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24. Land stability at Boat Harbour Beach.

W.L. Matthews

The main part of Boat Harbour Beach settlement is situated on slopes between the sea and a dissected basalt plateau which rises to about 122 m above sea level. Slopes of 25°-30° between the shoreline and the top of the plateau are common. Small areas of flat land occur in the western part of the settlement and a narrow flat occurs along the shoreline to the west of this.

GEOLOGY

The geology of the area has been mapped and described by Gee (1966, 1971). Basement rocks at Boat Harbour Beach are the Precambrian Rocky Cape Group and along the foreshore they consist mainly of quartzite with thin siltstone beds at some locations. Quartz veining is a common feature. An area of siltstone occurs west of the main settlement on the slopes up to the basalt plateau. The Precambrian rocks are folded and at some locations west of the settlement, folding is fairly intense. Gee (1966) mapped an E-W wrench fault passing through the northern section of the beach, with a possible lateral movement of about 8 m. The contorted beds near this fault are probably a result of this movement.

During the Tertiary, basalt flowed over and sediments were deposited on an irregular land surface. Most of the settlement is situated between two ridges of Precambrian rocks which rise almost to the level of the plateau.

In the area between the two ridges Tertiary basalt and sediments occur from sea level to the top of the plateau. The topographic high of the Precambrian rocks extends to the west for some distance except for a possible local low point just west of the settlement. East of the eastern basement ridge, Tertiary rocks extend down to sea level for several kilometres.

The basalt is deeply weathered and most of the slopes are covered with talus derived from this weathering. Occasionally small areas of unweathered and apparently *in situ* basalt occurs on these slopes.

Tertiary sediments interbedded with the basalt and on top of basement rocks, can be seen at some locations. These can only be traced laterally for short distances because of talus cover. West of the settlement quartzite is exposed overlying Precambrian rocks in one area and in another area it is topographically higher than a small basalt outcrop. Quartzite and quartz gravel with a limonite cement, about 60 m above sea level, is exposed in the heel of a large recent slip, the movement of which affected several shacks in the area. This exposure is probably not *in situ* as a further large slip occurs behind it. Around the eastern Precambrian ridge are areas of breccia, which were probably scree deposits on slopes which were later covered by basalt flows and became indurated by solutions associated with the volcanism. Boulder beds consisting of basalt and quartzite boulders, at least 3 m in thickness and overlain by a basalt flow are exposed just above sea level about one kilometre east of the post office. About 500 m further eastward, basalt can be seen overlying clay sediments at sea level. The position and nature of some of these Tertiary sediments indicates more than one flow of basalt in the area.

DISCUSSION OF LAND STABILITY

Various aspects of the stability of the area have been examined in the past. Jennings (1965) investigated landslips affecting the access road to the settlement and Matthews (1968*a*, 1968*b*) examined the stability of two small areas in the region.

An inspection of the area around Boat Harbour Beach settlement indicates that instability has been very pronounced in the past and is still a continuing feature of the present time. Many of the slips are shown in Figure 32 with the recently active slips also indicated. Some of the slips, particularly the older ones, are deep seated and of a rotational nature with areas of internal drainage in front of the heel. Others are elongated talus slips which are probably shallow.

The slips appear to be confined to the Tertiary basalt which tends to be deeply weathered. The basalt is also much more permeable than the Precambrian rocks, allowing the ready movement of groundwater through the areas underlain by basalt. The result of this can be seen along the foreshore where numerous seepages from the talus slopes behind the shoreline run into the sea. The estimated flow of many of these seepages is about 30 *l*/m and a few have flows estimated at about ten times this amount. These seepages were examined after an extended dry period and would be expected to flow more strongly after winter rains. The presence of the two basement ridges aids in directing underground drainage towards the Tertiary materials between them. The seepages on the slopes are used as a water supply by many residents.

