Near some of the springs a treacherous crust covers a soft, sticky, viscous, scalding mud; one may easily break in, and several accidents more or less serious have thus occurred. Quite recently a miner was so badly scalded as to be crippled, probably for life. Sulphur often issues with the steam and condenses in the most beautiful crystallizations on the cooler surface. Specimens of sulphur frostwork are of the most exquisite beauty, but too frail to be removed. We crossed this table and descended into the canyon above the geysers and followed it down. I found some flowers out in the canyon above, in the warm steamy air, of a species that elsewhere is entirely out of flower.

One can descend into the canyon and follow it down with safety, a feat that seems utterly impossible before the trial. Here is the grand part of the spectacle. Here are the most copious streams, the largest and loudest steam-jets, the most energetic forces, and the most terrific looking places. Standing part way down the bank at the upper end of the active part, where the canyon curves so that all its most active parts are seen at a glance, the scene is truly impressive. It seems an enormous, seething, steaming cauldron. Steam or hot water issuing from hundreds of vents, the white and ashy appearance of the banks, the smell of sulphur and hot steam in our faces, combined to produce an entirely novel effect.

We descended and followed down the canyon, threading our way on the secure spots. Hot water or steam issued on all sides—under us, by our side, over us, around us. Sometimes the whole party was enveloped in a cloud of vapor so that we could not see each other, at other times this was blown away by the winds. Once the sun came out from between the clouds and shone through this steamy air down on us, lurid, yet indistinct. In one place a rocky pool of black rock several feet in diameter, filled with thick, black water—black from sulphuret of iron, black as ink—was in the most violent agitation. It is the most peculiar feature of all the geysers and is well called the Witches' Cauldron. The water, black and mysterious, boils so violently that it spouts up two or three feet from the surface, inclosed in this rocky wall.

A considerable stream of hot water issues from this canyon, and a short distance below are sulphur banks where hundreds, or even thousands, of tons of sulphur could be cheaply obtained. A curious fact is that a low order of plant, like *confervae* or "frog spawn" grows in this hot water, most copiously in water of 150° F., and even on the margins of springs of a temperature of 200° F., and over surfaces exposed to the hot steam. As the springs are at an altitude of 1,600 or 1,700 feet, the water boils at a temperature of about 200° F., so these plants literally grow in boiling water! I have obtained specimens, but owing to their character, they were very unsatisfactorily preserved.

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LETOVICITE FROM THE GEYSERS, SONOMA COUNTY, CALIFORNIA

By G. E. Dunning and J. F. Cooper, Jr.

An examination of massive mascagnite from The Geysers, Sonoma County, California, collected during the summer of 1962, revealed the presence of a fine-grained mass of platy, colorless, pseudohexagonal crystals having an average size of about 0.03 by 0.05 mm. by 0.005 mm. in thickness. Although the crystal habit was compared with other known sulfate minerals previously reported from The Geysers, the material was not identified. Several samples were submitted to John S. White, Jr., of the United States National Museum, who identified the crystals as letovicite on the basis of x-ray methods. Type samples have been placed in the U. S. National Museum collection.

Letovicite, a rare ammonium hydrogen sulfate, $(NH_4)_3H(SO_4)_2$, was first described by Josef Sekanina in 1932 as a new mineral from Letovice, Moravia. It was found with sulfur and was formed during the burning of waste-heaps of a coal mine. A second, similar occurrence was discovered at a coal mine near Kladno, Bohemia, in 1937.

At The Geysers, letovicite was found along Geyser Creek at Boric Acid Spring described by M. Vonsen in 1946. Letovicite had crystallized from hot, strongly acid (sulfuric), fumarolic solutions as a coating of complex intergrown crystals on massive mascagnite. Massive boussingaultite, $(NH_4)_2Mg(SO_4)_2 \cdot 6H_2O$, occurred in close association with both mascagnite and letovicite.

The acidity of the fumarolic solutions (necessary for the formation of letovicite) has decreased gradually during the past 6 years as a result of the increased diversion of steam for geothermal power. Recent visits to the original fumarole at which letovicite occurred have yielded no further samples.

A study of the crystallographic data of letovicite by George Switzer of the U. S. National Museum * has shown that the published data are incorrect. Tests conducted by Dr. Switzer using the method of Sekanina to synthesize pseudohexagonal crystals of letovicite have yielded only $(NH_4)H(SO_4)$ in every case. From these observations he concludes that the crystallographic data given for letovicite in the 1951 edition of *The [Dana] system of mineralogy,*** are for the compound $(NH_4)H(SO_4)$ and not letovicite.

The occurrence of letovicite at The Geysers is the third verified locality for this rare sulfate mineral and the first for California and the United States. It is also the first occurrence of letovicite in a natural geothermal environment.

* Personal communication, 1968
** Vol. II, P. 397

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