

the area of any known crater or hollow which has been observed in any part of the world to be occupied by a lake of liquid lava. As the Spaniards have given to such large cavities the name of Caldera (or cauldron), it may be useful to use this term in a technical sense, whatever views we may entertain as to their origin. Many of them in Java are no less than four geographical miles in diameter, and they are attributed by Junghuhn to the truncation by explosion and subsidence of ancient cones of eruption. Unfortunately, although several lofty cones have lost a portion of their height within the memory of man, neither the inhabitants of Java nor their Dutch rulers have transmitted to us any reliable accounts of the order of events which occurred.*

Dr. Junghuhn believes that Papandayang lost some portion of its summit in 1772; but affirms that most of the towns on its sides said to have been engulfed were in reality overflowed by lava.

From the highest parts of many Javanese *calderas* rivers flow, which in the course of ages have cut out deep valleys in the mountain's side. As a general rule, the outer slopes of each cone are furrowed by straight and narrow ravines from 200 to 600 feet deep, radiating in all directions from the top, and increasing in number as we descend to lower zones. The ridges or "ribs," intervening between these furrows, are very conspicuous, and compared to the spokes of an umbrella. In a mountain above 10,000 feet high, no furrows or intervening ribs are met with in the upper 300 or 400 feet. At the height of 10,000 feet there may be no more than 10 in number, whereas 500 feet lower 32 of them may be counted. They are all ascribed to the action of running water; and if they ever cut through the rim of a caldera, it is only because the cone has been truncated so low down as to cause the summit to intersect a middle region, where the torrents once exerted sufficient power to cause a series of such indentations. It appears from such facts, that, if a cone escapes destruction by explosion or engulfment, it may remain uninjured in its upper portion, while there is time for the excavation of deep ravines by lateral torrents.

It is remarked by Dr. Junghuhn, as also by Mr. Dana in regard to the Pacific Islands, that volcanic mountains, however large and however much exposed to heavy falls of rain, support no rivers so long as they are in the process of growth, or while the highest crater emits from time to time showers of scorix and floods of lava. Such ejectamenta and such currents of melted rock fill up each superficial inequality or depression where water might otherwise collect, and are moreover so porous that no rill of water, however small, can be generated. But where the subterranean fires have been long since spent, or are nearly exhausted, and where the superficial scorix and lavas decompose and become covered with clayey soils, the erosive action of water begins to operate with a prodigious force, proportionate to the steepness of the declivities and the incoherent nature of the sand and ashes. Even the more solid lavas are occasionally cavern

* See Principles of Geol. 9th edit. p. 493.