# PLEISTOCENE DEPOSITS AT PARANGANA DAMSITE IN THE MERSEY VALLEY–RESULTS OF EXCAVATION AND CONSTRUCTION DRILLING

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(With two text figures and four plates)

## ABSTRACT

Pleistocene periglacial and glacial deposits exposed in the cut-off trench dug for Parangana Dam are described. The valley profile beneath the axis and downstream toe of the dam is discussed, and it is concluded that the dam lies in the terminal zone of the Mersey Valley Glacier.

## INTRODUCTION

The following information is the result of excavation of the cut-off trench for Parangana Dam, and of drilling piezometer holes at the downstream toe of the dam. The results of investigation of the damsite were given in Volumes 99 and 100 of this journal.

Parangana Dam is situated ½ mile below the Fisher River Junction in the gorge tract of the Mersey River. At the damsite (fig. 1, pl. 1) the river is superimposed and flows across the structural trend in a wide gorge that has been cut in vertically to near vertically foliated Precambrian Fisher Group quartzite, schist, phyllite and slate. Investigation drilling and a seismic survey along the dam axis revealed a narrow buried U-shaped central channel 200+ feet deep and 200 feet wide filled with Pleistocene and periglacial solifluction material containing bands of fluvioglacial and possibly fluvial material and overlain by glacial drift.

### Channel Filling

In order to construct a cut-off for the dam a trench was excavated into the Pleistocene deposits along the dam axis to a depth of 35 feet below the river bed. The information obtained from the trench is shown on section B-B1 of figure 2.

The bottom of the channel has not been located, but investigation drilling has shown that the bulk of the channel, from elevation 940 feet to 1125 feet (185 feet) is filled with periglacial solifluction material. That is, the channel was filled by a number of mass movement slides from the valley slopes when a glacier was in the near vicinity. The slides are thought to be the result of thawing of the surface talus layer in the summer months while the ground below remained frozen, so that the surface layer became saturated with water and flowed down the slope. The material accumulated at a time when the flow down the valley was probably greatly reduced, when precipitation remained in the upper reaches in the form of snow and ice. The characteristics of the deposit are those of a talus deposit, for it is unstratified and composed of material of local origin from the immediately adjacent valley walls and the material is angular, indicating little transport.

Along the dam axis, where the valley walls are formed by quartzite, the rock fragments (Drill Holes 5773, 5774, 5781, 5782, 5783, 5784 and 5791) consist mostly of angular pebbles, cobbles and boulders (up to 18 inches in diameter) of quartzite with minor schist in a yellowish to reddish-brown sandy-clay to clayey-sand matrix. Downstream, where the valley sides are formed by repetitions of quartzite and schist, the proportion of schist pebbles (Drill Holes 5767 and 5771) is markedly higher. In both areas the ratio of fragments to matrix averages about 60 : 40. The periglacial solifluction layer exposed in the cut-off trench on the left abutment of the damsite is shown on plate 4.

A distinctive reddish-brown clay occurs in the core from Drill Holes 5768 (82 feet-114 feet), 5772 (120 feet-125 feet) and 5784 (80 feet-97 feet). It is missing in Drill Hole 5782 which lies between Drill Holes 5768 and 5784. In this hole the clay is replaced by periglacial solifluction material containing a sand band (87 feet-91 feet), suggesting erosion of clay. The clay layer was probably deposited in a lake dammed by a solifluction slide.

Bands of fine to coarse-grained quartz, quartzite and schist sand and gravel, ranging up to 11 feet in thickness, occur within the solifluction deposit, and the distribution suggests that some may extend laterally over half the width of the channel. These sands were probably laid down under fluvioglacial conditions, that is, they are probably material of glacial origin transported a short distance by meltwater and redeposited. The number of distinctive sand and clay layers present suggests that at least five major periglacial solifluction slides took place. A layer of fluvioglacial sand that was deposited near the top of the periglacial solifluction deposit is shown on plate 2.

