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13. Stability of the rock faces of the cuttings at Tolmans Hill and Tunnel Hill, Hobart.

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The two cuttings on the Southern and Eastern Outlet Roads were visited on five separate occasions during the months of July and August following a request from the Public Works Department for an assessment of their stability.

It appears to the writer that the northern faces of both cuttings are potentially very dangerous. The reason that neither cutting has to date, experienced a major rock slide is that they have only stood for a very short period of time. Because of this the normal weathering processes have not had sufficient time to reach their optimum effect. Even allowing for this short period of time there are some alarming signs of instability already developing on both faces, as can be seen in the accompanying photographs. The longer remedial action is delayed the more hazardous this already dangerous operation will become.

TOLMANS HILL

Joints in dolerite

The cutting is in dolerite. In its natural state dolerite forms steep sided, often vertical outcrops. Well developed, closely spaced vertical joints, due to the cooling of this rock give rise to the columnar structure so frequently seen in Tasmania, for example the 'organ pipes' of Mount Wellington. These closely spaced, vertical to sub-vertical joints are the most conspicuous feature of the large cutting at Tolmans Hill (plate 1).

The vertical joints run in many directions but form two sets in approximately N-S and E-W directions giving rise to block-shaped outcrops (plate 3). The frequency of the occurrence of these vertical joints is variable. Along the face of cutting, areas of widely spaced joints are followed by zones of intense jointing where the joints occur very close together (plates 1, 2).

As well as these swarms of vertical joints, minor crush zones are also present along the face of the cutting. Here the rock has been pulverized. Travertine and zeolite veins and encrustations are present in these crush zones. No slickensides were found but some shear polish is evident indicating that some vertical movement had occurred in these zones (plate 3).

A set of horizontal to sub-horizontal joints is not as conspicuous as the vertical joints but is equally important. These joints are spaced wider apart than the vertical joints but are present on all the dolerite cuttings of Tolmans Hill and can be seen in all the photographs. These horizontal or plate joints are frequently parallel to the slope of the original hill. Particularly in the weathered zone forming the 3-4 m of the dolerite, these joints are clay filled (plates 4, 5).

Throughout much of the cutting many of these plate joints have a component of dip away from the existing wall of the cutting towards the road (plates 6, 7).

Erosional processes

Five distinct erosional processes appear to be acting on the joints at Tolmans Hill and also at Tunnel Hill. These processes are:

(1) *Freeze and thaw.* An alternating freezing and thawing of the groundwater between the joints gives rise to frost heave.

(2) *Load relaxation.* The removal of superincumbent material during the creation of the cutting allows the opening of joints which were formerly tight. In case of an area such as the Mt Wellington 'organ pipes' the jointing has probably arrived at a state of equilibrium with its present load because the last removal of any large load from the Mt Wellington plateau probably occurred at the close of the Pleistocene period. In the cuttings, relaxation must be expected to continue.

(3) *Washing out of the clay between the joints.* At Tolmans Hill the washing out of clay appears to be mainly confined to the weathered zone.

(4) *Swelling and shrinkage of the clay.* This process, which is caused by alternating wetting and drying, produces an effect analogous to that of frost.

(5) *Chemical weathering.* This process is of less importance because it is slower.

It is often difficult to assess which of these erosional processes is the dominant one at a particular locality. Frost heave is probably the dominant process at Tolmans Hill because of the amount of groundwater seen to be seeping out of the joints and the alignment of the cutting, which has a southerly facing wall.

A period of severe frost has occurred since the photographs were taken and several large perched blocks marked on Plates 8-11 have already fallen. The area behind the protective wall left at the foot of the eastern end of this cutting appears to be rapidly filling due to the continuous spalling of blocks from the face.

The opening of the joints due to load relaxation appears to be more active in the case of horizontal joints (plates 5, 6, 10), although some vertical joints are also opening because of this process (plate 3).

The washing out of the clay and its expansion through wetting and drying is very actively proceeding in the weathered zone and has undoubtedly caused the rock fall at the western end of the cutting (plate 12). The striking feature of this rock fall is the large amount of rock deposited on the bench floor (plate 13) compared with the small area from which the rock fall originated (plate 1).

Recommendations

(1) A fence should be placed along the foot of the face at the level of the present rock barrier. If this is not possible warning notices should be placed along this barrier at regular intervals to keep the public away from the face because of the danger of falling blocks.

(2) Some method should be devised to bar down the numerous 'perched' boulders from the existing face. The rock wall at the eastern end of the cutting is losing its effectiveness as a safety barrier as the area behind it is rapidly being filled by rock debris.

(3) If no further construction is contemplated the face should be inspected (from the top as well as the bottom) at regular

intervals (say every 2-3 months). Regular inspection is especially important during the winter months.

(4) If any further road construction is contemplated along the foot of this cutting the present face will need to be benched back in a series of terraces following the existing horizontal jointing as much as is practicable so as to provide a reasonable degree of safety. The bench steps should not be more than 1-2 m in height. Such a terracing technique would reduce the overall slope of the face to less than 60°. It would require the removal of an enormous amount of dolerite and would appear to be a disproportionately expensive operation. This matter is considered in further detail by Leaman (1973).

TUNNEL HILL

The cutting through Tunnel Hill on the Eastern Outlet Road consists of two long, high rock batters. The northern batter is wholly cut into bedded Permian siltstone, sandy siltstone and mudstone. The slope of the face ranges between 65-85°. There are two narrow benches (plate 14).

The southern batter is mainly cut in Permian mudstone and silty sandstone and siltstone; Tertiary sand caps the crest of the cutting revealing the profile of a buried Tertiary valley (plate 15). This batter contains one bench. Its overall slope is less steep than that of the northern face: for this reason and because it is facing north, this batter does not exhibit as great a deterioration as the northern batter.

The rocks exposed on both faces of the Tunnel Hill cutting vary in lithology from coarsely bedded sandy siltstone to lamina-bedded mudstone (plates 16, 17). Several faults pass through the cutting (plate 18). The sediments show a well developed set of vertical joints at approximately right angles giving the characteristic blocky outcrop pattern (plates 19, 20).

