the bed of Deep Creek) they could allow considerable loss from the dam.

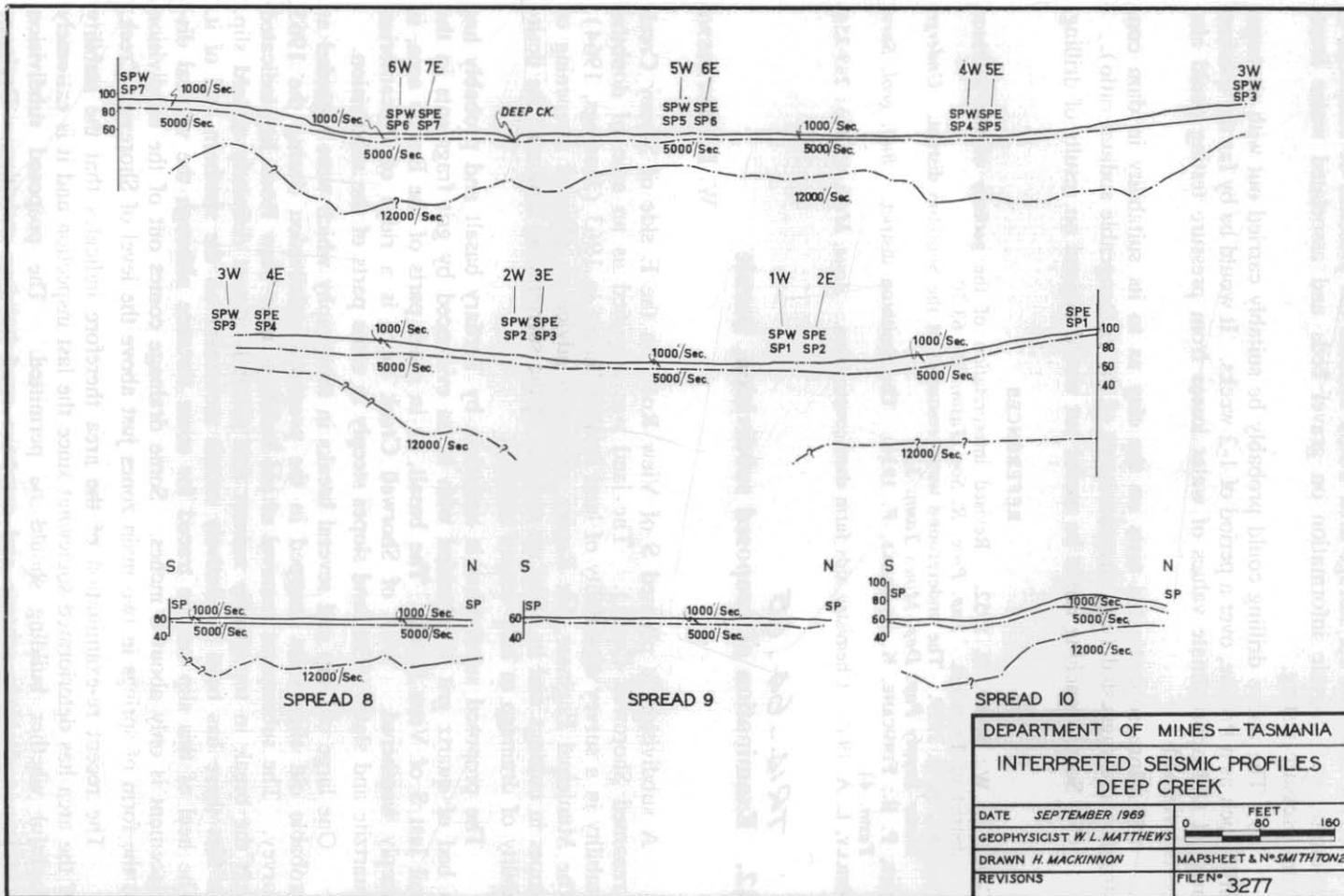
(4) The limonite areas are the result of deposits from springs and the head of water in the dam when filled could reverse the flow direction and cause some water loss.

(5) Preliminary tests on the clay suggest that it is not prone to dispersion and therefore as far as this factor is concerned, appears suitable as a dam construction material.

#### RECOMMENDATIONS

(1) Because of the possibility of leakage through gravel beds and open jointed quartzite, drilling at points along the axis of the dam should be carried out to test the extent of these beds and water losses associated with them by pressure testing.

Figure 16



(2) Drilling in the storage area would indicate the presence or otherwise of dolomite, and provide information on gravel beds and associated water losses from pressure testing.

(3) The above drilling could probably be suitably carried out with an auger drill, such as a Proline, over a period of 1-2 weeks. It would be by far the quickest method and approximate values of water losses from pressure testing could also be determined.

(4) More sophisticated tests on the clay as to its suitability in dam construction are suggested (e.g., measurements of the exchangeable sodium ratio).

(5) Some trenching might be useful but would depend on results of drilling.

#### REFERENCES

- CAREY, S. W.; SCOTT, B. 1952. Revised interpretation of the geology of the Smithton district of Tasmania. *Pap. Proc. R. Soc. Tasm.* 86: 63-70.
- GULLINE, A. B. 1959. The underground water resources of the Smithton district. *Undergr. Water Supply Pap. Dep. Mines Tasm.* 5.
- NYE, P. B.; FINUCANE, K. J.; BLAKE, F. 1934. The Smithton district. *Bull. geol. Surv. Tasm.* 41.
- REILLY, L. A. 1967. Chemistry aids farm dam construction. *Aqua, Melb.* 18(11): 249-254.