### Glacial Drift

Investigation drilling showed that glacial drift covers the periglacial solifluction layer and extends up both sides of the valley. The maximum thickness was 30 feet in the cut-off trench, but a 20

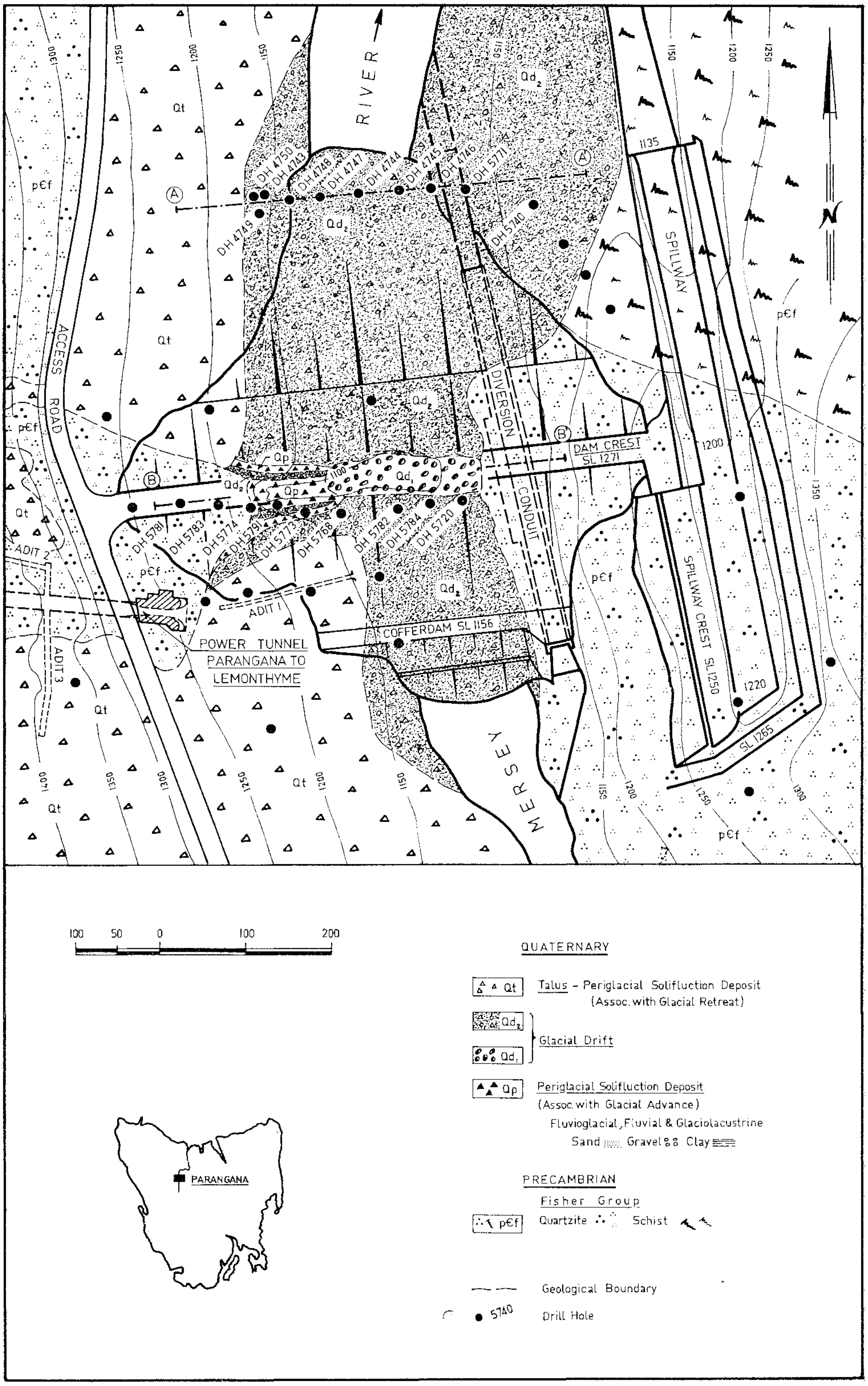


FIGURE 1.—Geological Map—Parangana Damsite.

feet thick deposit occurs on the right bank 150 feet above river level, and a 40 feet thick deposit occurs on the left bank 130 feet above river level.

