same methods, the floor in a volcano like Vesuvius may be raised, preparatory for another eruption.

This principle in volcanic science, first made out by C. S. Lyman, is established by facts observed by him on Hawaii. In May, 1840, an eruption emptied the crater of Kilauea, and left it with two thirds of the floor sunken nearly 400 feet below the level which it had just before the eruption. (This was 6 months before the author's first visit to the crater.) Fig. 245 is a transverse section of the crater as it was after the eruption, mo, $o'm$ being the opposite walls, and np, $p'n'$ the sunken central region or "*lower pit.*" Six months later,

245.

Vertical section of crater of Kilauea in 1840. D. '49.

the walls of the lower pit, which were then 360 feet high, had a talus of broken lava alongside, falls of the rocks being frequent at the time. In 1846, C. S. Lyman found the lower pit of the crater obliterated, and the talus, at the foot of its walls, constituting a ridge 100 to 150 feet high. Its floor had been raised as a whole, with the talus of lava-blocks upon it; and fault-planes made in the sinking of the floor at the eruption in 1840 were those used in the rise. This ridge was gradually buried by the outflow of lavas over the floor, but it still existed in 1864, as shown in the view of Kilauea on page 270, and also in a map of the crater of that date by W. T. Brigham.

At times of approaching eruption, the heat and projectile action of the crater become intense. The heat may be expended, as in Kilauea, in multiplying lava-lakes for ebullition and raising blowing-cones, or, on the other hand, as in Vesuvius, in projecting cinders to enormous heights besides starting some lava-flows.

(*b*) *The eruption.* — The eruption begins after the lavas have risen within the crater up to what may be called high-lava mark; and when the pressure from the vapors generated and confined below and from the hydrostatic pressure of the lava-column — chiefly the former — is too great to be withstood by the containing mountain. The mountain consequently breaks; the conduit is rent open on one side or the other, and the lavas run out. If the mountain were too strong to break, as it perhaps is in the earlier part of its history, when it is of little height, the lava would rise to the top of the crater by the methods described, and overflow from the summit on this side or that. But modern eruptions, as has been stated, are usually through fissures.

The discharge of the lavas empties the *upper part* of the lava-conduit or lowers the level of its upper surface, and undermines the lifted crater-floor; and the result may be (1) a collapse or down-plunge of the floor within the crater, making again a pit hundreds of feet deep, or 1000, or 2000, as the case may be; and (2) sometimes also a down-plunge of the walls of the crater.

Part of the undermining at Vesuvius is due to outflow of lavas, part to discharge of volcanic cinders; but at basaltic Kilauea, it all comes, ordinarily, from the escape of liquid lavas.