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26. Geological investigation of a dam site at Craigbourne Road, Colebrook

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The dam site is located about 750 m downstream from the Craigbourne road bridge over the Coal River, about 5 km south-west of Colebrook.

It was investigated between 25 February and 26 March 1970 in response to a request by the Rivers and Water Supply Commission.

The investigation consisted of a small amount of surface geological mapping followed by a seismic survey; 8 diamond drill holes were cored and pressure tested. The storage area was not examined but has been covered by regional mapping (Leaman, 1971).

PREVIOUS WORK

The site was examined by Blake (1960) who described it as site B and stated that it was the better of two on this part of the Coal River but that some drilling was required to detect any weathered zones.

The area was also mapped as part of the Brighton quadrangle by Leaman (in press). He showed that the area consists of flat-lying Triassic sandstones intruded by dolerite with some Jurassic and later faulting.

TOPOGRAPHY AND GEOLOGY

The river below the Craigbourne road bridge enters a small but steep-sided gorge in dolerite. This is very sinuous so that only narrow meander cores are left between successive reaches of the river. The nearby contact of the dolerite with sandstones raised doubts about the site on two counts. Firstly the suspicion that sandstone could exist under the dolerite in the region of the dam wall and secondly that the proximity of the contact was responsible for the close surface jointing seen throughout the site.

The investigation was therefore intended to show whether sandstones did exist in depth below the dolerite and whether the joints penetrated to any great depth below surface and so provided leakage paths through the narrow meander cores and under the site of the dam.

DIAMOND DRILLING AND SEISMIC SURVEY

The borehole programme and the seismic survey were co-ordinated so as to complement one another and the results can best be presented in a similar form.

The positions of the boreholes are shown in Figure 22. The boreholes were sited (Table 1) to reveal the frequency, attitude and condition of joints and were subsequently subjected to water pressure testing to measure the consequent permeability (fig.23).

Seismic spreads 55 m in length, with 12 geophones, were fired from both ends in positions straddling boreholes 1, 2, 6, 7 and 8 with the intention of correlating seismic velocity variations in depth with the joint conditions revealed by drilling and also to ensure that the boreholes were reasonably representative of the whole rock mass.

Two further seismic spreads, not correlated with boreholes were fired, as indicated in Figure 22, to reveal the rock quality and probable cover in the quarry site to the north of the dam site.

