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35. Geological examination of No 5 dam site on the Clyde River.

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The site was examined during the period 17 July and 9 August 1968 at the request of the Rivers and Water Supply Commission on behalf of the Clyde Water Trust. The examination was intended to elucidate the general geological setting of the site, and to recommend the work needed to decide on the suitability of the site.

The site is located on the Clyde River at [47/79257600]* where the course of the river turns from south-west to north and enters a large double-lobed meander (fig. 56).

Access for vehicles is easiest from the Bothwell-Hollow Tree road at 'Sherwood'. The road to the old deserted Sherwood House, is followed for about 5 km and a diversion is then made from it towards the north, to the river and the dam site.

GEOLOGY

The geological succession at the site is as follows:

Quaternary alluvium, river gravels.
Blown sand.
Tertiary basalt, lava flows and vent material.
Jurassic dolerite dykes.
Triassic massive sandstone with interbedded shale.
Permian siltstone and interbedded mudstone.

Permian

The Permian rocks are seen *in situ* in the northern part of the area, where they dip gently, and consist of 0.6-2 m beds of hard massive white and light grey siltstone with blocky jointing, interbedded with layers of softer grey siltstone 0.3-0.6 m thick. Occasional quartz pebbles are seen in the siltstone and the rocks show disrupted bedding in hand specimen.

A raft of Permian sediments similar to the above, but often crowded with bryozoan fossils is seen in the north abutment of the site, but is described more fully under 'Dolerite'.

Triassic

Triassic rocks form most of the area on both sides of the river. In the southern half, outcrops of medium-hard, massive, current-bedded brown quartz sandstone in beds up to 2 m thick, form cliffs on the outside of the river bend. In these rocks the joints are spaced at intervals of 0.6-3 m. Along the southern slopes upstream from the site, wind action on the softer sandstone has produced small caves, and the loose sand resulting from this form of erosion mantles the lower slopes. Further upstream in the south-eastern part of the reservoir area no outcrops of sandstone are seen but the sandy soil and occasional loose fragments show that Triassic rocks are still present.

North of the river, exposures of the Triassic rocks are generally poor. A horizontal 0.5 m band of regularly jointed sandstone forming 0.5 m polygonal blocks occurs as a ford across the river, which is adequate for

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*kiloyard grid

pedestrians and four-wheel drive vehicles when the river is low. Similar sandstone is seen in the river banks at several points upstream. On the slopes on the northern side of the reservoir area, no outcrops are to be seen and the presence of the sandstone is again inferred from the nature of the soil. As is usual in the Triassic sequences the interbedded shales are rarely seen.

In the north-western part of the area massive hard sandstone and grit is seen to overlie the Permian rocks and dip gently to the south-west with apparent conformity. The sandstone is strongly cemented with silica and appears to have been affected locally by the intrusion of the dolerite.

Jurassic dolerite

The dolerite within the area is intruded as a nearly vertical dyke about 60 m wide which for part of its course infills a fault plane between the Triassic and Permian rocks. It can be traced from a hill on the eastern boundary of the area westward obliquely across the river where it forms stony bluffs, and further across a hill and valley, its trace being marked by outcrops at summits and by much talus on slopes. In outcrop, it is sometimes widely jointed so as to form blocks up to 1.2 m wide, and is not extensively weathered. The fault dyke has been displaced by a later fault and widens out to form a prominent hill on the central northern side of the reservoir area. Here again large fresh 1.2-2 m blocks of dolerite form cliffs up to 15 m high which are skirted by talus.

A further extension of the dyke which appears to have no surface connection with the section described above, runs southwards across the river and forms the north and south abutments. This section of the dyke is complicated by the inclusion of a large raft of fossiliferous Permian sediments apparently surrounded on all sides by dolerite. The sediments are baked, and have been hardened by this process so that where they are seen in outcrop on the north abutment, they are as hard as the dolerite itself, and are not extensively jointed. Where the thin panels of dolerite lie alongside the raft, close jointing is seen in the dolerite giving fragments measuring about 12 mm across, but this effect is usually seen only within a few metres of the contacts, and joint blocks up to 0.6 m and more are commonly seen within the panels. The eastern panel is well exposed in small cliffs, but the western panel only shows in outcrops less than one metre high.

