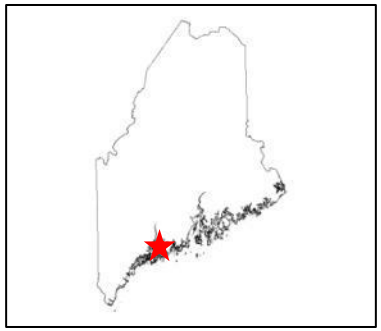
Maine Geologic Facts and Localities

December, 2004

Coastal Landslide with Outrunner Blocks Bunganuc Bluff



43° 51‘ 35.63“ N, 70° 0‘ 50.48“ W

Text by
Thomas K. Weddle and Henry N. Berry IV

Introduction

In late March of 1997, staff at the Maine Geological Survey received a telephone call from a concerned homeowner in the coastal area in Brunswick, Maine, known as Bunganuc. The homeowner reported that a few days earlier, a landslide (Figure 1) occurred on his property at the edge of the coastal bluffs of glacial marine deposits exposed there.

Figure 1. Photo of Bunganuc Bluff, 1997; landslide scarp is near the center of the bluff below house in background. The top of the bluff is approximately 40 feet above the mudflat.

Bunganuc Bluff

Figure 2. (Left) Close-up of slump in 1997. (Right) November 2004 photo. Old 1997 landslide scarp is just to the left of the most prominent part of the bluff in the center of the photo (dead trees at base). Note light gray mud at base of scarp lying on the mudflat; this is a remnant of a small slump that occurred fairly recently, and is now being reworked by tidal and wave activity.

Bunganuc Bluff

Several months earlier, a geologist from the Survey had been to the bluff and noted that a new home was under construction, and he left a business card with a worker as a courtesy to the owner, who then called the Survey, inquiring about the possibility of a slide occurring. A discussion followed, the owner wanting to know more about landslides, and what might be done to prevent them. He was aware that they do occur in the Bunganuc area, and it had been just a year earlier that a large landslide took down two homes in Rockland.

Photo by Thomas K. Weddle and John Poisson

Photo by Thomas K. Weddle

Figure 3. (Left) Photo from 1997 of house above landslide scarp (head of scarp is visible in right of photo). (Right) Photo from 2004. The fresh exposures of clay along the base of the bluff indicate that the bluff is still being gradually eroded at high tide. Erosion at the foot of the bluff steepens the bluff slope and will eventually lead to another landslide.

Bunganuc Bluff

However, he felt that with enough shore frontage, he was willing to take the risk of building in a landslide-prone area. Following the slide in March, the owner's home measured approximately 100 feet from the edge of the landslide head scarp (Figures 3 - 4), and he thought it was important to contact the Survey.

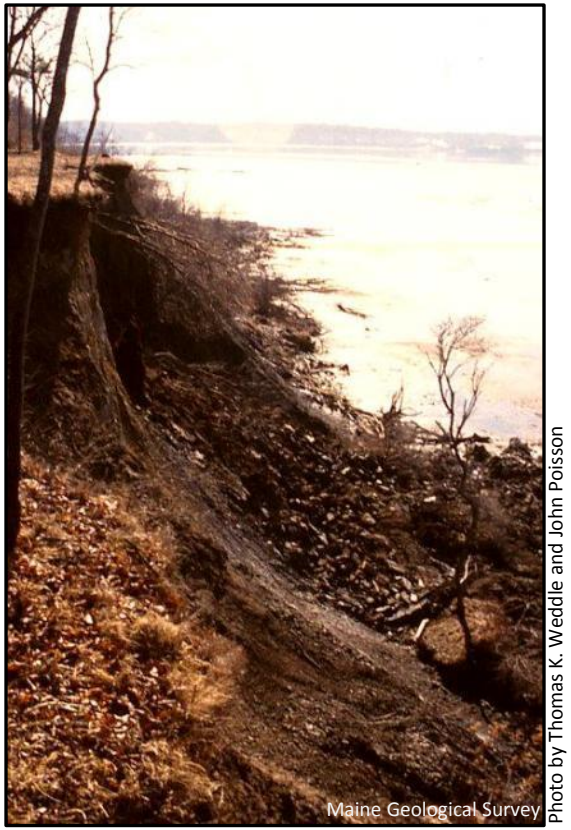


Figure 4. Photo of head of scarp, 1997.

