In a region of former volcanic activity, hot springs with a temperature of about 80° C. break forth through a fissure in granodiorite, and at the base of a basaltic bluff the waters have deposited a large amount of siliceous and calcareous sinter, some of which is colored red by antimony sulphide. The sinter from one of the springs was analyzed by Mr. Melville,[2] and his results, re-calculated to grams per kilogram, showed:

	Grams per Kilogram.
Ferric oxide,	1.0263
Antimonious and arsenious sulphides,	22.9298
Mercuric sulphide,	0.0021
Cupric sulphide,	0.0124
Lead,	0.0211
Gold,	0.0010
Silver,	0.0003

The relative quantities of antimonious and arsenious sulphides are not given in the above analysis, but I believe that the former greatly predominated.

The water of one of the springs was also analyzed by Melville and the re-calculation of this analysis to salts that were possibly present is given in Table I.

TABLE I.—*Possible Composition of the Water of Steamboat Springs, Prior to Oxidation.*[3]

	Grams per 10 Liters.
Ferrous carbonate, $FeCO_3$,	0.0029
Magnesium carbonate, $MgCO_3$,	0.0099
Calcic carbonate, $CaCO_3$,	0.1577
Calcic phosphate, $Ca_3P_2O_8$,	0.0137
Potassic chloride, KCl,	1.9735
Lithic sulphate, Li_2SO_4,	0.5650
Sodic chloride, NaCl,	14.1475
Sodic sulphydrate, NaHS,	0.0358
Sodic sulphate, Na_2SO_4,	1.1147
Sodic bicarbonate, $NaHCO_3$,	2.9023
Sodic monocarbonate, Na_2CO_3,	0.4314
Sodic biborate, $Na_2B_4O_7$,	3.1368
Sodic tetrasilicate, $Na_2Si_4O_9$,	5.9090
Sodic sulphantimonide, Na_3SbS_3,	0.0100.
Sodic sulpharsenide, Na_3AsS_3,	0.0866
Alumina, Al_2O_3,	0.0025
Sodium-mercury sulphide, HgS, nNa_2S,	trace

[2] *Op. cit.*, p. 344 (Sample II.).

[3] *Op. cit.*, p. 347.

With the other classes of substances a very different state of affairs exists, the alloy being copper embedded in a matrix of an alloy of copper and the impurity. The conductivity of this matrix is, in general, low, and its amount is beyond all proportion to that of the impurity added, and hence the magnified depression of the conductivity of the whole. Metallographic work with the microscope bears this out; 0.1 per cent. of bismuth, for example, causing but a thin skin around the copper crystals, while the same amount of arsenic forms a thick wall.[5] It is often possible to counteract the detrimental mechanical effects of one impurity by adding another, as in the case where a relatively innocuous impurity may dissolve an otherwise insoluble one, like lead.[6]

The results given in Table I show what a severe requirement the customary 97- or 98-per cent. conductivity-specification is, especially as copper is usually associated with arsenic; and when it is considered that the average electrolytic refinery daily passes this requirement by a margin of 2 or 3 per cent., frequently using anodes containing 1 per cent. or more of arsenic, it will be appreciated that electrolysis would have come as a refining operation even did copper never carry gold or silver.

The Occurrence of Stibnite at Steamboat Springs, Nevada.

BY WALDEMAR LINDGREN, WASHINGTON, D. C.[4]

(Washington Meeting, May, 1905.)

THE important investigations of Dr. G. F. Becker at Steamboat Springs, Nev., in 1885, aided by the analytical work of W. H. Melville, established the fact that sulphides were being deposited at the surface by hot ascending waters.[1] Steamboat Springs is situated near the eastern base of the escarpment of the Sierra Nevada, six miles distant from the Comstock lode.

[5] Arnold and Jefferson, *Engineering* (London), February 7, 1896.

[6] Lewis, *Engineering* (London), December 4, 1903.

[4] Published by permission of the Director of the U. S. Geological Survey.

[1] *Monograph XIII., U. S. Geological Survey*, pp. 331–353.

The recalculation given in Table I. is, of course, only of very approximate value, since it is not known with certainty in what condition the different acids and bases are present. Moreover, the salts are partly dissociated. Attention should be called to the fact that the water contains far more arsenic than antimony, but during its filtration a red precipitate formed, consisting of arsenic and antimony sulphides,—in what relative amounts the report does not state.

Having assisted Dr. Becker in his examinations in 1885, I naturally felt a strong interest in this locality; and, in 1901, I revisited the place for a few hours, making a few observations which are here recorded.

