

VANADIUM IN THE SIERRA DE LOS CABALLOS, NEW MEXICO.

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During 1910 and 1911 considerable attention was attracted to the vanadium deposits in the Sierra de los Caballos by numerous articles in the mining press,¹ which reported the erection of a plant at Cutter for the manufacture of vanadic oxide and the mining of the ore in the mountains 12 to 15 miles southwest of that place. Cutter is in Sierra County and is a station on the Atchison, Topeka & Santa Fe Railway, 149 miles south of Albuquerque and 104 miles north of El Paso.

The Sierra de los Caballos, in which are the vanadium deposits, lies along the east side of the Rio Grande and can be reached from Cutter or from Engle, 10 miles north of Cutter. As described by Schrader,² the mountains form a range trending nearly north and south and reaching a maximum height of 10,000 feet at Timber Hill, south of the vanadium deposits. He says:

The range consists mainly of a monocline bounded on the west by a great north-south fault scarp overlooking the Rio Grande. * * * In the vicinity of Palomas Gap the average elevation of the crest is about 6,500 feet; the average width of the mountains is 4 to 6 miles, including a foothill belt several miles wide on the east. The most prominent feature of the mountains is the great limestone and quartzite series, 1,200 to 1,400 feet in thickness. It consists chiefly of heavy-bedded massive gray or blue limestone, with some intercalated shale, and has at its base about 100 feet of hard quartzite. Much of the limestone is semicrystalline, and some of it contains black flinty or cherty nodules or inclusions. Part of it is greatly crushed and recemented by calcite veins.

The quartzite at the base of the limestone series ranges from 50 to perhaps 200 feet in thickness; it is massive or heavy bedded and consists of black and red beds resting upon the granite. Its age is probably Cambrian.

¹ Among the articles appearing upon the subject have been the following:

Leatherbee, Brigham, Sierra County, N. Mex., vanadium deposits: Min. World, vol. 33, Oct. 29, 1910, p. 799.

Carrera, J. C., Vanadium; its importance in the Southwest: El Paso Min. Jour., February, 1911.

Johnson, E. D., The vanadium industry in New Mexico: Min. Sci., vol. 63, Mar. 9, 1911, p. 259.

Larsh, P. A., Caballo Mountain vanadium mines: Eng. and Min. Jour., vol. 92, July 15, 1911, p. 118.

Allen, C. A., Vanadium deposits in the Caballo Mountains, N. Mex.: Min. and Sci. Press, vol. 103, Sept. 23, 1911, pp. 376-378.

Clifford, J. O., Vanadium in New Mexico; Caballos Mountains deposits: Min. and Eng. World, vol. 35, Oct. 23, 1911, pp. 857-858.

² Schrader, F. C., in Lindgren, Waldemar, and others, The ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, pp. 284-285.

The granite is stated to be probably basal, but there are dioritic rocks that are apparently intrusive, and south of the vanadium deposits are porphyritic intrusive rocks. The limestones are of Carboniferous age and on the east are overlain by fine-grained red sandstones, also Carboniferous.

About two-thirds of the way toward the north end the range is cut by a narrow canyon known as Palomas Gap, in the vicinity of which are the vanadium mines. The mines were discovered in 1906 just after Schrader's visit to the locality.

At the mines the range proper shows nothing from the east side but the limestone. On the north side of the gap the limestone is in open folds. A valley follows the range here, running about N. 25° W. (magnetic), which suggests a fault separating the limestone and the red beds.

The vanadium-bearing veins lie at and about three-fourths of a mile south of Palomas Gap. They strike nearly northeast (magnetic) and dip from 60° NW. to vertical. They occupy fissures in limestone containing brecciated country rock cemented by calcite, with some white and amethystine fluorite, barite, and less quartz. The metallic minerals noted are galena, a little cerusite, copper carbonates, vanadinite, zinc-bearing cuprodescloizite, and another mineral which may be an amorphous form of cuprodescloizite. The galena alters to a black mineral that forms a narrow band around the crystals but occurs in too small quantity to determine. Besides these minerals, pyromorphite and wulfenite have been reported by others, although they were not recognized by the writer after diligent search for them during his short visit and on the specimens collected.

At Palomas Gap there are two such veins, one on either side, on the property of the Vanadium Mines Co. The vein on the north is known as the Dewey, and that on the south as the White Swan. Both are developed by shafts, but permission to enter them was refused, so that observations could be made only upon surface workings and a drift on the Dewey opening into Palomas Gap, across which the vein cuts. In the drift the vein has been taken out for a width of 6 to 12 feet and has been stoped to a height of 30 feet. The vein is spongy and much weathered. On the north side of the gap, which is not over 100 feet wide at this point, in a prospect hole 8 or 9 feet deep, part of the limestone is coated with a yellowish-green crust not over one-sixteenth of an inch thick. Under the microscope part of it is seen to be brown vanadinite with a thin powdering of the green material, but other specimens show much more of the green matter. Purer material from the Red Top claim is crystalline but seems to be the same green mineral, carries vanadium, lead, copper, and zinc, and is probably cuprodescloizite.