Landslide Hazards

The Maine Geological Survey has published a series of Coastal Landslide Hazards Maps that covers most of Maine's coastal bluffs. The Bunganuc area is shown on the Coastal Landslide Hazard Map of the Freeport quadrangle to be a location of known or interpreted landslides (Figure 5).

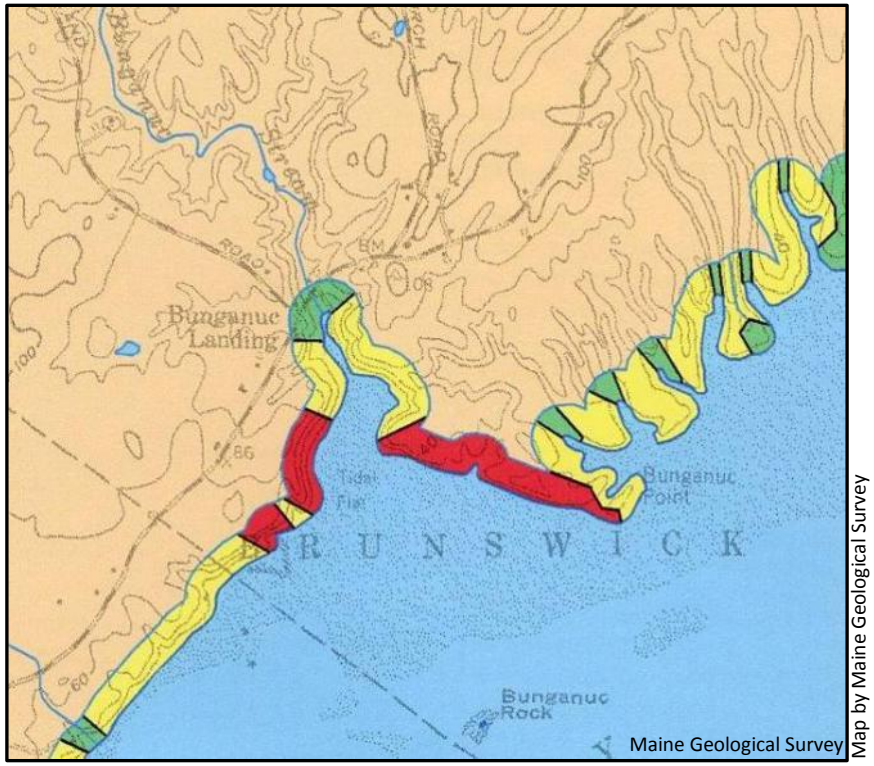


Figure 5. Bunganuc area as shown on part of the Coastal Landslide Hazard Map of the Freeport quadrangle. Red indicates areas of known or interpreted landslides. Areas colored yellow are potential landslide areas; green colored areas are low coastal bluffs generally not at risk of landslides (Refer to map explanation pdf for more details).

Landslide at Bunganuc Bluff in 1952

Moreover, landslides in the area were documented in reports as early as March 1952 (Figure 6) in the Report of the State Geologist 1951-1952. Slides at the bluffs have been known by local people well before the early 1950's. The mudflat, exposed during low tide, is a prime clam and worm-digging locale. The source of the mudflat is the glacial marine clay found in the bluff; it is eroded by the landslide process and is distributed to the mudflat by tidal cycles and wave processes.

Figure 6. View of the bare brown marine clay bank at Bunganuc Shore.

Landslide at Bunganuc Bluff in 1952

All three of these 1953 archival photos (Figures 6-7) show the bluff where the March 1997 slide occurred. Notice the lack of trees at the top of the bluff, and no visible homes. Residential development in this location has been relatively recent, starting after 1980.