The cut-off trench was taken below the base of the glacial drift layer into the periglacial solifluction layer. The material excavated agreed well with the section constructed from the investigation drilling with one exception. In the central part of the channel it was possible to recognise an early till in material that had been included in the periglacial solifluction deposit in the interpretation of the investigation drill holes. This till is composed of sub-rounded boulders, cobbles and pebbles of quartzite and sparsely scattered rounded dolerite boulders in a sandy-clay matrix. Seen in the face of the trench it was possible to distinguish it from the periglacial solifluction deposit by the roundness of the coarse material and by the presence of the dolerite boulders, but the layer could not readily be recognised in the drill holes, none of which encountered dolerite boulders in this zone.

The overlying younger till is distinguished by a predominance of dolerite boulders, cobbles and pebbles, with basalt, quartzite and schist contributing only minor amounts. The material is toughly compacted, uncemented to weakly cemented, unstratified and heterogeneous and up to 70% of the material consists of pebbles, cobbles and boulders coated with clay, silt and sand. Boulders of dolerite and basalt up to 7 feet in diameter occur and these are sub-rounded to rounded, whereas the boulders of quartzite and schist range up to 10 feet in diameter and are angular. The quartzite basalt and schist boulders are locally derived, possibly superglacial till, but the dolerite boulders have been transported from the Central Plateau. The till layer exposed in the cut-off trench is shown on plates 2, 3 and 4.

On the left abutment a pocket of periglacial solifluction material up to 90 feet wide and 30 feet deep occurs within the glacial drift (Drill Holes 5774, 5783 and 5791). This deposit was exposed in the walls of the cut-off trench and is shown on plate 3.

### Talus

Talus originally obscured the greater part of the right abutment and all of the left abutment. Talus fans (pl. 1) extend almost to plateau level on both sides of the prominent quartzite cliffs that lie above the left abutment. The deposits have a maximum thickness of about 35 feet (Drill Hole 5719) and slopes of up to 30°. They consist of an upper few feet of loose rock fragments overlying lightly compacted, tough bony talus containing angular fragments of quartzite, schist and basalt set in a sandy-clay matrix. The junction of the talus with the underlying drift is a free draining zone coated with black carbonaceous material.

The upper loose layer is forming under the existing environment, but the thick compacted layer is considered to be the product of a periglacial environment and to have formed by solifluction as the glacier retreated from the site. It is stable under the existing environment.

### Channel Profile

Examination of sections A-$A_1$ and B-$B_1$ (fig. 2), which were drawn along the dam axis and at the downstream toe of the dam respectively, show a notable change in valley profile within a distance of 320 feet. At the dam axis the profile drawn from drilling and seismic information suggests that the channel, which here was cut in quartzite, has been modified by glacial action, whereas at the downstream toe of the dam modification by glacial action appears lacking. Here in weaker schist a central high ridge was found with channels on both sides filled with periglacial solifluction material. The channel against the right bank is particularly narrow and V-shaped. This change in profile, together with the change from a straight broad valley with truncated spurs that exists upstream of the damsite to a narrow valley with interlocking spurs immediately downstream of the damsite, suggests that the dam is sited in the terminal zone of the Mersey Valley Glacier.