Because of these well developed vertical joints and the low dip of the bedding, the Permian sediments of Tunnel Hill are similarly vulnerable to the erosional processes outlined for Tolmans Hill. The Permian sediments include mudstone which quickly weathers to clay. The removal of this clay by rain and running water appears to be as effective as an erosional agent as frost heave on Tunnel Hill.

The amount of clay that can be removed from the bedding and joints within these Permian sediments is illustrated in Plate 21. The opening of the vertical joints through removal of the load is shown in Plates 22-24. The effect of freeze and thaw in the spalling of large blocks is illustrated in Plates 25-27. The speed with which this block spalling is eroding away the existing rock benches is seen in Plate 28 and 29. The perched block shown in Plate 31 has fallen since the photograph was taken and debris is present on the lower rock bench in Plate 32.

The greatest danger at Tunnel Hill cutting does not appear to be from single blocks falling as illustrated, but from a rock fall from a higher level triggering the collapse of the lower benches. The existing benches, because of the bedding, have a tilt towards the cutting face. Water and water-saturated clay collect in this area and remain for long periods (plates 24, 28).

Some of this water must seep down the joints (plate 24) below the bench. Through the wetting and drying of the clay in these joints and the freezing and thawing of the water, the rocks forming the bench become potentially unstable (plates 29, 30). Rocks falling from a higher level on to this bench may trigger off larger falls from the lower benches.

There is no safety zone at Tunnel Hill (in contrast with Tolmans Hill) so that rocks fall directly on to the roadway. Such fallen rocks are not readily seen by oncoming traffic because of the curve of the roadway.

Recommendations

(1) The existing loose blocks should be barred down.

(2) The cutting should be patrolled regularly at roadway level, and on the benches.

(3) The existing benches should be drained so that water will not collect on their surfaces, these drains should run parallel to the face and be capable of transporting much of the fine clay as well as the water.

(4) To make this southern batter absolutely safe further terracing will be required. The existing benches are too few and too narrow.

REFERENCE

LEAMAN, D.E. 1973. Treatment of cuttings at Tolmans Hill, Hobart. *Unpubl. Rep.Dep.Mines Tasm.* 1973/68.

[4 September 1973]

Plate 1. *Tolmans Hill cutting. Vertical jointing in dolerite.*

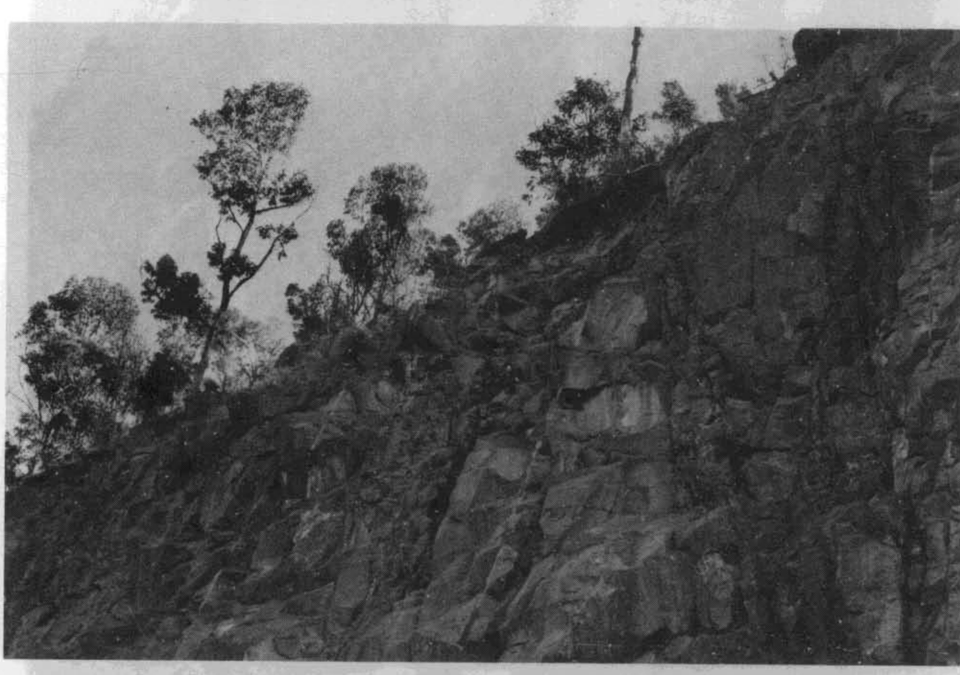

Plate 2. *Tolmans Hill cutting. Vertical joints in dolerite, with a zone of closely spaced joints. Note the slip-circle basin in the weathered zone from which a rock fall originated.*

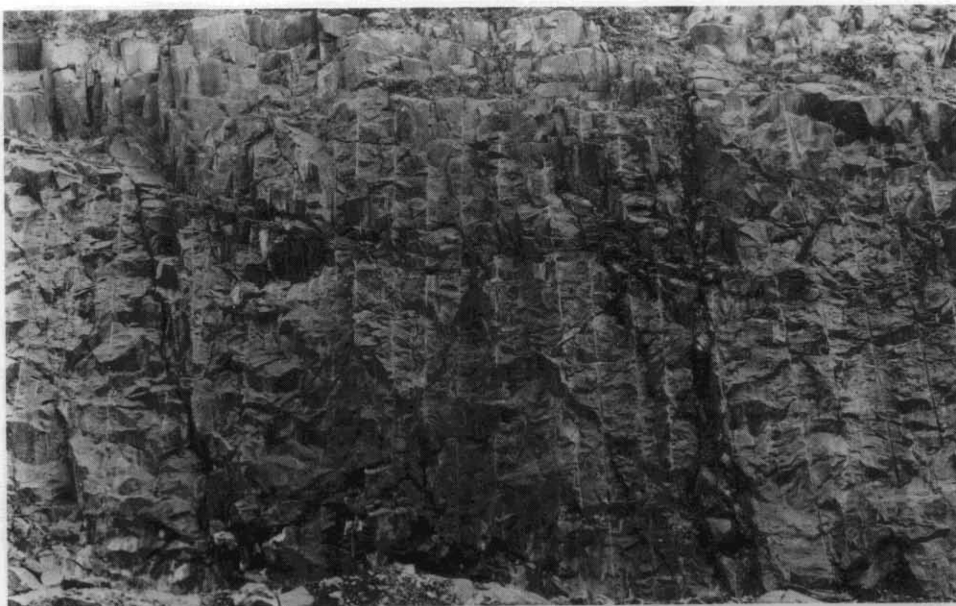

Plate 3. *Tolmans Hill cutting. Vertical joints in dolerite with a crush zone at right centre.*