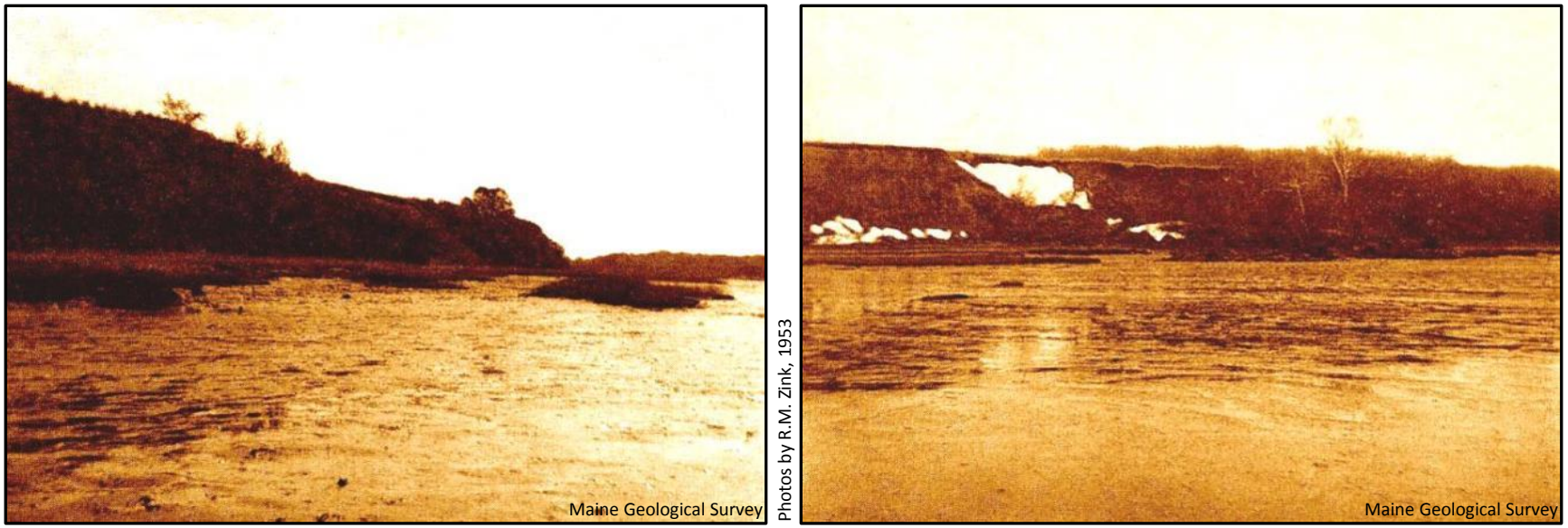


Figure 7. (Left) View of Bunganuc Shore showing how the shoreline looked before the landslide occurred. (Right) View of the landslide that took place on March 21, 1952. Notice the pocket of snow in the cuplike depression left by the landslide. The overall shape is similar to that of the 1997 landslide.

Maps of Bunganuc Bluff

The slide of March 1997 is interesting because of how far from the bluff face some of the blocks slid. Figure 8 is a map of the various landslide features including the "outrunner" blocks, the farthest of which traveled 183 feet from the base of the bluff. Grass and trees indicate that some blocks were at the top of the bluff before the slide. Bedding in the displaced blocks is tilted generally back toward the bluff, as illustrated by the map symbols. This backward tilt is typical of a rotational slump in which the slope failure occurs on curved planes behind the bluff face. The higher blocks move down on nearly vertical surfaces, and the weak clay at the base of the bluff is forced outward laterally onto the tidal flat.

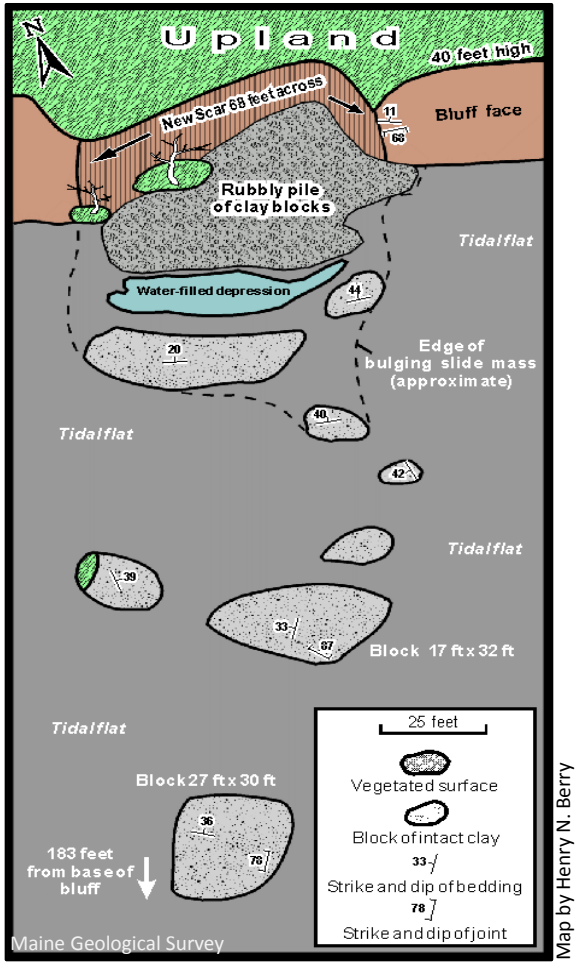


Figure 8. Map (drawn to scale) of the landslide at Bunganuc Bluff. See Figure 9 for a cross-section.