The situation suggests terminal moraine conditions such that both lodgement and ablation till might be expected. A degree of lithification corresponding to a weak tillite occurred in Drill Holes 5769 (47 feet-48 feet 6 inches), 5770 (27 feet-31 feet) and 5771 (16 feet-20 feet) suggesting deposition as a lodgement till under a considerable weight of ice. By comparison the glacial drift on the left abutment is only toughly compacted, and the high proportion of coarse material suggests some washing by meltwaters. The presence of a pocket of periglacial solifluction material within the till suggests a retreat and readvance of the glacier. A high proportion of rounded pebbles, cobbles and boulders occur in the till at Parangana. This may be the result of weathering of the dolerite in the source area, the distance of transport (up to 20 miles), and reworking in part by water during transport.

The degree of weathering of the glacial drift at Parangana is unusually deep, for in the adit on the left abutment the matrix was weathered yellowish-brown at a depth of 85 feet below the surface, which was 45 feet below the base of the talus. Deep weathering also occurs at the Fisher River Junction, where dolerite boulders are almost completely decomposed at a depth of 15 feet. By contrast the till in the Rowallan Dam borrow area 7 miles upstream is fresh a few feet from the surface. Weathered material may have been transported by ice to the Parangana area from the upper valley, but the difference in degree of weathering may also be indicative of an age difference between the two deposits, for the glacial drift at Parangana may be much older than the surface glacial drift at Rowallan damsite.

### Summary of the Geomorphic History

The Mersey River took its present course (Spry, 1958) after extrusion of the Tertiary basalts, and at the beginning of the Pleistocene a valley about 1,600 feet deep was in existence. The nature of the basal deposits in the central channel is not known, but the profile at the dam axis suggests some modification by glacial action. By contrast the profile at the downstream toe of the dam is prominently fluvial. The central channel was