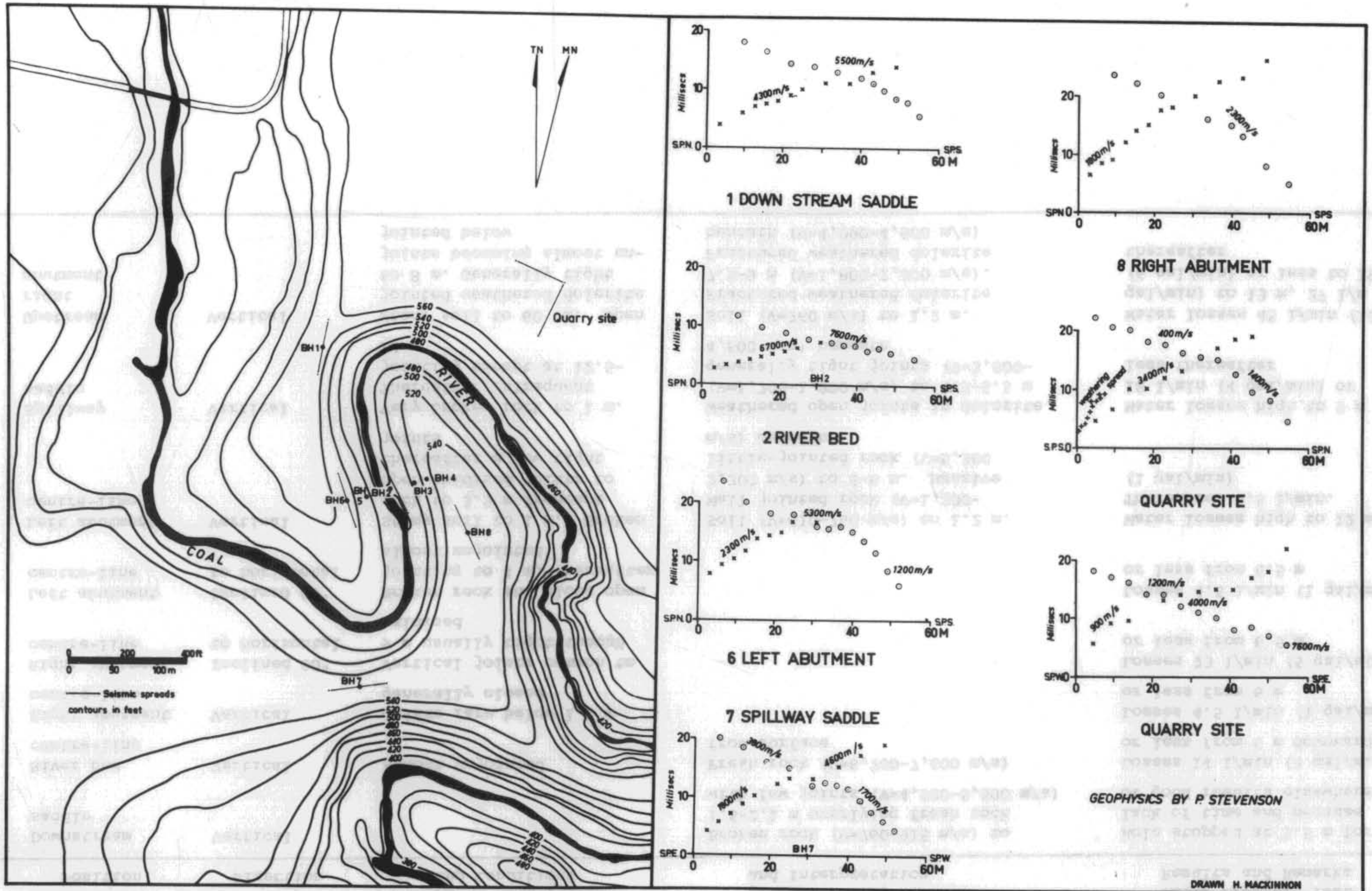

Figure 22. *Seismic survey, Craigbourne dam site.*

5 cm

Table 1. DIAMOND DRILLING AND SEISMIC SURVEY RESULTS

B.H. No.	Position	Direction	Joint Frequencies and Conditions	Seismic Survey Results and Interpretation	Water Pressure Test Results and Remarks
1	Downstream saddle	Vertical		Broken rock (V=760-915 m/s) to 1.5-2.1 m overlying fresh rock with few joints (V=4,500-5,500 m/s)	Hole stopped at 5.5 m for lack of time and because of good results elsewhere
2	River bed centre-line	Vertical	Almost unjointed	Fresh rock (V=6,700-7,600 m/s) from surface	Losses 14 l/min (3 gal/min) or less from 6 m downwards
3	Right abutment centre-line	Vertical	Joints rare below 1.5 m generally closed		Losses 4.5 l/min (1 gal/min) or less from 6 m
4	Right abutment centre-line	Inclined 60° to horizontal	Vertical joints common to 9 m usually tight though oxidised		Losses 23 l/min (5 gal/min) or less from 6.5 m
5	Left abutment centre-line	Inclined 60° to horizontal	Broken rock and close open jointing to 4 m, thereafter almost unjointed		Losses 4.5 l/min (1 gal/min) or less from 6.5 m
6	Left abutment centre-line	Vertical	Stony soil to 1 m. Broken rock to 3.5 m frequent open oxidised joints to thereafter a few tight joints	Soil (V=610-760 m/s) to 1.2 m. Well jointed rock (V=1,200-2,300 m/s) to 5-6 m. Massive little-jointed rock (V=5,300 m/s) beneath	Water losses high to 12 m. Thereafter 4.5 l/min. (1 gal/min)
7	Spillway saddle	Vertical	Very broken rock to 1 m. Thereafter infrequent jointing except at 12.5-14 m	Weathered open joints in dolerite (V=1,700-1,800 m/s) to 4.5-5.5 m generally tight joints (V=3,800-4,600 m/s) beneath	Water losses high to 9 m 18 l/min (4 gal/min) or less thereafter
8	Upstream right abutment	Vertical	Stony soil to 60 cm. Open jointed weathered dolerite to 8 m. Generally tight joints becoming almost un-jointed below	Soil (V=760 m/s) to 1.2 m. Fractured weathered dolerite 7.5-9 m (V=1,800-2,300 m/s). Fractured weathered dolerite beneath (V=4,000-4,600 m/s)	Water losses 45 l/min (10 gal/min) to 13 m, 27 l/m (6 gal/min) or less to 19 m thereafter