Maps of Bunganuc Bluff

Figure 9 is a cross-section perspective showing the same features viewed from the side. The initial blocks that slumped from the bluff were propelled seaward along the slick mudflat surface by a combination of their initial momentum and sliding on a gentle slope with very low friction. An important aspect of rotational slumps, common in high clay bluffs such as this, is that failure occurs on a curved slip surface at depth because the clay is not strong enough to support the overlying weight. Comparison of the bluff before (dashed line) and after the slump shows that the base of the bluff has moved forward and the top of the bluff has moved back, effectively reducing the slope angle to a more stable configuration.

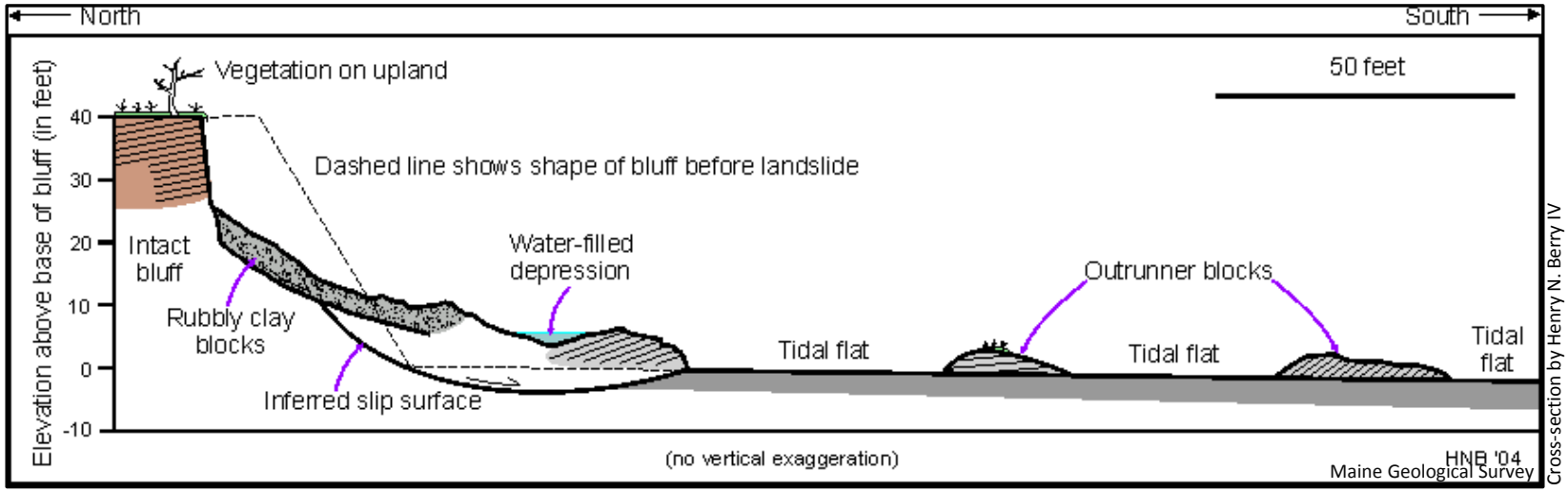


Figure 9. Cross-section of the March 1997 landslide, drawn through middle of the map in Figure 5. The upland is to the left, and the outrunner blocks traveled toward the right. The ruled lines in the intact bluff represent clay layers (beds) that are tilted slightly to the north. Similar ruling in transported blocks shows that they have rotated by various amounts during the landslide movement as measured at the site.

Views of Bunganuc Bluff

The series of photos below shows the landslide scarp, the large mass of slide debris at the base of the bluff, and the outrunner blocks. These photos were all taken in March 1997.