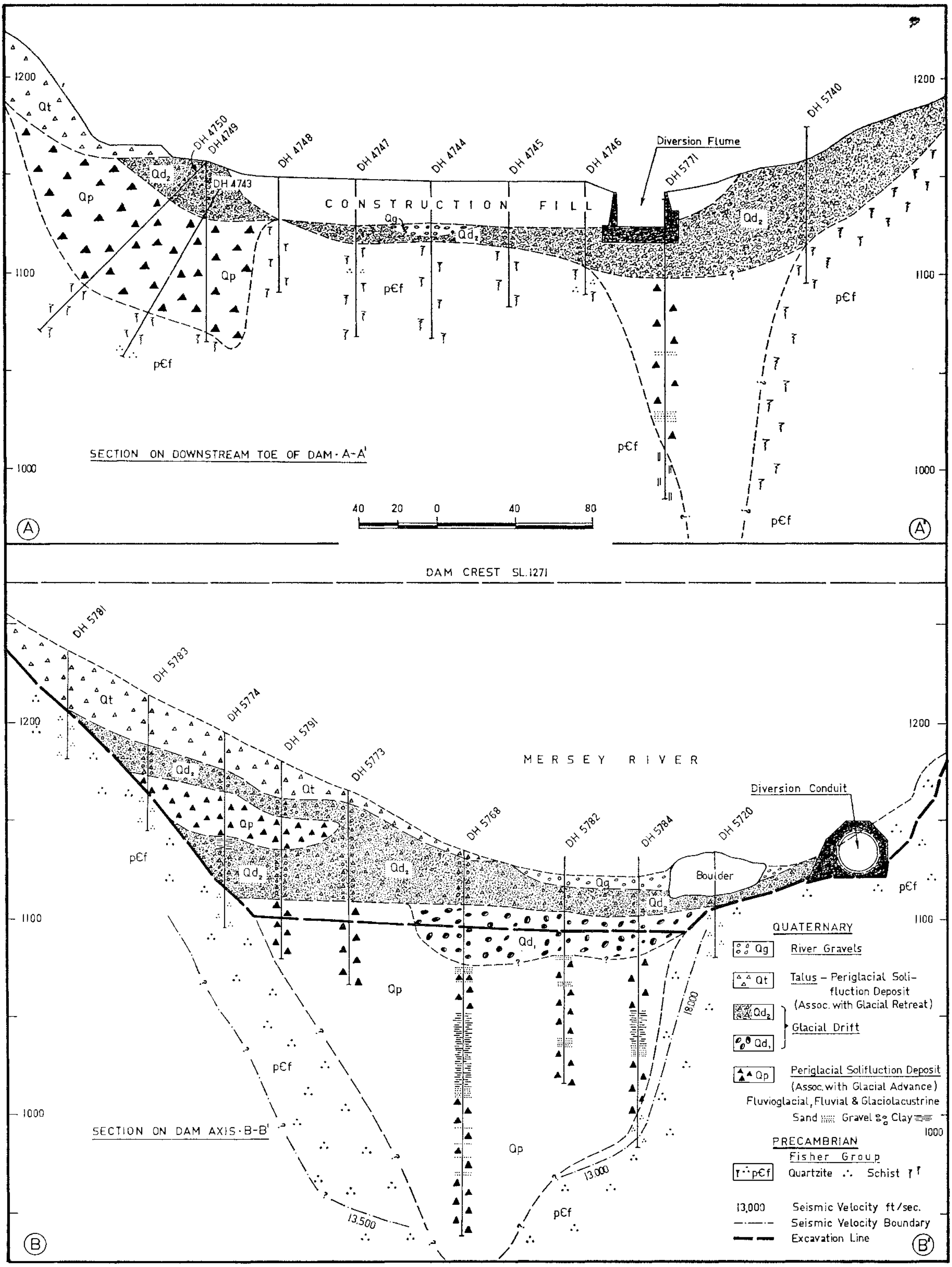
SECTION ON DOWNSTREAM TOE OF DAM · A-A'
CONSTRUCTION FILL
Diversion Flume
DAM CREST SL.1271
MERSEY RIVER
Diversion Conduit
Boulder
SECTION ON DAM AXIS · B-B'
QUATERNARY
Qg River Gravels
Qt Talus – Periglacial Solifluction Deposit (Assoc. with Glacial Retreat)
Qd2 Qd1 Glacial Drift
Qp Periglacial Solifluction Deposit (Assoc. with Glacial Advance)
Fluvioglacial, Fluvial & Glaciolacustrine
Sand Gravel Clay
PRECAMBRIAN
Fisher Group
pЄf Quartzite Schist
13,000 Seismic Velocity ft/sec.
Seismic Velocity Boundary
Excavation Line

FIGURE 2.

filled by a series of solifluction slides while a glacier was in the near vicinity. During this period of reduced river flow the slides apparently effectively dammed the river permitting deposition of 32 feet (Drill Hole 5768) of clay. The sand and gravel bands present are thought to be fluvioglacial deposits laid down as the dams were overtopped. The presence of two distinctive tills and a pocket of periglacial solifluction material within the younger till suggests that at least three glacial advances occurred, at which time the solifluction deposits were protected from erosion by ground freezing. The dam is located within the terminal zone of the glacier.