A shaft has been sunk on the east end of the outcrop of the vein. A keg of rich ore contained lumps of hair-brown vanadinite in a pinkish clayey material. The crystals reach one-eighth of an inch in diameter, many are hollow, and of those which are not hollow many show two distinct stages of growth in their cross fracture.

The White Swan vein, on the south side of the gap, has been developed by a shaft and by open-cut work. The vein is very similar to the Dewey but is vertical and is said to carry wulfenite (lead molybdate), though none was seen in the exposed portions of the vein nor in the ore on the dump. The visible portions of the vein carried calcite, quartz, barite, colorless and amethystine fluorspar, galena, copper carbonates in small quantity, and vanadinite.

The vanadinite is mostly in hair-brown crystals which are so small that cavities lived with them in the spongy calcareous gangue look velvety. Under strong magnification they form a beautiful bristling array, pointing in all directions from protuberances and surfaces. Many of the cavities lined are evidently left by the decomposition of galena. The crystals are so fine that there must be great loss unless the ore is very carefully handled.

Some very unpromising-looking limy material from the dump gave good reactions for vanadium, and microscopic examination showed that through the calcite were great numbers of colorless or nearly colorless vanadinite crystals so minute as to be invisible to the unaided eye.

Persons familiar with the ground stated that the shaft was 400 feet deep and that 800 or 900 feet of drifting had been done. It has also been stated that a fault, corresponding to the surface indications as mentioned, has been struck on the east.¹ The mined ore is hauled by wagon to a mill about $1\frac{1}{2}$ miles south and the concentrates are hauled to Cutter, where a plant was erected for making vanadium oxide and lead sulphate. It is understood that a few hundred pounds of vanadium oxide had been produced up to the time the locality was visited.

Much money was expended to obtain water. A pumping plant was erected and a number of wells dug 4 miles east, and a disagreeably alkaline water was piped to the mill and mine. At the time the property was visited good water had been found across the narrow valley, only a few hundred feet from the mines.

About three-fourths of a mile south of the Dewey and White Swan veins Ralph Widener has claims known as the Gladys, Red Top, Red Top Annex, and Billiken, named seriatim from southwest to northeast. All are situated on the same vein. On the northeast J. H. Hardin has a claim called the Owl which is apparently also

¹ Allen, C. W., op. cit., p. 378.

on the same vein. The strike is parallel to the Dewey and White Swan veins (about northeast, magnetic), and on the Gladys claim the dip is 60° NW. (magnetic). In a prospect shaft 15 feet deep on the Gladys claim the vein was shown to be about 3 feet wide and appeared not to be fully exposed on the footwall side.

The vein consists of crushed limestone, considerably disintegrated and cemented by secondary calcite, with white and pink fluorspar. In the hasty examination made no barite or copper minerals and very little quartz were seen. Some galena is scattered through the ore. About a foot of the vein is very spongy, and the cavities are lined with small hair-brown crystals of vanadinite, in places shading into brownish yellow and colorless. The largest crystals are probably not over one-sixteenth of an inch long and very slender, so that although they make a beautiful appearance in the mine they are so fragile that it is almost impossible to transport good specimens, for all crystals not in cavities are broken by the almost inevitable rubbing incident to handling, and many others are broken by small fragments of rock which become loosened and strike them. The ore on the other claims is similar, but the exposures were not so good.

Some cuprodescloizite found on these claims is apparently fairly homogeneous and is crystalline. The determination was made on ore from the Red Top.

Across the valley to the northeast are other claims upon which vanadium minerals are said to have been found, but the time at the writer's disposal did not allow examination.

Nothing definite is known of the richness of the ores. The vanadium content has been estimated to be from a fraction of 1 per cent to 3 per cent, but the latter figure is probably much too high.

Other lead-bearing veins occur along the Sierra de los Caballos within a mile south of the Red Top, and these are reported by Larsh¹ and others to carry no vanadium, although the veins evidently belong to the same group, apparently have the same gangue minerals, and cut the same country rock.² These facts would seem to indicate that the vanadium did not come from the country rock. The veins do, however, carry wulfenite.

¹ Larsh, P. A., *op. cit.*, p. 118.

² Schrader, F. C., *op. cit.*, p. 285.