The flow of water from the springs was found to be greatly reduced, probably on account of clogging of the channel. Several bore-holes had been sunk in order to obtain a better flow, and from these holes fragments of quartz had been brought up which were said to assay high in gold and silver. Of this I know nothing except from hearsay; but, at any rate, these results seem to have stimulated prospecting activity, for a shaft had recently been sunk to a depth of 30 ft. near the railway-station, on the sinter-flat a few hundred feet away from, and about 20 ft. above, Steamboat creek, which is the main drainage-line of the valley. After sinking 25 ft. through sinter, a loose sandy gravel was struck containing well-washed pebbles of granite and andesite, which carried so great an abundance of hot water as to lead to the suspension of mining operations. The gravel was said to contain small quantities of gold and silver, but I am not prepared to discuss this aspect of the case; moreover, the assays or the material would have no great value regarding the derivation of the gold and silver if found, for they might have been introduced in different ways. A sample of the same or similar material, transmitted to me in the summer of 1904 by Mr. W. H. Weed, was assayed and yielded a trace of gold.

Upon examining the dump, I found that the gravel throughout contained small shining prisms and particles of metallic luster. A generous sample of the material was collected, but further work was delayed, until 1908, when an examination of the sandy part of the gravel showed it to contain a considerable quantity of stibnite, in the form of loose slender prisms of the usual type, up to about 1mm. in length, and usually with-

out terminal faces. The prisms are sometimes bent and often combined in radiating groups, and may be observed adhering to the surface of nearly every pebble of the gravel, both large and small. Some of the larger granite-cobbles, which usually are soft and decomposed, contain bunches of stibnite crystals in cracks and crevices. With the exception of clastic magnetite, the only other metallic mineral found in the gravel is pyrite, which forms loose or intergrown crystals of octahedral form, sometimes combined with the cube. In many cases both pyrite and stibnite have crystallized on the surface of pebbles, the former often being tarnished to a black color. Grains of quartz occur with the pyrite, but they are not clearly crystallized and may be clastic. A black opaline material containing about 1 per cent. of carbon, according to Dr. E. T. Allen, of the U. S. Geological Survey, sometimes adheres to the andesite pebbles.

In order to obtain an idea of quantitative relationships, the sandy part of the gravel was further examined by Dr. E. T. Allen, who found that lead, copper, zinc and mercury were absent, and that the material contained antimony, 0.4, arsenic, 0.067, and sulphur, 1.88 per cent., which corresponds to stibnite (Sb_2S_3), 0.56; orpiment, (As_2S_3), 0.107; and pyrite (FeS_2), 3.13 per cent.

It is not certain in what form the arsenic is present. Stibnite does not usually contain arsenic, and, on the other hand, no separate arsenical mineral could be recognized.

That stibnite and pyrite could be of clastic origin is entirely out of the question, and I believe it absolutely certain that they have been deposited by the hot waters which permeate the gravel. Considering that the waters have been shown to contain a considerable quantity of antimony, the occurrence seems of great interest.

No metallic sulphides, corresponding in appearance to the normal minerals, were found by Dr. Becker in the sinters, but cinnabar occurs disseminated in the decomposed granite, some distance away from the present springs. The antimonious sulphide, which colors parts of the sinter and always appears red and amorphous, was called metastibnite by Dr. Becker. The absence of ordinary minerals of metallic luster indicated, in a way, a missing link in the chain of evidence to prove the deposition of ores from hot ascending waters; and this link is now supplied by the observations recorded above.

Physical conditions differing very slightly from those at the actual surface will evidently produce crystallized minerals of normal habit and form. Many years ago Senarmont succeeded in forming crystals of stibnite from the amorphous sulphide by heating it to 250° C. in a closed tube with a solution of sodium carbonate.

During the investigation of the quicksilver-deposits of the Pacific slope, Messrs. Becker and Melville found that stibnite is easily crystallized from solutions similar to the waters of Steamboat Springs in sealed tubes heated to about 150° C. This renders it probable that a moderate pressure, such as exists at a small distance below the surface, is sufficient to induce the formation of the crystals described in this paper. Very likely, also, the presence of organic matter in the gravel is one of the conditions favoring such deposition.

Many important deposits of stibnite occur in sedimentary rocks in a manner which renders very probable a genesis somewhat similar to that of the occurrence here described.

Features of the Occurrence of Ore at Red Mountain, Ouray County, Colo.

BY T. E. SCHWARZ, DENVER, COLO.

(Washington Meeting, May, 1905.)

THE publication of the report by Mr. F. L. Ransome[1] was welcomed by many engineers who had mined in the heart of the San Juan country, braved its long and snowy winters, climbed its lofty peaks, run the gauntlet of its snow-slides, and studied its problems of geology, while making dividends for their English or American clients. This report helps one to understand why the bonanzas occurred, and why the inevitable "borrasca" presents itself where least expected.

The Red Mountain district of Ouray county, a very productive section from 1884 to 1893, occupies considerable space in the report mentioned. The character of the ore-occurrence,

[1] A Report on the Economic Geology of the Silverton Triangle, Colorado, by F. L. Ransome, *Bulletin No. 182, U. S. Geological Survey.*