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Vanadium in New Mexico - Caballos Mountains Deposit

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Since the introduction of vanadium as a purifying agent in the manufacture of steel, great interest has been evidenced in prospecting for and the location of deposits of vanadiferous ores of commercial use.

While vanadium is comparatively widely distributed in nature, but few deposits of economic importance have thus far been discovered. The most important producing districts are Spain, Peru, Colorado, and New Mexico. Of these, Spain produces vanadinite - a vanadate of lead with an inferior portion of lead chloride; Peru produces patronite (a vanadium sulphide), its oxidation products, and a vanadiferous asphaltite; Colorado produces carnotite (a uranyl potassium vanadate, contaminated with calcium and barium compounds) and roscoelite, a vanadium - aluminum silicate. The New Mexico product is mainly vanadinite.

The discovery of vanadium in New Mexico was made by Dr. F. M. Endlich in 1884, during his examinations of the Lake Valley silver-lead mines. There the mineral occurs as long, slender needle-like crystals, and as flat crusts along the walls of the ore deposits. In chemical composition it varies from true vanadinite by its lesser percentage in vanadium pentoxide, and higher content of arsenic pentoxide. Being intermediate in composition between vanadinite and mimetite it was named endlichite, in honor of its discoverer, and is so listed by Dana. The mineral does not occur in commercial quantities in the Lake Valley district.

Vanadinite occurs near Hillsboro, Cooks Peak, Chloride, Georgetown, and in the Caballos Mountains, New Mexico. Roscoelite and descloizite have been found in the northwestern part of the state. Of the several districts above mentioned the Caballos Mountains deposits, in

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p 226

view of their more extensive development, are the most important; therefore particular reference will be made to that district.

Caballos - Mountains - District -History -

The presence of vanadinite in the mines of the Caballos Mountains was first noticed by the writer during his examination of the Red Top property in the spring of 1909. A trial shipment of the mineral was made to the General Vanadium Co. of America. Subsequently the property was leased by representatives of that company, and other shipments forwarded to the reduction works at Liverpool, England. In view of the low vanadic acid content of the crude ore, and the absence of efficient milling facilities in the immediate vicinity of the mining properties, the General Vanadium Co. withdrew from the field.

Immediately following the abandonment of the district by the General Vanadium Co., the Vanadium Mines Co., (a re-organization of the Southwestern Lead & Coal Co., owning properties adjoining the Red Top mine) was incorporated and has developed a fairly large tonnage of low-grade vanadite ores in the White Swan and Dewey mines.

Geography - Mineralogy - Geology

The Caballos Mountains are situated in Sierra County, New Mexico, 100 miles north of El Paso, Texas, and 14 miles west from Cutter Station on the A. T. & S. F. R. R. The range lies parallel to, and 6 miles east of the Rio Grande. The Elephant Butte damsite (one of the government reclamation projects) is near the extreme northern part of the range.

The range trends nearly north and south over a distance of 25 miles, with an average width of 3 miles. The elevation of the highest point, Timber Peak, is about 9,500 feet. On the west, overlooking the

Rio Grande, is a great north-south fault scarp having an average elevation of 6,500 ft. along its crest in the vicinity of Palomas Gap. Palomas Gap divides the range into the North and South Caballos. A foothill belt several miles wide extends from the range east and north towards Cutter and Engle respectively.

There have been at least three distinct earth movements at widely separated periods of time. The first movement formed the monocline bounded on the west by the fault scarp mentioned in the preceding paragraph, with consequent fissuring of the eastern slope. These parallel fissures cut the thick sedimentaries and low-grade lead ores have been found in several places along the veins. The cross-cutting of the range by a system of steep, southward-dipping, east-west fissures, (which is particularly noticeable in the North Caballos where the limestone series are folded and warped, and in some cases turned on edge) resulted from the second movement. East of the main range are evidences of other minor disturbances, extending far to the north and northwest. These last mentioned movements occasioned tremendous fissuring a few miles east and north of the range, followed by extensive ^{basic} lava flows which form the western mesa boundary of the Jornada del Muerto.