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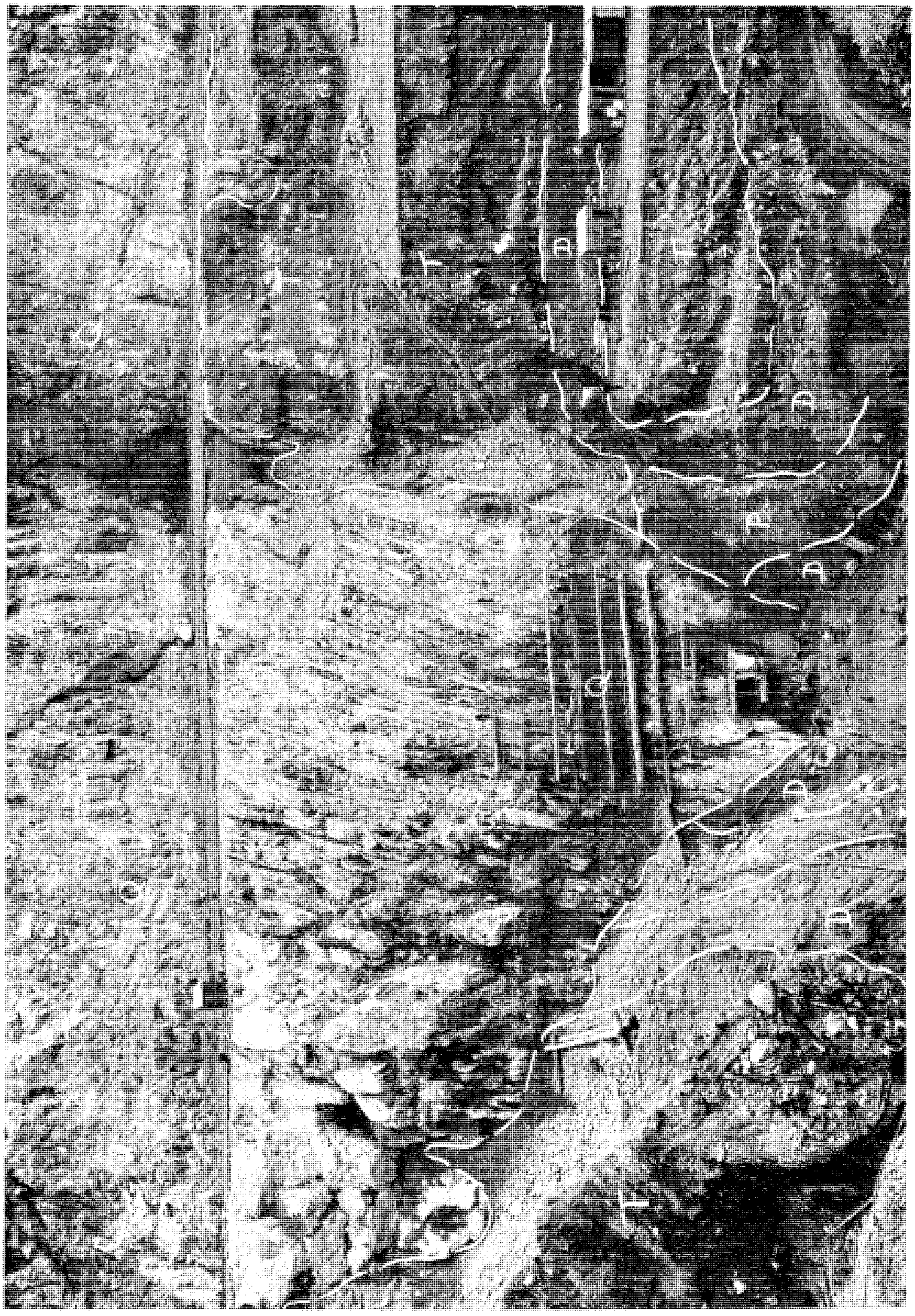

PLATE 1.—The left abutment of Parangana Damsite after stripping of the overburden and excavation of the cut-off trench showing near vertically foliated Precambrian Fisher Group quartzite (Q), periglacial solifluction material (P), glacial drift (D) and talus (T).

PLATE 2.—A fluvioglacial sand layer (F) at the base of the glacial drift (D) exposed in the upstream wall of the cut-off trench.