Plate 4. *Tolmans Hill cutting. Sub-horizontal joints in dolerite.*

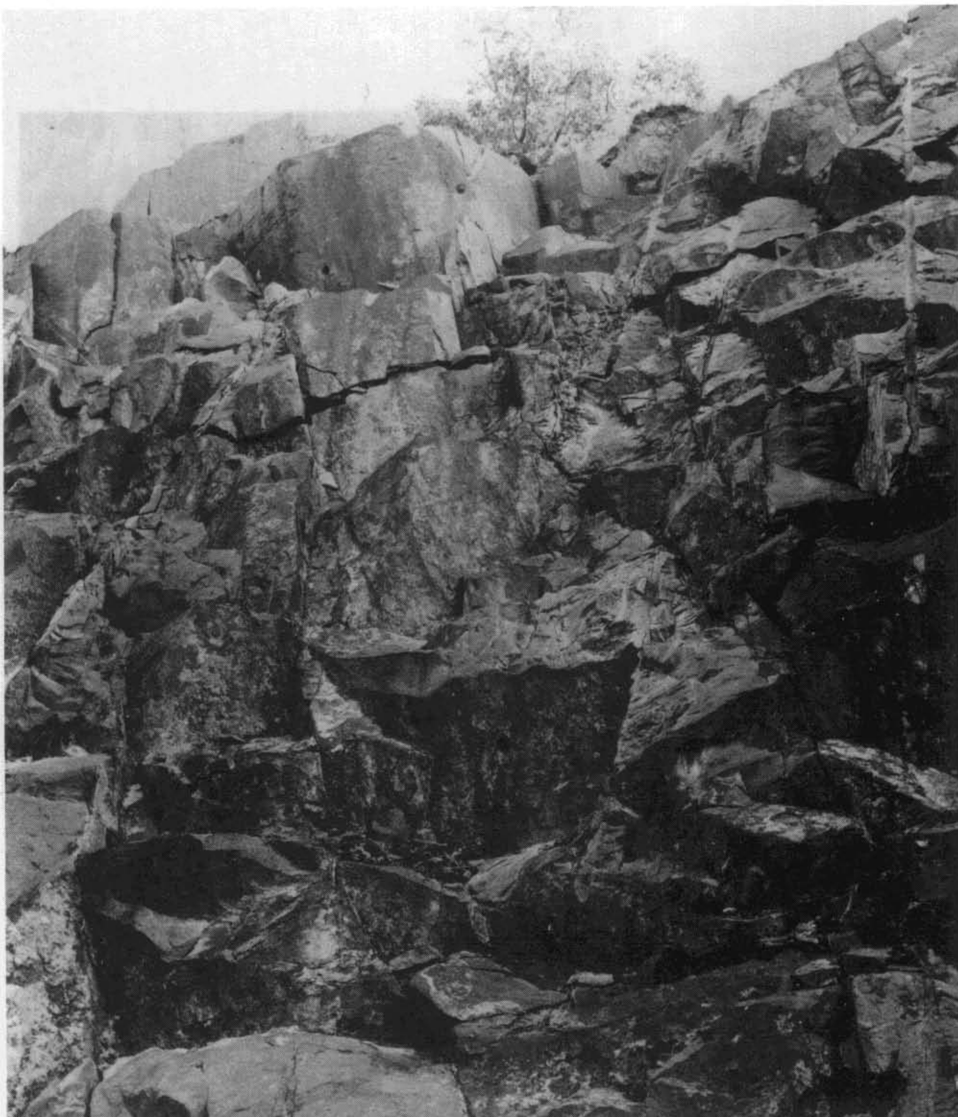

Plate 5. *Tolmans Hill cutting. Sub-horizontal joints and a clay-filled joint in the weathered zone near the top of the cutting.*

Plate 6. *Tolmans Hill cutting. Sub-horizontal joints with dip towards the road.*

Plate 7. *Tolmans Hill cutting. Sub-horizontal joints with dip towards the road.*