The access road extends diagonally across an area that has been subject to movement for a long period of time. A section of road about 128 m long is said to have subsided about one metre in the last year and the Wynyard Council has recommended that it not be sealed as the movement is expected to continue (Wynyard Council Technical Officer, pers. comm.). A large area was affected by a landslide in 1969 which resulted in damage to 10 shacks and a part of the road (Technical Officer, pers. comm.). Other movements have occurred recently but have not affected buildings or roads. Because of the continued movement in the eastern part of the settlement, the Wynyard Council has restricted development in this area.

The presence of deeply weathered basalt and accumulations of talus on steep slopes, associated with widespread seepages on these slopes, has resulted in the landslips developing. If there are clay sediments interbedded with the basalt flows then these would also contribute to landslips. Movement is likely to be a continuing feature of the area and little can be done to prevent it. Certain preventive measures could be attempted such as:

(1) draining of areas of internal drainage;
(2) draining areas where seepages appear on the surface with surface drains, rather than allowing the water to percolate underground again;
(3) disallowing excavation around the slopes, in particular in the toe area of old slips.

All these measures could have a delaying effect on the land movement but it is not expected that they would be a permanent solution.

Areas where further movement can be expected are indicated on Figure 32. The upper basalt-talus boundary is marked at the top of the scarp. In addition to the area marked, a zone inland from this line, taking in part of the plateau, must be considered as potentially unstable. With removal of support by slips occurring downslope, new slips can be expected to develop further up the scarp and involve part of the plateau. Depending on the location, a distance of about 45 m from the edge of the scarp would probably be a safe distance from the scarp if any development is considered near the plateau edge.

A large proportion of the central part of the settlement appears to be built on debris from a large slip to the south. The slip would have been promoted to some degree by the probably steep contact between the basalt and basement rocks. It is difficult to locate the boundary between the debris and the *in situ* basalt that occurs along the foreshore. Where there are relatively low angle slopes there is little risk of instability developing in this debris, but there are zones, marked in Figure 32, where slopes of up to 15° occur. Excavations around the sides of these slopes should be kept to a minimum and any seepages should be drained if any further development takes place.

The steep slopes facing the sea, east of the area shown in Figure 32 were examined briefly for a distance of about 500 m. It was noted that landslips are also common along this section of coastline and no doubt this feature continues even further to the east. It is considered unlikely that development could be safely undertaken in these areas.

The safest area for further development is the area just west of the settlement where the land is underlain by Precambrian rocks, Tertiary basalt and quartzite boulders. It is not known whether the Tertiary material is weathered *in situ* material or whether it is an accumulation of debris from the plateau, but the slopes are low and there is little danger of unstable conditions developing.

It is apparent that repairs to the access road are going to be a continuing expense as a considerable length of road crosses unstable and potentially unstable land. Jennings (1965) suggested that some study should be made on alternative routes. As the Precambrian rocks do not appear to be involved in the slips, a suitable access should occur where the topographic highs in the basement reach almost to plateau level. In the vicinity of the settlement, the slopes of the Precambrian ridges are very steep and road construction would be difficult. Point A (fig. 32), west of the settlement, could well be a favourable area for road construction from the plateau to the shoreline, as the slopes are underlain by Precambrian rocks and are at a relatively low angle. Other suitable points for an access road probably occur further to the west.

CONCLUSIONS

Large areas of the slopes around Boat Harbour Beach are unstable or potentially unstable and there is considerable risk in undertaking any development of these areas. The areas considered to be at risk are shown in Figure 32. In addition, a zone along the edge of the plateau should be regarded as potentially unstable.

Any remedial measures taken are likely to have only a temporary effect in most cases.

Care should be exercised to see that excavations are kept to a minimum and seepages be drained around the centre of the settlement or any other areas where development takes place in steep land underlain by Tertiary rocks.

The safest area for future development appears to be west of the main settlement where there is a narrow strip of relatively flat land.

Alternative access routes should be examined and a possible area for a road from the plateau to the shoreline is suggested.

