

4. Making of Veins.

In the making of veins, the material has usually been deposited against the walls; and from the wall layer thus made there has been a thickening to the center. The work is, therefore, centripetal.

The materials have been introduced either (1) from above, or (2) laterally, from the rocks adjoining some part of the fissure, or (3) from below. The filling of superficial cracks is done usually without aid from heat. But in most vein-making, heat has been required.

1. *Superficial Vein-making, not requiring Heat.* — The shallow cracks of rocks, like those of mud-beds, and any cavities opening upward, may take in calcite, silica, or other ingredients from cold solutions, and make superficial veins. The process is mere deposition, and commonly without heat. In a similar manner cavities and caves have sometimes become filled. Or when a bed is slightly calcareous, permeating waters have taken into solution some of the calcareous portion (calcite), and if cracks or fissures existed, have filled them with calcite. Siliceous solutions, in like manner, may make veins of quartz. So any solution made by oxidations or other means, may carry material into cracks and produce veins or veinlets.

2. *Vein-making requiring Heat.* — Vein-making requiring heat is carried on in regions of hot springs in a superficial way. But in general, the process has gone forward in fissures permeating hot rocks, and the work of filling has been dependent on the heat and moisture the rocks afforded. These fissures, in the case of the majority of veins, have not descended to regions of fusion; while in the case of other veins of even greater importance, as regards ore-production, they have reached fusion-depths and have let up melted rock. The veins of the first of these kinds are especially common in Archæan rocks; while those of the second belong mostly to later time.

Superficial Vein-making.

Superficial vein-making is in progress at hot springs in Nevada, California, and elsewhere. Such springs, making solfatara areas, are usually in regions of former eruptions.

In Nevada, at Steamboat Springs, according to J. Arthur Phillips (1879), fissures are being lined with a siliceous incrustation, while at the same time steam and gases, with boiling water, are escaping; and "they have been subjected to a series of repeated widenings," and become lined, to a thickness of several feet, with silica, which is in bands, amorphous and crystalline alternating, and contains some hematite, pyrite, and chalcopyrite. According to Mr. Laur (1863), the silica of these fissures contains also traces of gold; so that the facts exemplify, as he states, the essential points in the origin of auriferous quartz-veins. This view was presented by B. Silliman and W. P. Blake, in 1864, with reference to the banded quartz-veins (gold-bearing) of Bodie Mountain, north of Mono Lake, which are *contact veins* intersecting porphyry. At Clear or Borax Lake, as observed by Mr. Phillips,