attendant waves, are the efficient agents, because they act directly against and along the coasts, and have great power.

Storm-winds, as stated on page 159, have often a velocity of 60 to 100 miles an hour. They have built up, by drift-sands alone, the east side of the Bermuda reefs to a height exceeding 200 feet, while the regular winds have not raised the side of the coral reef facing them above high-tide level. They have made similar drift-hills on the Bahamas, and over the Florida reefs.

Waves rise in long lines transverse to the course of the winds, but with irregularities in the lines, owing to veerings and other variables in the driving agent. Their height depends on the size of the sea, as well as on the winds, and in shallow water on its depth. But every seventh or eighth wave is often a maximum, it being a combination of two, one overtaking another.

Waves have at times great height. The highest measured by Scoresby stood 43 feet above the intervening trough, or 21½ feet above the mean water-plane or plane of rest. According to results obtained by the United States Hydrographical Department, the storm-waves of the North Atlantic have a maximum height of 44 to 48 feet, but ordinarily a height of 30 feet, and a length of 500 to 600 feet.

But the depth of the action of waves is moderate. In a wave, each particle of water moves in a circle about its center of rest, — a circle of 21½ feet radius in a wave of 43 feet. But these circles at a depth of only *one* wave-length have a radius $\frac{1}{535}$ of that at the surface, and at a depth of *two* wave-lengths, $\frac{1}{286000}$; so that if, for the 43-foot waves, the wave-length — or the distance between the crest of two consecutive waves — is 300 feet, the circle at a depth of *one* wave-length will have a diameter of $\frac{4}{10}$ of an inch, and at two wave-lengths, $\frac{1}{1200}$ of an inch. Consequently the movement of the heaviest waves in the open ocean is exceedingly slight, if apparent at all, at a depth of 100 fathoms. This depth is the probable limit of the movement of sand by wave-action, but not the limit of the action of currents.

3. Earthquake Waves.

In an earthquake, the movement of the earth may be either (1) a simple vibration of a part of the earth's crust, or (2) a vibration with actual elevation or subsidence. If submarine waves are produced, they have a forward impulse, and, in the second case, an actual forward movement or amplitude equivalent to the amount of change of level; in each case, therefore, they are *translation waves*. The velocity of propagation varies as the square root of the depth, the number of miles per hour being 12·2 miles in a depth of 10 feet; 38·7 in that of 100 feet; 122·3 in that of 1000. An earthquake at Concepcion, Chile, set in motion a wave that traversed the ocean to the Society and Navigator Islands, 3000 and 4000 miles distant, and to the Hawaiian Islands, 6000 miles; and on Hawaii it swept up the coast, temporarily deluging the village of Hilo. An earthquake at Arica, and other parts of southern Peru, August 14, 1868, sent a wave across the Pacific, west-