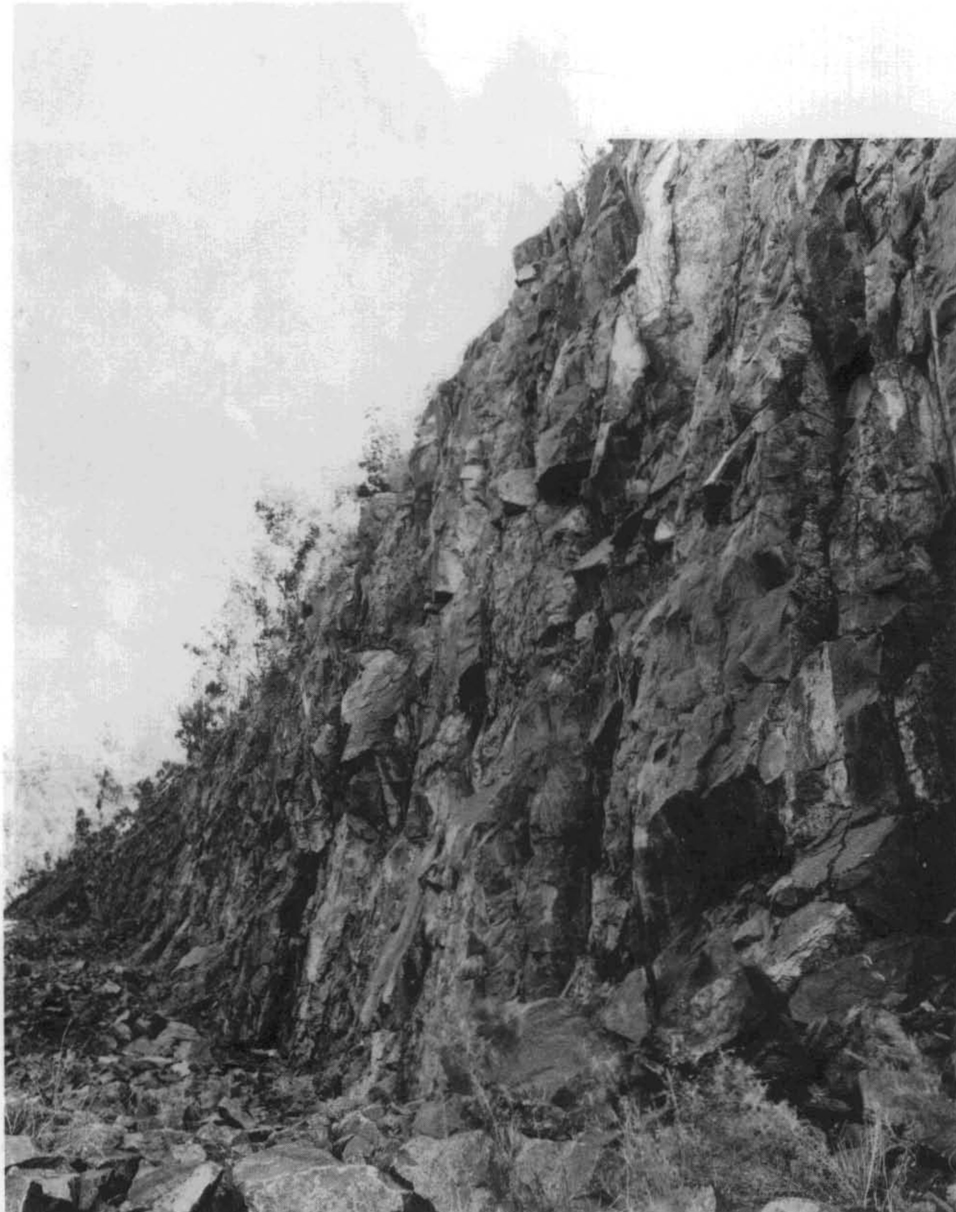

Plate 8. *Tolmans Hill cutting. Perched blocks on the cutting face.*

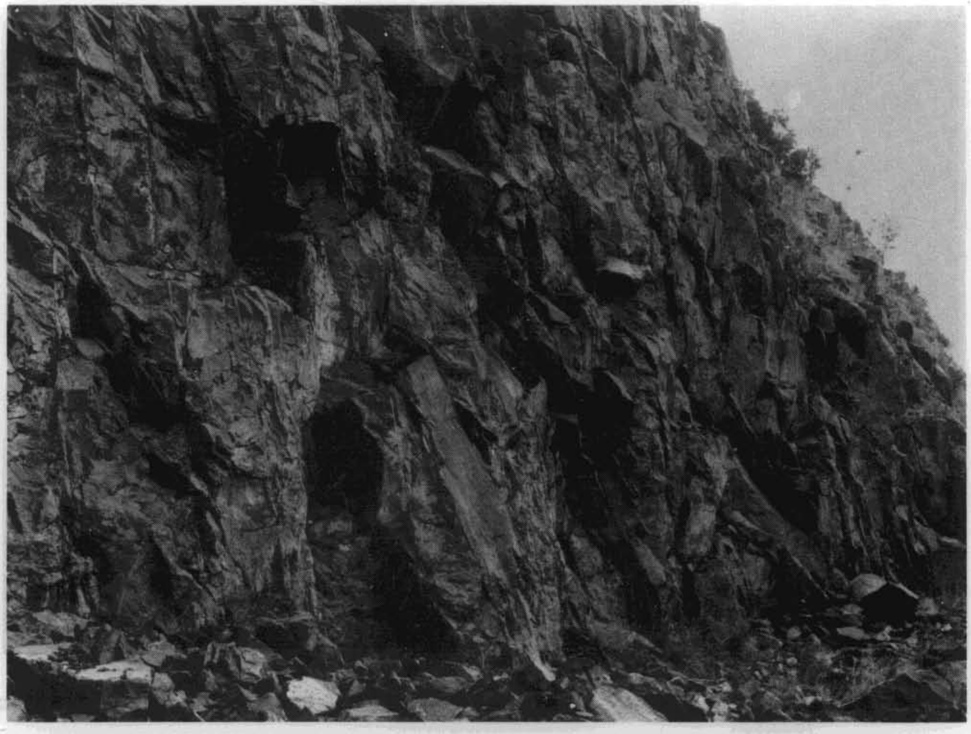

Plate 9. *Tolmans Hill cutting. Perched blocks on the cutting face.*

Plate 10. *Tolmans Hill cutting. Unstable perched block.*

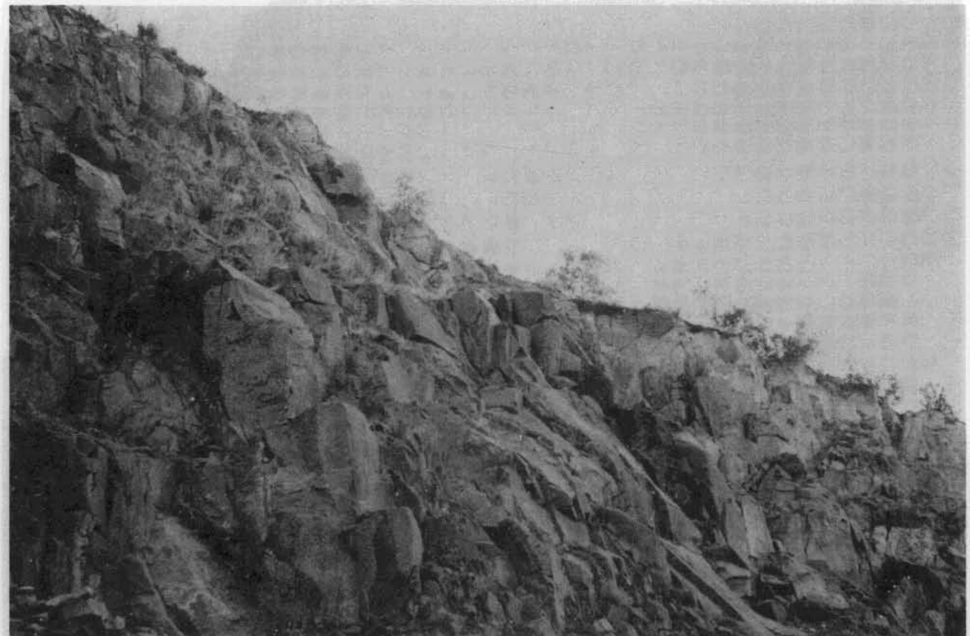

Plate 11. *Tolmans Hill cutting. Perched blocks and horizontal relaxation joints.*

