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# BEACHROCK

by K. O. Emery

Beachrock occurs around many islands of the Atlantic, Pacific, and Indian Oceans and even on the shores of some of the large lakes of the western United States. At Bikini Atoll, in the Marshall Islands, it covers perhaps 15 percent of the beach area, exhibiting no marked preference for seaward or lagoonward sides. It is practically restricted to the intertidal zone. Except for cementing calcite, it is the same in composition as the loose beach material that adjoins or overlies it: corals, Foraminifera, echinoid spines, shells, and calcareous algae. Usually, the grain size is also similar to that of the beach material, and, just as in the beach, the sand grains in the beachrock form alternating coarse and fine-grained laminae from 1/16 to 1 inch thick. These laminae, as well as the surface of the beachrock, have, in places, the same slope toward the water as does the surface of the loose beach sand; where the beaches are of cobbles, the beachrock is apt to exhibit a similar composition.

In some areas the beachrock is collected and used as flagstones, building stones, and grave markers. It may form discontinuously, but certainly some of it in Kwajalein Atoll is of very recent origin, because of the inclusion of a Coca Cola bottle, shell cases, and other wartime debris.

Although there are numerous published references to the presence of beachrock, little is known of the mechanics of its formation. One theory requires humic acids carried by rainwater to dissolve calcium carbonate from the interior of islands and to deposit it again when the water seeps out through the beach. Another relates it to unknown biochemical processes. A few physical-chemical measurements made in a loose sand beach at Bikini showed that the interstitial sea water a few feet below the surface was acid enough to dissolve calcium carbonate, whereas that near the surface was alkaline enough to cause precipitation. Upward capillary movement of interstitial water is known to exist from studies of other beaches. It is supposed that the water-bearing calcium bicarbonate in solution rises close to the surface, where the higher pH, higher daytime temperature, and high evaporation cause loss of carbon dioxide [$CO_2$] and precipitation of calcium carbonate as cement. The accuracy of this theory is not yet known; it is hoped that more data can be secured in other investigations. Measurements of $CO_2$, alkalinity, pH, temperature, chlorinity, and calcium ion should be made on interstitial beach water at several depths over a 24-hour period to test this suggestion. Methods for some of these analyses are given by Doax Cox in connection with studies of ground water (see Chapter 4). Moreover, an attempt should be made to observe, if possible, an area where beachrock is being actively formed. Perhaps this would be indicated by weak incipient cementation.

Once deposited, the beachrock soon begins to be destroyed. Abrasion wears and polishes it to a shiny surface, often with flutings, and it also develops deep cylindrical pot holes. Wave action undermines it. Solution by sea water, charged with $CO_2$ from respiration of animals and plants at night dissolves some of the beachrock, forming shallow flat-bottomed solution basins that eventually join and deepen to develop a jagged surface.