The sediments are of very similar type to those seen in outcrops in the northern parts of the area, and do not appear to have been transported more than a few scores of metres vertically from their original position.

The raft of sediments does not appear in the outcrops of the dyke in the river bed, and no sediments are to be seen within the dyke in the southern abutment. Here the normal dolerite pattern is of close jointing (down to 12 mm intervals) close to the contacts and larger fragments (slabs up to 0.3 m) in the centre of the intrusion. The dyke can be followed up the steep hillside, where it narrows before passing under the basalt capping the hill tops.

The contacts of the dolerite with the sandstone on the south abutment are obscured by dolerite and sandstone talus. The sandstone has however been arched over the dyke and dips of 50° were recorded. This local arching is not usual in dolerite intrusion and probably indicates that the dyke is seen here at the limit of its vertical extent and had no extension above the present land surface.

Tertiary basalt

The basalt occurs as a capping on the higher hills and is usually recognised by the red soil it produces and by the float of fine-grained black basalt cobbles. Only occasionally is a true outcrop seen as prismatic subvertical columns. An area of vesicular basalt and mixed basalt and sediments is seen on the lower slopes in the south-east of the area and appears to mark a section through a small vent. The basalt obscures the older rocks in several critical areas, for instance where the faulted contact between Triassic and Permian rocks runs N-S in the northern part of the area, the north end of the Permian sediment raft in the N-S section of the dyke, and where the dyke disappears under the basalt to the south of the south abutment.

Blown sand

The blown sand has probably been produced by the weathering of the Triassic sandstone, and forms a constituent of the soil in many parts of the area. It is thickest on the eastern side of the N-S section of the dolerite dyke. Here it lies against the dyke and forms a slope down to the valley floor which has been widely exploited by rabbits.

Quaternary alluvium

An alluvium predominantly of sandstone, dolerite, and basalt boulders covers the floor of the valley. It can be seen in the river banks to have a thickness of up to 1.2 m. The boulders are normally well-rounded and up to 0.5 m in diameter. There is very little sand present. Clay was not seen.

Structure

The Permian and overlying conformable Triassic sediments are almost horizontal, the dip being slightly towards the south-west. As mentioned above, the Triassic rocks are arched in the region of the south abutment and only here are high dips seen.

The E-W section of the dolerite dyke dips steeply south, and infills the trace of a fault down-throwing the Triassic against the Permian. The throw of this fault is probably less than 45 m. The dyke has been slightly offset by the movement of a later fault trending N-S, again of small throw which has also faulted Permian against Triassic and terminates the strike of the sandstone forming the cliffs to the south of the river. This fault may also have provided a conduit for the extrusion of the basalts.

The complex N-S section of the dyke has been described above.

DAM SITE

The site appears to have few disadvantages as a location for a rockfill dam. No hazards appear to exist anywhere in the reservoir area. The north abutment, in spite of its complex character appears to be sound and would lend itself well to the location of a spillway. The south abutment is closely jointed in some areas but more massive areas exist and could be exploited. The river bed is not well exposed but appears to consist of sound dolerite.

Good supplies of fresh dolerite for rock-fill are available from the prominent hill to the north of the reservoir area in blocks up to 1.2 m across.

No clays have been discovered.

RECOMMENDATIONS

Further investigation is needed in two areas to:

(1) determine the detailed structure of the abutments and river bed along the centre-line, and

(2) ensure that adequate reserves of sound dolerite are available.

The abutments would have to be cleared of loose material and soil to the top water level of the dam, and trenches excavated across the river alluvium along the centre-line. This would enable an appreciation of the jointing conditions to be made.

Some diamond or air drilling is required to prove the quantity and quality of the dolerite available with particular reference to sizes of blocks, state of weathering and total volume available.

CONCLUSIONS

The preliminary geological investigations have revealed no conditions which would indicate that the site is unsuitable for a rock-fill dam. The actual dam site, being the most highly stressed part of the system requires further investigation which should take the form of improved exposure and cleaning.

Some drilling is required to prove reserves of rock-fill.

CLYDE RIVER DAM SITE 5

5 cm

FIG 56. TR16-195-198