Plate 12. *Tolmans Hill cutting. Vertical joints opening by load relaxation.*

Plate 13. *Tolmans Hill cutting. Debris from the rock fall on the bench.*

Plate 14. *Tunnel Hill cutting. North cutting wall with two cut benches. Well-bedded Permian sediments.*

Plate 15. *Tunnel Hill cutting. South cutting wall. Well-bedded Permian sediments, and a Tertiary valley near the top of the cutting.*

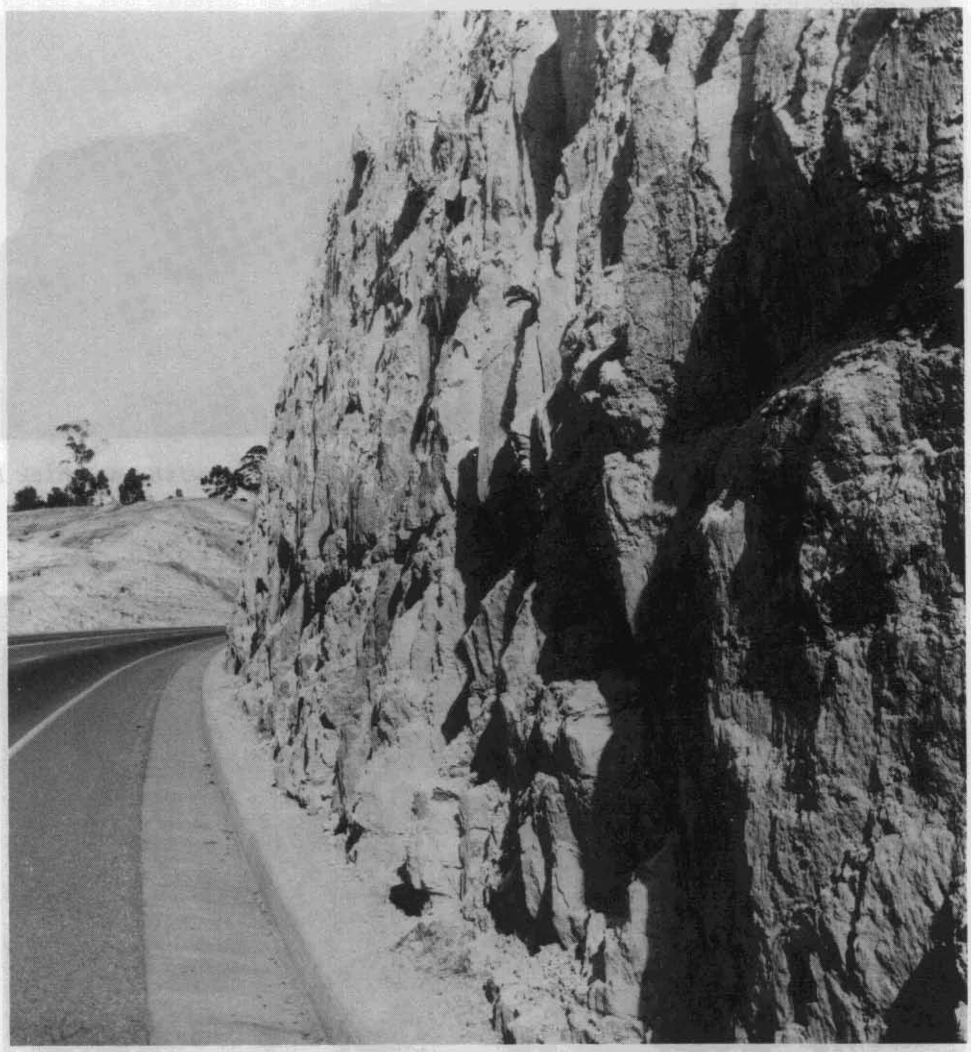

Plate 16. *Tunnel Hill cutting. Coarsely bedded sandy siltstone.*

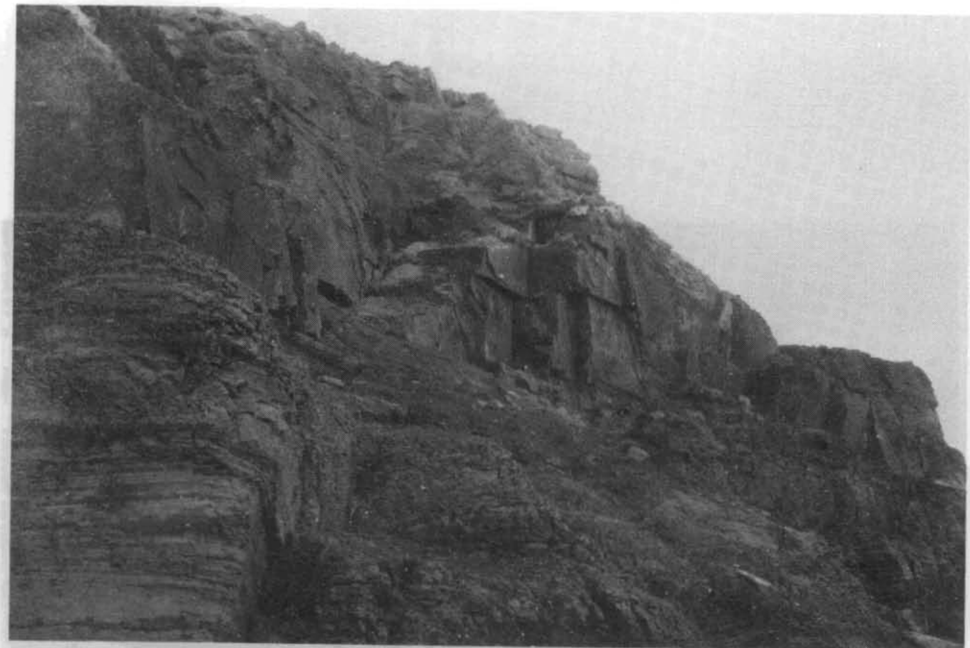

Plate 17. *Tunnel hill cutting. Lamina-bedded mudstones with one thick bed of silty sandstone.*