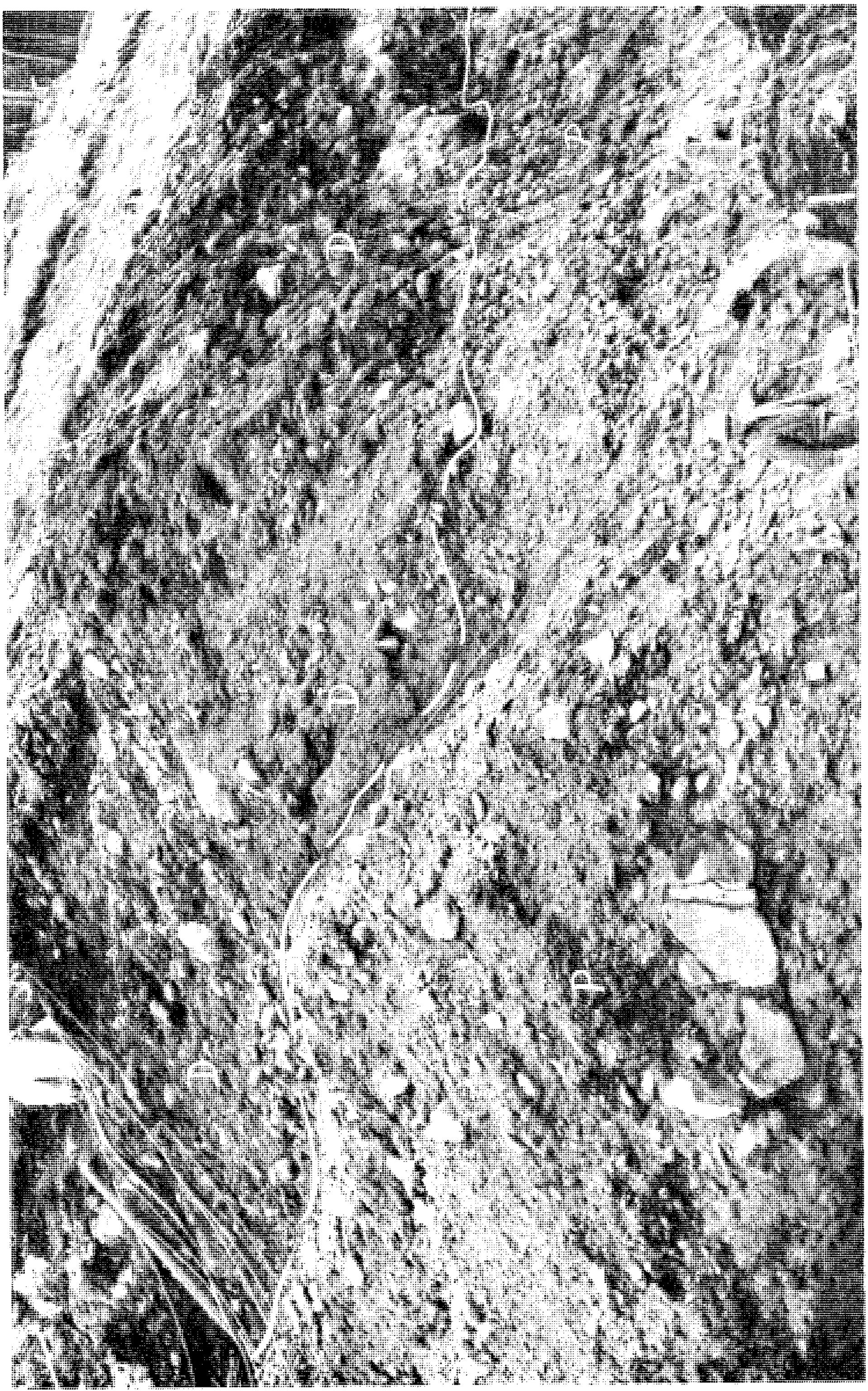


PLATE 3.—A pocket of periglacial solifluction material (P) exposed within glacial drift (D) in the downstream wall of the cut-off trench. Note the angular nature of the quartzite fragments within the periglacial solifluction deposit and the roundness of the dolerite boulders in the glacial drift.