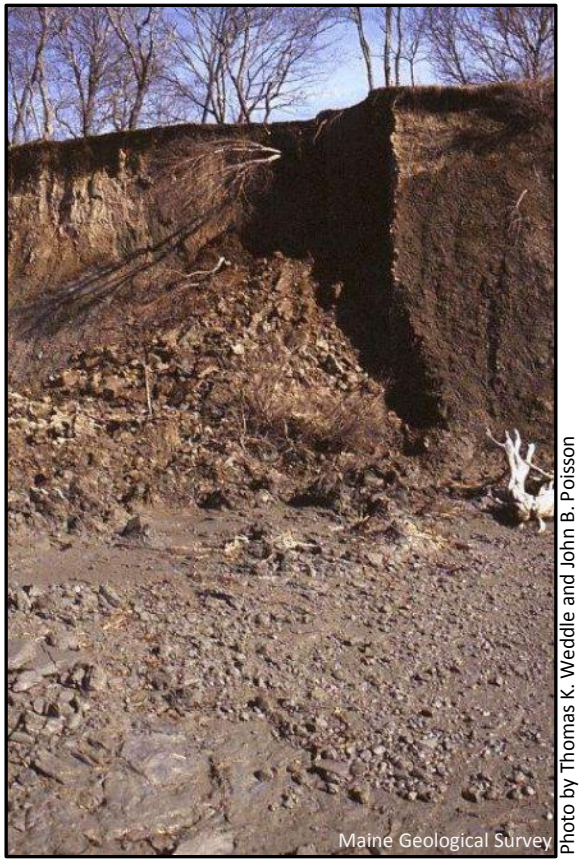


Figure 10. View facing the bluff with exposure of the vertical landslide scarp; note blocky and rubbly debris at the base of the bluff and the sharp sidewall.

Views of Bunganuc Bluff

Figure 11. Maine Geological Survey staff examining landslide scarp. Thin layering (bedding) in the fine-grained glacial marine deposit is exposed in the undisturbed bluff face to the right of the geologists. About half way up the section from the base, a white layer of fine sand is visible.

Views of Bunganuc Bluff

Figure 12. View from top of the bluff looking seaward. Note rubbly debris near base of bluff and detached outrunner blocks farther seaward. Of the three farthest-traveled blocks, the one on the right has vegetation on its surface indicating that it started at the top of the bluff and slid to its position on the mudflat.

Views of Bunganuc Bluff

Photos by Thomas K. Weddle and John B. Poisson

Figure 13. (Left) Mudflat view looking west, perpendicular to the sliding direction of the landslide. (Right) Seaward view from base of rubbly and blocky debris.