Plate 18. *Tunnel Hill cutting. Faulting exposed on the southern face.*

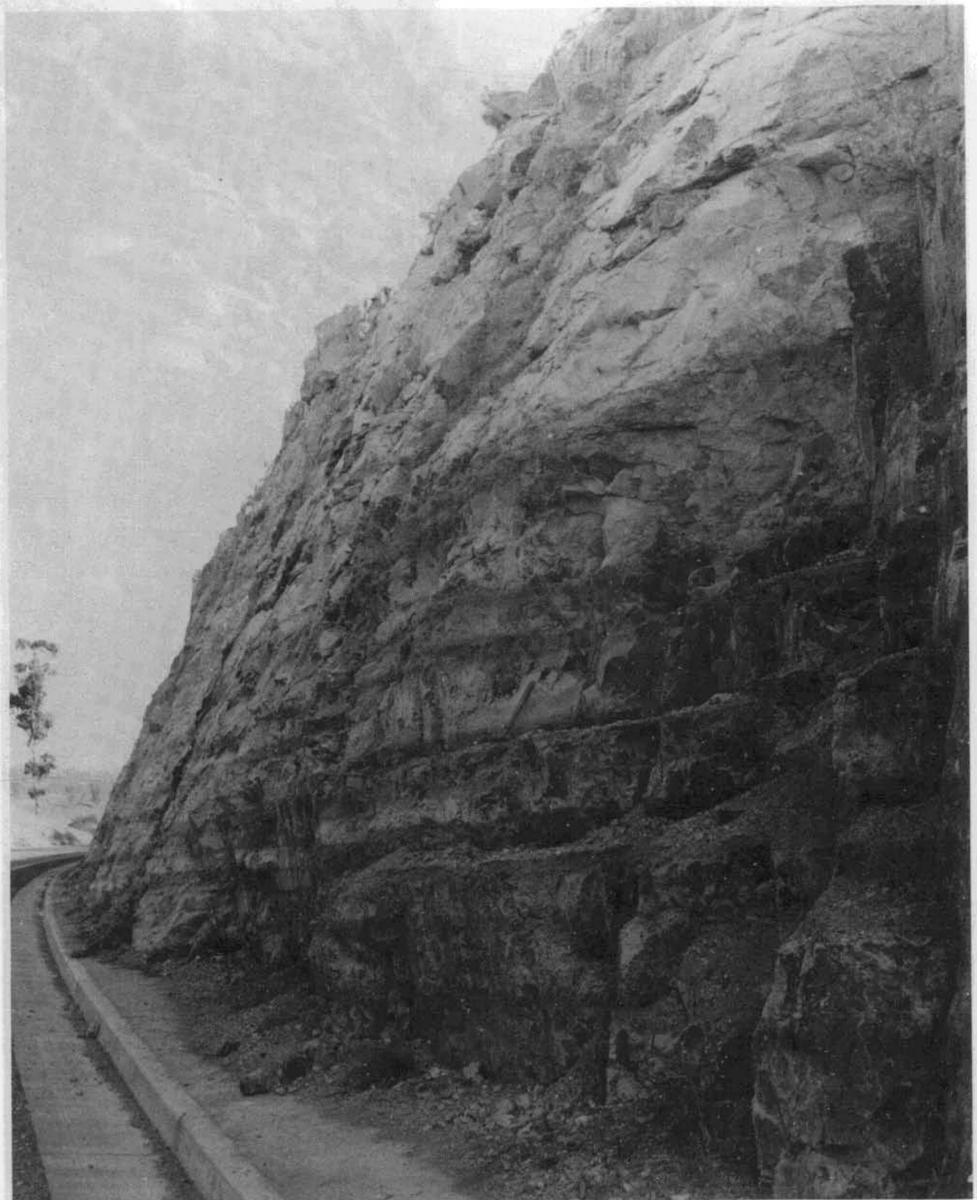

Plate 19. *Tunnel Hill cutting. Vertical joints in Permian sediments.*

Plate 20. *Tunnel Hill cutting. Blocky appearance of the Permian outcrop due to vertical jointing and gently dipping bedding.*

