



Figure IV-2-21. A section of cliff, projecting out from the shore, is likely to collapse soon. To the left, rubble at sea level marks the location of a previous slump. The lower cliffs are poorly cemented conglomerate while the higher, vertical cliffs (above the trees), are limestone (near Nauplió, Greece, April 1992)

at water's edge, often housing periwinkles and other animals, may have been caused by biochemical leaching.

(5) Salt weathering is caused by the pressure exerted by NaCl and other salts in the capillaries of rocks. The weathering is caused by:

- (a) Changes of volume induced by hydration.
- (b) Expansion of salt crystals caused by temperature changes.
- (c) Crystal growth from solution.

The main factor in determining the efficacy of chemical weathering is the amount of water available for chemical reactions and the removal of soluble products. This suggests, but does not necessarily restrict, that the greatest chemical weathering will occur in hot, humid climates (Trenhaile 1987).

IV-2-9. Marine Deposition Coasts - Barriers

a. Introduction.

(1) Barriers are narrow, elongate sand ridges rising slightly above the high tide level and extending generally parallel with the coast, but separated from the mainland by a lagoon or marsh (Bates and Jackson



Figure IV-2-22. Lake Michigan shore south of St. Joseph, Michigan (November 1993). A triangle-shaped wedge of the bluff has recently slumped. The bluffs in this area have suffered rapid retreat, and many homes have been destroyed. At least three factors account for the erosion: (a) offshore downcutting of the till lake bottom; (b) wave attack on the bluffs; (c) ice expansion and lubrication of bedding planes caused by groundwater

1984). The term *barrier* identifies the sand ridges as ones that protect parts of the coast from direct wave attack of the open ocean. In this manual, barrier will refer to the overall structure (sometimes called a barrier complex), which includes the beach, submerged nearshore features, underlying sediments, and the lagoon between the barrier and the mainland (Figure IV-2-24). Inlets and channels can also be considered part of a barrier system.

(2) The term *beach* is sometimes used as a synonym for barrier, but this can lead to confusion because a beach is a geomorphic shore type found throughout the world, even on volcanic or coralline coastlines where barriers are rare. Whereas all barriers include beaches, not all beaches are barriers.

(3) The following sections describe general barrier island morphology, history, and formation, subjects that have fascinated geologists for more than 100 years. The emphasis will be on long-term changes, covering periods of years or centuries. The purpose is to explain factors that lead to barrier migration or evolution. Longshore sediment transport, details on the morphology of sandy shorefaces, and the normal effects of waves and tides will be covered in Part IV-3, "Coastal Morphodynamics." This distinction is arbitrary because, clearly, the day-to-day processes that affect beaches also influence barrier development. In addition, the evolution of barriers during the Holocene Epoch is intimately related to sea level changes (see Part IV-1). These factors underscore the complex interrelationships that exist throughout the coastal zone and the difficulty of separating the constituent elements.



Figure IV-2-23. Cemented conglomerate with many pits and cavities shows evidence of dissolution. The rock mass has been undercut over 1 m (near Nauplió, Greece). Note that the conglomerate is distinctly graded, with fine grains near the bottom and cobble near the top