Views of Bunganuc Bluff

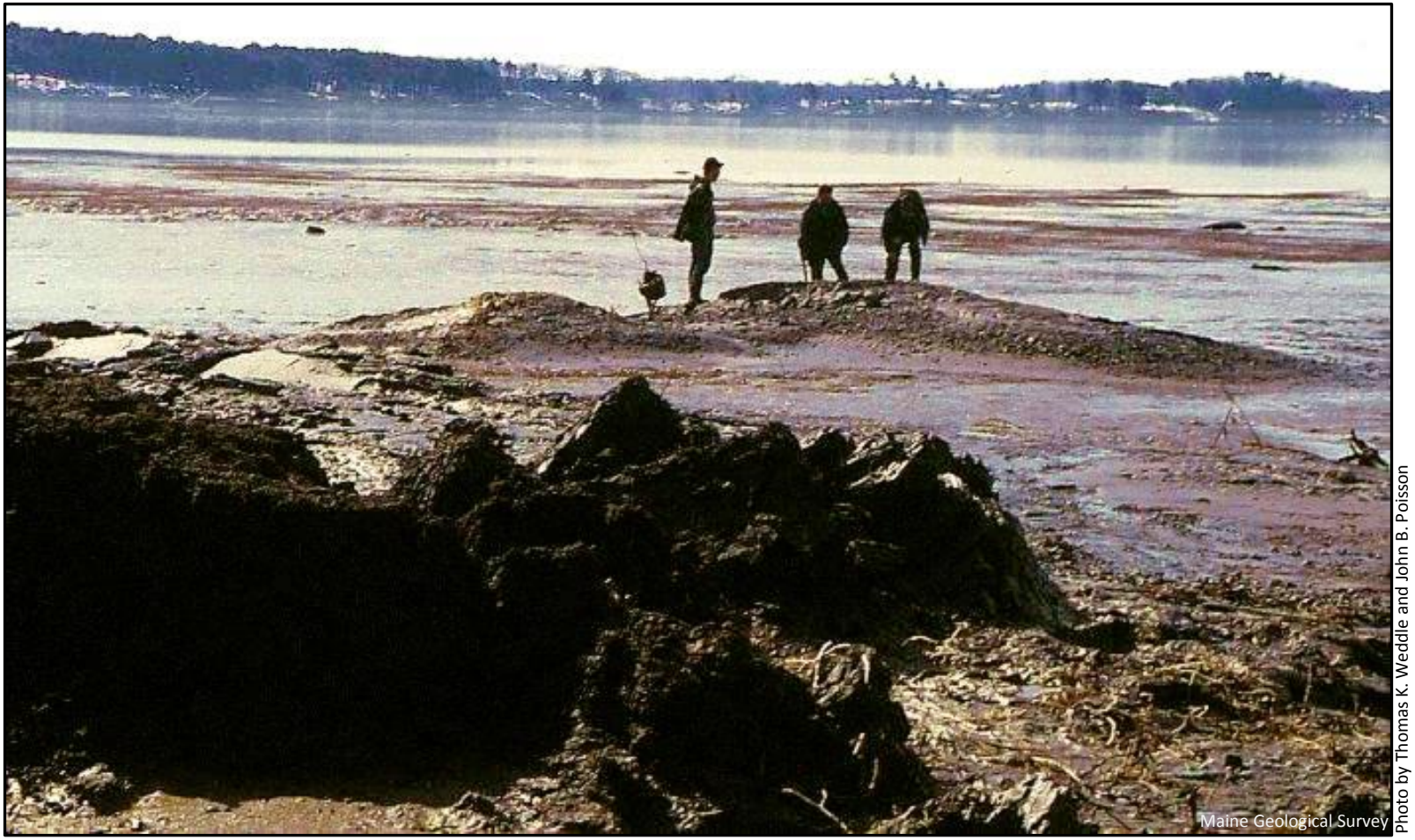


Figure 14. Maine Geological Survey staff examine detached distal landslide block.

Views of Bunganuc Bluff

Photos by Thomas K. Weddle and John B. Poisson

Figure 15. Close-ups of detached block. The original bedding in the deposit is represented by the light- and dark-colored layers parallel to the shovel handle. The dark features on the block surface are fractures in the block, nearly perpendicular to the bedding. Some of the fractures are filled with muddy debris, including mud and small, broken clay fragments (right-hand photo). Notice that the bedding in the smaller block in the background has a different orientation from that in the larger foreground block, demonstrating that the two blocks moved independently.

References and Additional Information

Coastal Landslide Hazards Maps (Scale 1:24,000) These color maps show locations of known landslides and areas of potential landslide hazard on bluffs along the Maine coast. The explanation describes factors influencing landslide risk.

Coastal Bluff Maps (Scale 1:24,000) These color maps show the shoreline type and relative stability of bluffs along the Maine coast. The slope, shape, and amount of vegetation covering a coastal bluff and the adjacent shoreline are directly related to the susceptibility of the bluff face to ongoing erosion.

The April 1996 Rockland Landslide, by H.N. Berry IV, S.M. Dickson, J. T. Kelley, D.B. Locke, R.G. Marvinney, W.B. Thompson, T.K. Weddle, R.T. Reynolds, and D.F. Belknap, 1996, 55 p., 13 figs., 3 appendixes. (Catalog No. 96-18)

Stability of Natural Slopes in the Presumpscot Formation, by S.C. Devin and T.C. Sandford, 1990, 75 p., 17 figs., 5 tables, 5 apps. (Catalog No. 90-24)

Mineralogy and Pore Water Chemistry of Presumpscot Clays, by L.M. Mayer, 1990, 3 p., 1 table. (Catalog No. 90-23)

Air Photo Reconnaissance of Slope Failures in the Presumpscot Formation, Cumberland County, Maine, by I.D. Novak, 1990, 4 p., 1 fig., 1 table, map (1:50,000). (Catalog No. 90-22)

Landslides in the Presumpscot Formation: An Engineering Study,by J. Amos and T.C. Sandford, 1987, 68 p., 22 figs., 7 tables, 3 apps. (Catalog No. 87-4)

Inventory and Bibliography of Maine Landslides, by I.D. Novak, 1987, 27 p., 2 figs., 3 tables, 1 app., map (1:500,000). (Catalog No. 87-3)

Living with the Coast of Maine, by J.T. Kelley, A. R. Kelley, and O. H. Pilkey, Sr., 1989, 174 p., 118 figs., 3 app. (Catalog No. COAST)