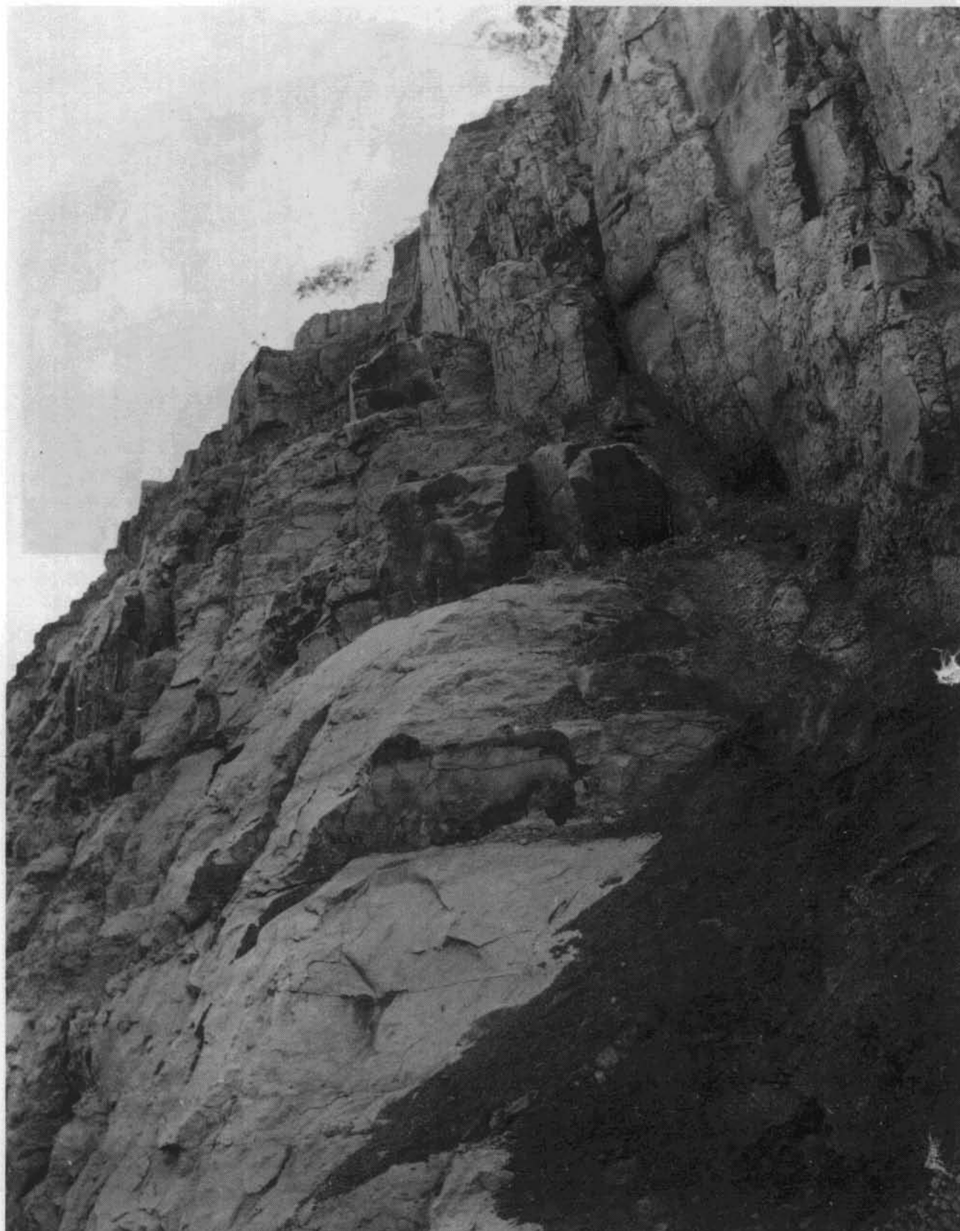

Plate 21. *Tunnel Hill cutting. Clay removed from bedding planes and joints.*

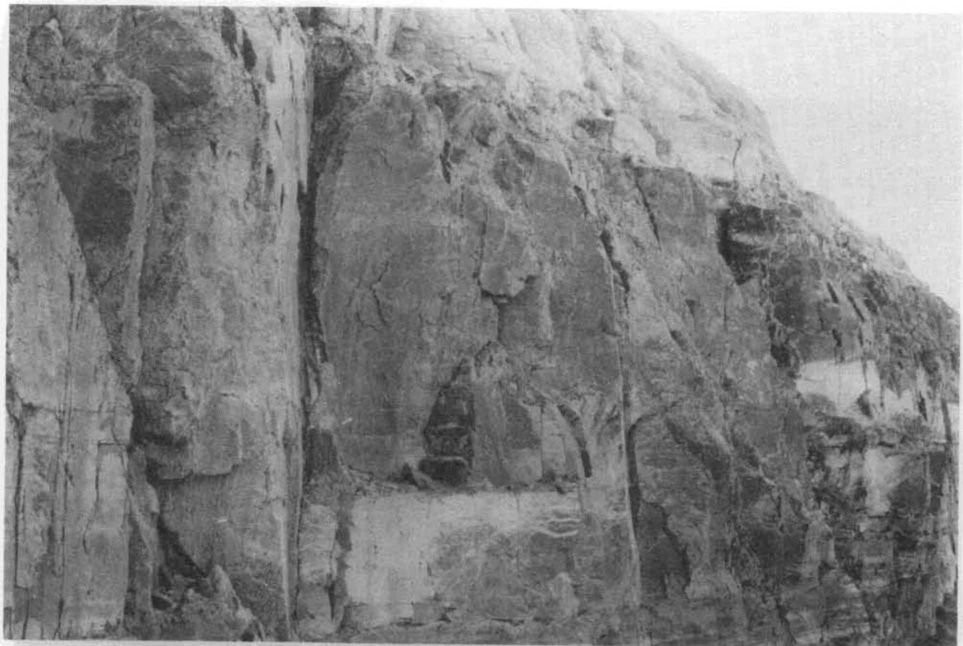

Plate 22. *Tunnel Hill cutting. Opening of vertical joints.*

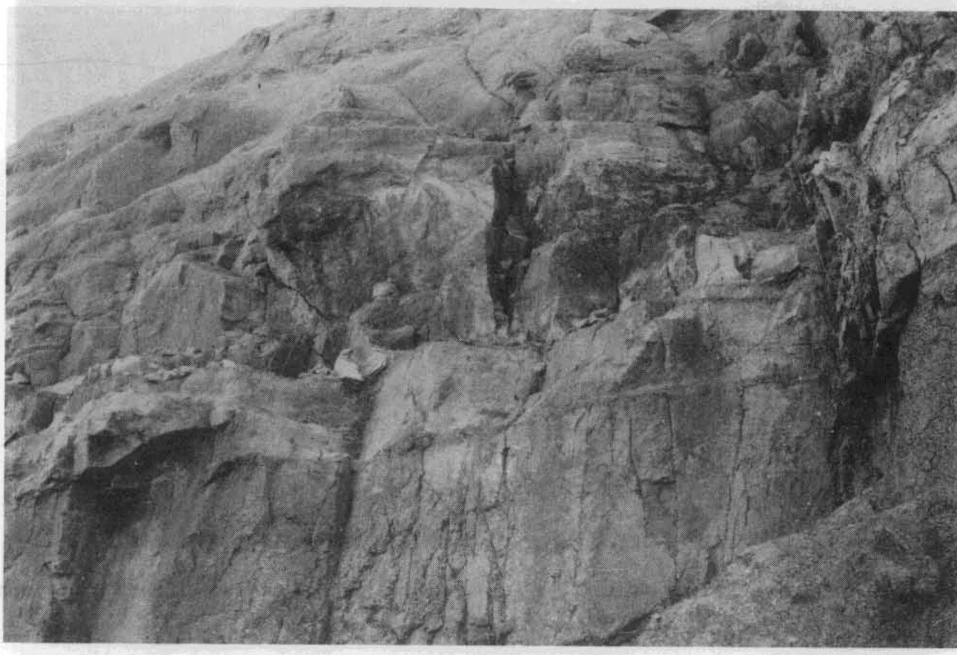

Plate 23. *Tunnel Hill cutting. Opening of vertical joints.*

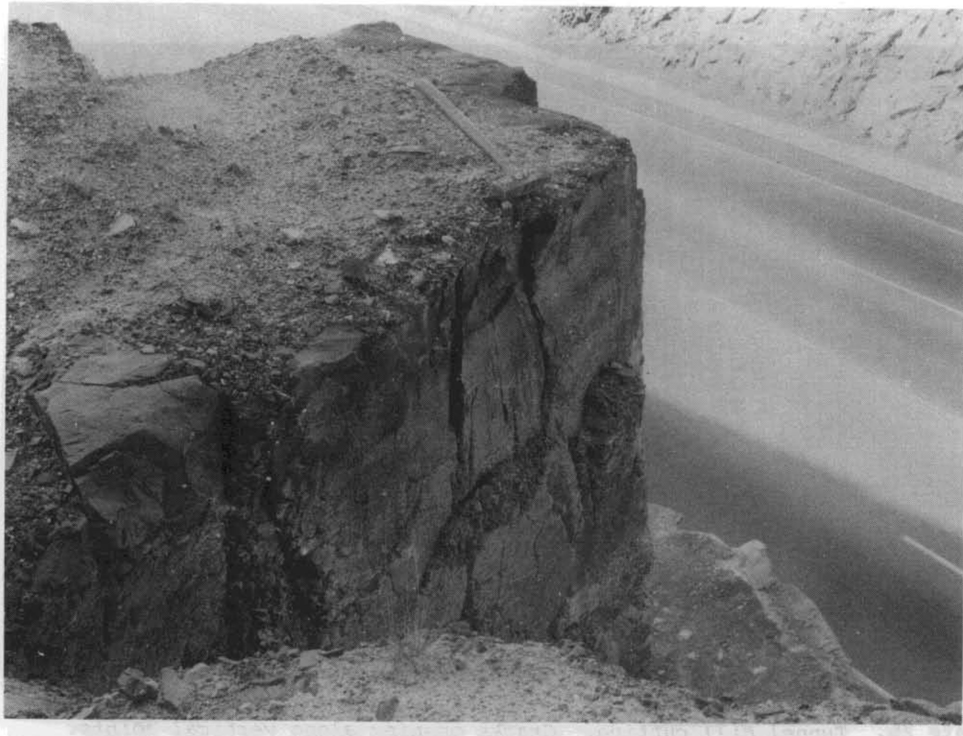

Plate 24. *Tunnel Hill cutting. Vertical joints opening due to load relaxation.*

Plate 25. *Tunnel Hill cutting. Movement of blocks due to freeze and thaw.*

Plate 26. *Tunnel Hill cutting. Cracks opening along vertical joints.*

