

their greater velocity, plunge with violence upon the barrier before it. The force of the ocean's surge is therefore mostly confined to the summit waters, which add weight to superior velocity, and drive violently upon whatever obstacle is presented. The *lower* waters of the surge advance steadily but more slowly, owing to the retarding friction of the bottom; the motion they have is directly forward, and thus they act with little mechanical advantage; moreover, they gradually swell over the shores, and receive, in part, the force of the *upper* waters. The wave, after breaking, sweeps up the shore till it gradually dies away. Degradation from this source is consequently most active where the upper or plunging portion of the breaker strikes.

But, further, we observe that at low-tide the sea is comparatively quiet; it is during the influx and efflux that the surges are heaviest. The action commences after the rise, is strongest from half to three-fourths tide, and then diminishes again near high tide. Moreover, the plunging part of the wave is raised considerably above the general level of the water. From these considerations, it is apparent that the line of greatest wave-action must be above low-water level. Let us suppose a tide of three feet, in which the action would probably be strongest when the tide had risen two feet out of the three; and let the height of the advancing surge be four feet:—the wave, at the time of striking, would stand, with its summit, three feet above high-tide level; and from this height would plunge obliquely downward against the rock, or any obstacle before it. It is obvious that, under such circumstances, the greatest force would be felt not far from the line of high tide, or between that line and three feet above it; moreover, the rise of the waters to half or two-thirds tide affords a protection against the breaker to whatever is below this level. In regions where the tide is higher than just supposed, as six feet for example, the same height of wave would give nearly the same height to the line of wave action, as compared with high-tide level. Under the influence of heavier waves, such as are common during storms, the line of wave-action would be at a still higher elevation; as may be readily estimated by the reader.