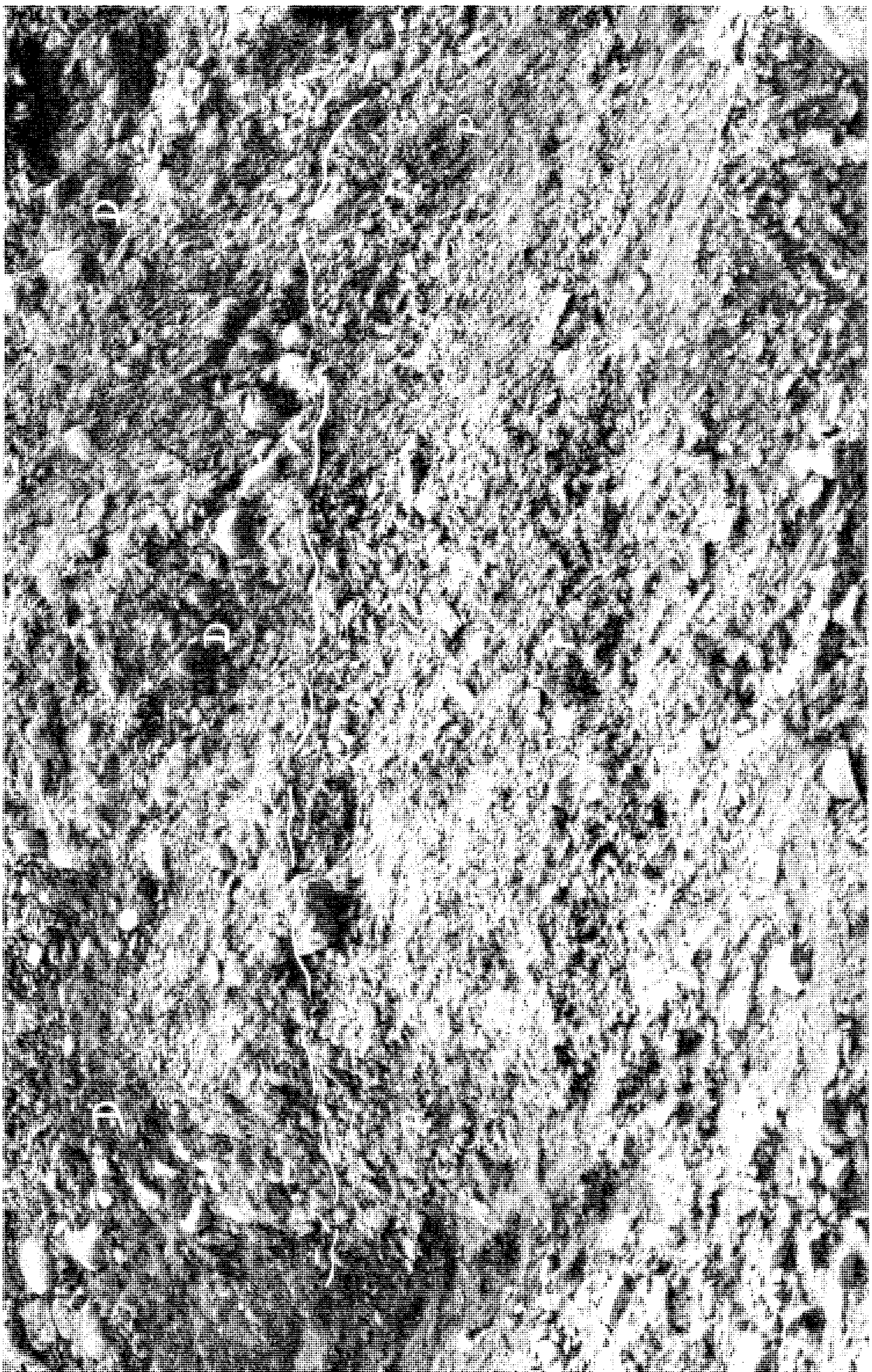


PLATE 4.—The junction of the glacial drift (D) and periglacial solifluction material (P) in the downstream wall of the cut-off trench. Note the angular nature of the quartzite fragments in the periglacial solifluction deposit and the roundness of the dolerite boulders in the glacial drift.