RESULTS

The combined results of diamond drilling seismic work and pressure testing are presented in the Table 1.

The joint frequencies and descriptions as summarised in the table correlate well with the seismic and pressure test results.

Unjointed dolerite has an apparent seismic velocity of 6,700-7,600 m/s and water losses are less than 14 l/min (3 gal/min).

Where rock is fractured but unweathered, velocities of 3,700-4,600 m/s are observed and water losses are also low. Well jointed and weathered rock gives a velocity 1,700-1,800 m/s and high water losses.

Soil and broken rock talus has a velocity of 610-760 m/s.

Some discrepancy in depths may arise because the seismic results are observed over a spread of 55 m while the corresponding borehole samples only one vertical section. Similarly water pressure results are measured over a 3 m section of a borehole and fractured rock in any part of one section may produce losses which appear to apply to the whole section. Despite these limitations a good correlation is still apparent.

The seismic results for the quarry site show that overburden consisting of 2-3 m of stony soil and loose rock (velocity 760-1,200 m/s) overlies slightly fractured and unweathered dolerite (velocity 3,400-4,500 m/s). This material is probably comparable to the section of Bore Hole 7 below 3 m.

CONCLUSIONS

The site for the dam wall is wholly on dolerite. In spite of the very obvious surface jointing all over the site, the joints do not penetrate far below surface and the rock is massive unweathered and almost unjointed in depth. Permeabilities are very low except near the surface. No sandstone has been found below the dolerite.

From regional studies it appears that the dolerite mass of Craigbourne is the top of a deep-seated plug. This could account for the distribution of jointing: a large mass such as this would be expected to have extensive jointing near its top and margins but with the joint frequency rapidly diminishing and tying out at shallow depths.

The open state of the surface joints could also be accentuated by the strong differential unloading that has occurred during the cutting of the deep gorge of the Coal River at the dam site.

Massive rock can be found nearby in a position suitable for a quarry.

RECOMMENDATIONS

Although the results have been most encouraging so far, they must only be regarded as a partial investigation. Large portions of the narrow interfluves near the abutments have not been examined, and must be considered a risk until this is done. Drilling and seismic work in combination has proved to be an economical means of doing this. Six further holes would probably be required.

The storage area has not been examined and whilst there is no reason to doubt its serviceability, prudence demands than an examination be made.

Additionally, no search has been made for clay core material, which might be expected in the area.

A quarry site has been found, but further work might locate an area with less soil and loose rock cover.

Elastic and static modulus measurements depending on details of dam design (*e.g.* in siting dam buttresses) might be necessary.

A trial grouting cell in the areas of high water loss would be advisable.

No investigation has been made of the rock conditions downstream of the spillway and it is not known whether a concrete lining would be necessary.

