

the case of the Rhone, for example, it is concluded by M. Guérard, that the quantity of sand rolled along the bed of this river into the Mediterranean in the course of a year is much greater than the lighter matter held in suspension in the water, and that "when the river, on approaching the sea, is no longer confined by embankments, the greater part of its alluvium is rolled along its bed." In flood-time it is not uncommon for whole banks of sand to travel bodily down the river.¹⁵⁴

The most extensive and accurate determinations yet made upon the physics and hydraulics of a river are those of the United States Government upon the Mississippi. As the mean of many observations carried on continuously at different parts of the river for months together, Humphreys and Abbot, the engineers charged with the investigation, found that the average proportion of sediment contained in the water of the Mississippi is $\frac{1}{1500}$ by weight, or $\frac{1}{2900}$ by volume.¹⁵⁵ But besides the matter held in suspension, they observed that a large amount of coarse detritus is constantly being pushed along the bottom of the river. They estimated that this moving stratum carries every year into the Gulf of Mexico about 750,000,000 cubic feet of sand, earth, and gravel. Their observations led them to conclude that the annual discharge of water by the Mississippi is 19,500,000,000 cubic feet, and consequently that the weight of mud annually carried into the sea by this river must reach the sum of 812,500,000,000 pounds. Taking the total annual contributions of earthy matter, whether in suspension or moving along the bottom, they found them to equal a prism 268 feet in height with a base of one square mile.

The value of these data to the geologist consists mainly in the fact that they furnish him with materials for an approximate measurement of the rate at which the surface of the land is lowered by subaerial waste. This subject is discussed at p. 771.

2. *Excavating Power*.—It was a prominent part of the teaching of Hutton and Playfair, that rivers have excavated the channels in which they flow. Experience in all parts of the world has confirmed this doctrine. The mechanical

¹⁵⁴ Mem. Proc. Inst. Civ. Engin. lxxxii., 1884-85, p. 309.

¹⁵⁵ "Report," p. 148. The specific gravity of the silt of the Mississippi is given as 1.9.