Plate 27. *Tunnel Hill cutting. Freeze and thaw and washing out of clay along vertical joints. Note old drill hole.*

Plate 28. *Tunnel Hill cutting. Eroding away of existing rock bench. Water and clay lying at the foot of the bench face.*

Plate 29. *Tunnel Hill cutting. Part of bench which has dropped along vertical joints.*

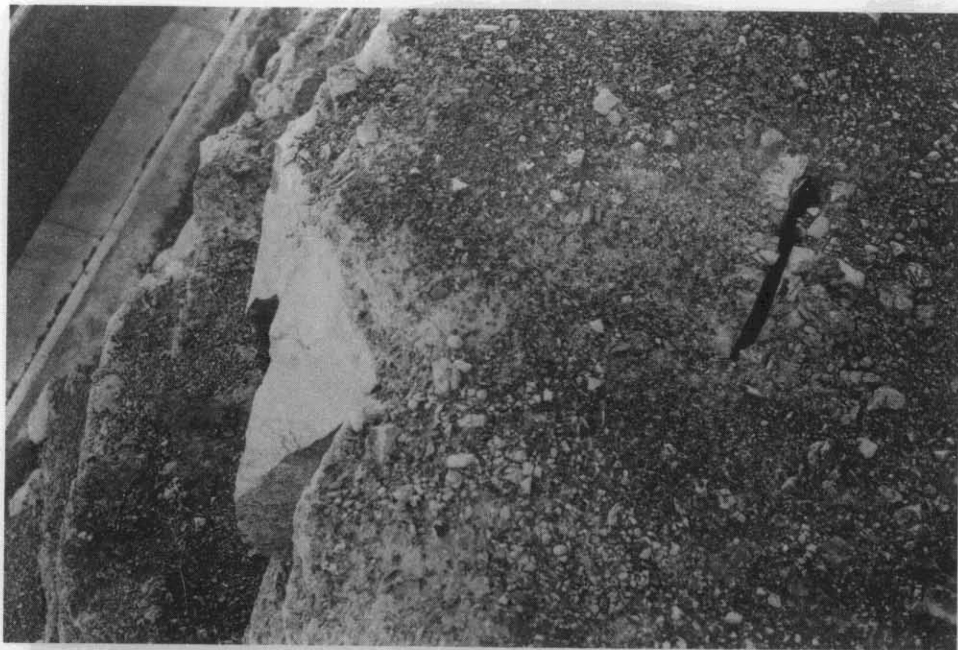

Plate 30. *Tunnel Hill cutting. Crack opening along vertical joints on the bench.*

Plate 31. *Tunnel Hill cutting. Perched block on the upper bench face.*

Plate 32. *Tunnel Hill cutting. Perched block now fallen onto the lower bench: note water lying on bench.*