

sulphurous acid; then steam; and, finally, carbon-dioxide and combustible gases.<sup>4</sup> More recent observations tend to corroborate the deductions of C. Sainte-Claire Deville that the nature of the vapors evolved depends on the temperature or degree of activity of the volcanic orifice, chlorine (and fluorine) emanations indicating the most energetic phase of eruptivity, sulphurous gases a diminishing condition, and carbonic acid (with hydrocarbons) the dying out of the activity.<sup>5</sup> A "solfatara," or vent emitting only gaseous discharges, is believed to pass through these successive stages. Wolf observed that on Cotopaxi while hydrochloric acid and even free chlorine escaped from the summit of the cone, sulphuretted hydrogen and sulphurous acid issued from the middle and lower slopes.<sup>6</sup> Fouqué's studies at Santorin have shown also that from submarine vents a similar order of appearance obtains among the volcanic vapors, hydrochloric and sulphurous acids being only found at points of emission having a temperature above 100° C.,

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<sup>4</sup> C. Sainte-Claire Deville and Leblanc, *Ann. Chim. et Phys.*, 1858, lii. p. 19 *et seq.* For accounts of Vesuvius and its eruptions, besides the general works already cited on p. 327, consult J. Phillips' "Vesuvius," 1869; "Mount Vesuvius," J. L. Lobley, 1889; J. Schmidt, "Die Eruption des Vesuv. 1855," Vienna, 1856; Mercalli's "Vulcani, etc.,"; H. J. Johnston-Lavis, *Q. J. Geol. Soc.* xl. 35; *Geol. Mag.* 1888, p. 445. A diary of the volcano's behavior for six months is given in *Nature*, xxvi.; one for four years (1882-86) by Dr. Johnston-Lavis "Spettatore del Vesuvio," Naples, 1887; a valuable series of reports on the mountain by the same author will be found in recent volumes of the Reports of the British Association (1885-91) and a large detailed map of the volcano, also by him, published by Philip, London, 1891.

<sup>5</sup> He distinguished volcanic emanations according to their order of appearance as regards time, nearness to the vent, and temperature: viz. 1. Dry fumaroles (without steam), where anhydrous chlorides are almost the only discharge, and where the temperature is very high (above that of melted zinc). 2. Acid fumaroles, with sulphurous and hydrochloric acids and steam. 3. Alkaline (ammoniacal) fumaroles; temperature about 100° C.; abundant steam with chloride of ammonium. 4. Cold fumaroles; temperature below 100° C., with nearly pure steam accompanied by a little carbon-dioxide, and sometimes sulphuretted hydrogen. 5. Mofettes; emanations of carbon-dioxide with nitrogen and oxygen, marking the last phase of volcanic activity.

<sup>6</sup> *Neues Jahrb.* 1878, p. 164.