Ground stability

Landslides and tourist development

The slow slide of eastern Barbados into the sea

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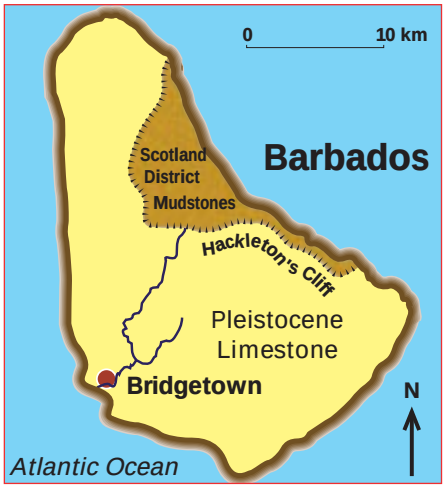

Sketch map of Barbados; the Scotland District in the east of the island is the area most affected by landslides.

The island of Barbados is geologically divisible into two distinct parts. Most of the island is underlain by a Pleistocene limestone cap on average 70 metres thick, but a sector of the east coast (the Scotland District) is largely devoid of this cover and is underlain by structurally complex Tertiary turbidites and oceanic bedded and diapiric mudstones. The island has an asymmetric E–W cross-section, with a steeper eastern side rising to a height of 330 metres and a much gentler western slope. The trade winds blow continuously on to the east coast but the west coast lies in the lee. In 1997–98 Sir William Halcrow and Partners carried out a coastal zone management study of the eastern coast for the Barbados Government, and the BGS provided geological input to this project. Professor Robert Speed of Northwestern University, Illinois carried out most of the onshore mapping. Tourist development on the island is concentrated on the sheltered, gentler-sloping south and west coast, and this project addressed the potential for tourist development of the eastern coast. Of specific interest were the geological hazards which might have constrained development along this coast.

Barbados is part of a forearc high lying about 170 kilometres west of the oceanic trench that marks the position of the Atlantic plate subducting under the Caribbean Plate. The subduction has caused the island to rise; evidence from the Pleistocene limestones suggest that this uplift has gone on for at least the past 300 thousand years and continues to this day. Present uplift of the central part of the island is estimated at about 1.13 to 1.6 metres per 1000 years.

Initially the Pleistocene limestone cap covered the whole island but, as uplift proceeded, the cap covering the eastern steeper slopes of the island fractured and slid downslope. The landsliding was most active where mudstones underlay the limestone and the slip planes lay just below the interface. The process is continuing and Hackleton's Cliff (see map) marks the back scar of the landslide area.

Geological mapping of the Scotland District by Professor Speed identified individual slides with downslope lengths of up to 1000 metres and thicknesses of about 40 metres. Motion of the landslides varies from creep, identified from undulations in those road surfaces, to singular and rapid flows. The latter are rare but events in historic times have moved sheets measuring up to 120 thousand square metres. The process has been facilitated by high rainfall and rapid flow of surface water down through the limestone cap but uncertainty remains about the sliding mechanism.Damage to the road system is extensive and dwellings are locally affected.

Steep cliffs of Pleistocene limestone form the coast. The high wave energy along this coast and low tidal range erode deep wave cut notches, leading to undercutting and ultimately collapse of the cliff.

The limestone cap rocks move as individual blocks or sheets down the steep slope towards the sea, where wave erosion removes the mud matrix and finer limestone debris to leave behind large blocks such as those common along the foreshore south of Bathsheba.

Outside the Scotland District, steep cliffs of Pleistocene limestone form the east coast. The high wave energy along this coast and low tidal range erode deep wave-cut notches leading to undercutting and, ultimately, collapse of the cliff. The process is sporadic and collapse occurs in sections up to tens of metres long and a few metres deep. The precise form of the collapse depends on the strength and diagenesis of the limestone. Understanding the processes leading to cliff failure is important in assessing risk at the coast but this analysis has yet to be carried out.

An understanding of the process and location of landsliding across the area is essential before the infrastructure necessary for tourist development can be put in place. In addition, the dangers presented by landsliding must be assessed along with the hazard presented to tourists by collapse of the coastal cliffs.