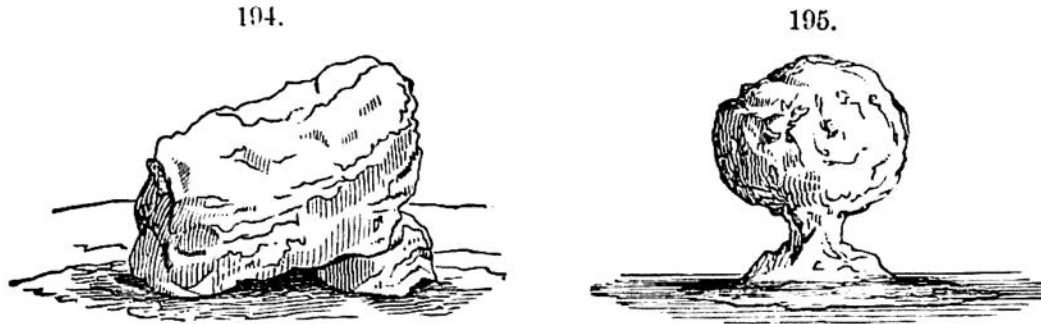


than blocks of rock are torn from submerged strata. The earthquake of 1746, on the coast of Peru, carried a frigate several miles inland, besides deluging the seaport Callao, and the city of Lima seven miles distant. The following figures represent masses of coral limestone torn off from the margin of an atoll and thrown on the shore-platform. That of Fig. 194, was $10 \times 6 \times 6$ feet in its dimensions, and that of Fig. 195 seven feet high and six



Blocks on the shore-platform of atolls in the Paumotu Archipelago. D. '49.

broad. The latter is attached solidly to the reef-rock, and is half cut through by wave action. Another mass on the shore-platform had a length of 15 feet.

4. *Transportation and deposition; the making of beaches.* — Waves, as they rise on a shelving coast, take up and bear along detritus of all degrees of coarseness according to the velocity, and throw or wash it up the shore. Grinding work or corrosion is also ever going on. By such means they give the beach its material, and through the return of the waters, by which much of the finer debris is restored to the sea, its angle of slope.

The materials are derived from the wear of cliffs and ledges above the beach; from the loose material of the bottom; from any corals and shells and other organic objects living in the waters; and from the contributions of marine currents as well as those of rivers — whatever is at hand being used. The transported materials may be gathered from depths of 30 feet or more. In regions of high tides and stormy seas, the great, rapidly driven waves, as they move up the coast, may pick up large stones or produce them out of the rocks, and make stony beaches, or they may make a place too rough for a beach. But with lower tides, and away from the rocks, the beaches consist mostly of sand and gravel. Nine tenths of all the beaches between Florida and Cape Cod are *sand-made*.

The slope of the beaches varies much in angle. It is 15° to 18° along the coasts of stormy seas and high tides, 7° to 10° along those of low tides, and 3° and less in sheltered bays. Deposition by the return-flow waters gives this part of the beach a straticulate structure parallel to the inclined surface (page 93).

Since the waves go up and down the beach twice in each 24 hours, and gradually become stronger in flow and plunge as the tide rises, the beach is made to consist of: (1) The *summit ground*, of uneven surface. This is the receiving place for the coarser material, including stones, shells, etc., and also