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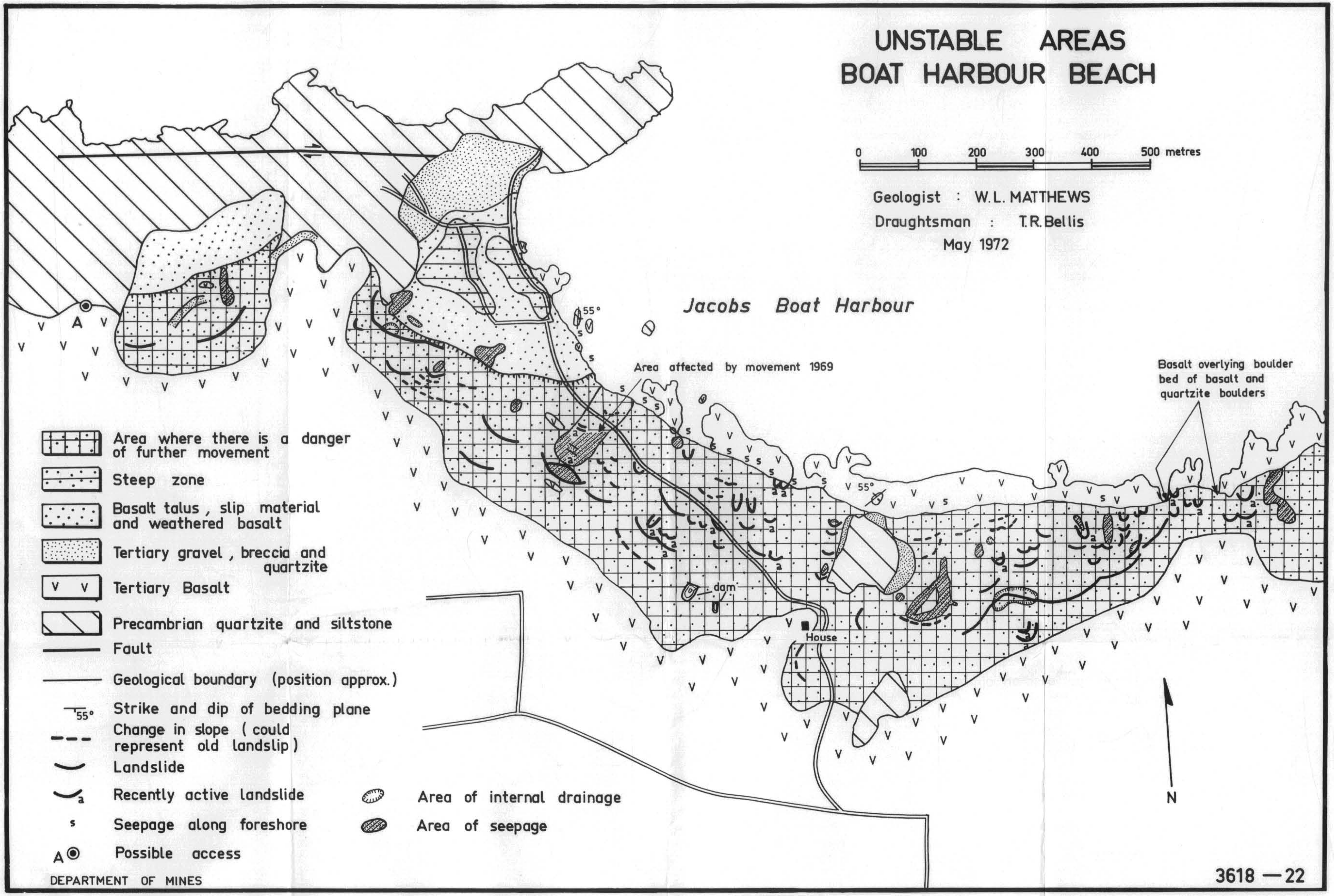

Figure 32.

5 cm