REFERENCES

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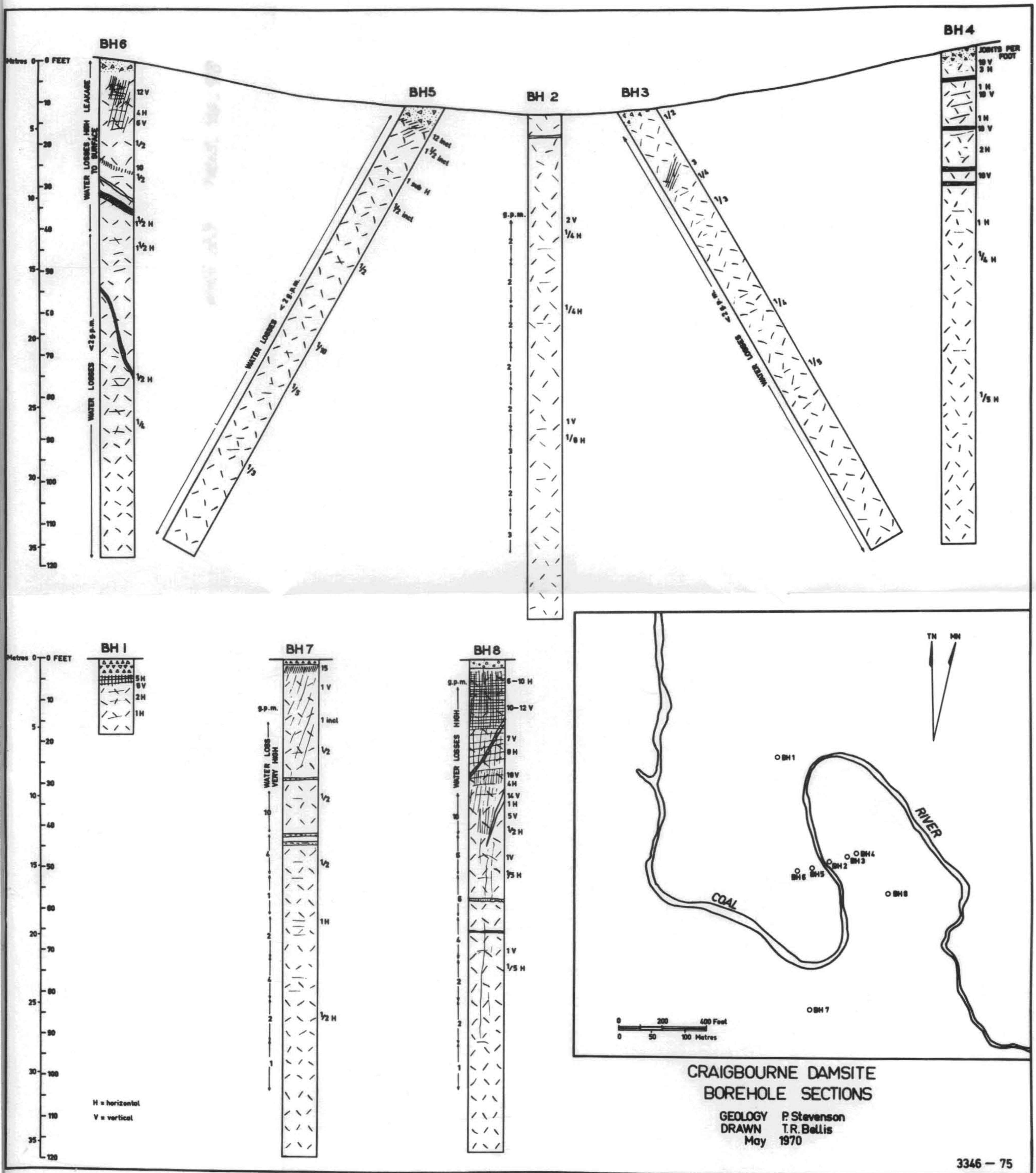

Figure 23.

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