The prominent geological feature of the range is the great limestone and quartzite series 1,000 to 1,500 ft. thick. The base of the range consists of massive red and black Cambrian quartzite, about 200 feet thick, resting upon granite. Heavy-bedded Silurian and Carboniferous limestones, intercalated with shales, rest upon the Cambrian quartzite; the quantity of the shale series is, however, small. About 1/2 mile east of the mines on the eastern slope are the "Red Beds" above which the Cretaceous sandstones occur.

The minerals of the district comprise vanadinite, wulfenite, cerussite, anglesite and galena; the predominating minerals are vanadinite and galena.

The vanadinite occurs in well-formed hexagonal prisms in colors ranging from red and yellow to brown and brownish black in the vug-holes, and as flat crusts along the walls of the small caves. Small seams of almost pure massive vanadite of a reddish-yellow color are also found, usually along the foot-walls of the veins. Galena occurs in coarse cubes, in many instances accompanied by well-formed crystals of wulfenite.

- Development -

The mining properties thus far developed in the range comprise coal-copper-lead and vanadium deposits. The coal area is negligible, as but little development has been done. The copper deposits are confined to the steep westward-facing slope of the range. Greatest development of the lead and vanadium deposits has been done in the vicinity of Palomas Gap, within an area of less than 2 square miles.

The three most important veins in the Palomas Gap section are the White Swan, Dewey, and the Red Top. These veins belong to the system of parallel fissures above referred to. The first two mentioned lie about 700 ft. apart; the Red Top is about $5/8$ of a mile eastward.

The ores of these properties occur in shoots ranging from 2 to 15 ft. in width. The vein filling is a porous, friable calcite (an altered limestone) with some barite, fluorite and quartz from which the original mineral (lead sulphide) has been dissolved and partially replaced by the vanadite. In point of ore occurrence the properties are analogous; therefore I will describe the White Swan only in detail.

Of the three properties mentioned the White Swan is the most

developed. Development consists of a vertical shaft about 200 ft. deep with drifts from the 75 and 150 ft. levels. So far as developed the ore-body is continuous and averages from 3 to 15 ft. in width. The gangue is an altered limestone containing numerous vug-holes and small caves. The vug-holes are usually filled with vanadinite crystals of a brownish-black color. The larger cavities contain wall incrustations of the same material, or are filled with disintegrated masses of almost pure vanadinite. Seams of pure massive vanadinite are found, usually along the foot-wall of the vein or not very far removed therefrom. In some instances, as in the Dewey mine, fine crystallized vanadinite occurs in ^a manganese oxide gangue. A remarkable feature of all three veins is the transition from the soft, porous gangue containing the vanadite to a firm, silicified limestone (in some cases barite) containing galena in coarse crystals accompanied by small quantities of molybdate. The ores cannot be satisfactorily hand-sorted, consequently the entire vein filling is milled as mined.

The next important property is the Dewey. Altho not so well developed as the White Swan the mineralogical and structural conditions appear identical.

The Red Top property and extensions are not so well developed as the two others mentioned, but in view of the higher general average of the ores produced and the better surface indications, gives promise of becoming important producers. The vein on this property can be traced on the surface over a distance of 1,000 ft. Development consists of a vertical shaft about 100 ft. deep with drifts at the 40 and 80 ft. levels respectively. The ore shoot varies from a few inches at the surface to 6-8 ft. in width below the first level, and is similar in structure and

composition to the White Swan and Dewey properties. The vein filling in this is more uniform in grade, due ^{to} the more extensive surficial impregnation of the brecciated limestone.

There has not been sufficient prospecting work performed to determine the absolute extent of the ore deposits, but the district is worthy of more extensive development.

- Conclusion -

The average vanadic acid content of the vanadinite ores mined is from 1 to 3 per cent, which necessitates preliminary treatment at the properties. A small concentrator erected several years since by the Southwestern Lead & Coal Co. is being used by the Vanadium Mines Co. as a testing plant to determine the most efficient equipment for a modern mill to be constructed near the White Swan and Dewey mines.

An oxide plant was built at Cutter station to handle the vanadinite concentrates produced by the old concentrator at the mines, but it proved unsuccessful, and will therefore be dismantled and shipped to Pennsylvania. The sulphuric acid treatment employed to leach the vanadium from the concentrates did not effect a high percentage recovery of that metal; one of the other metallurgical processes would, no doubt, have proved more satisfactory.

The water supply is a very serious problem in the district. The Vanadium Mines Co. has a power and pumping plant several miles north of the mines near the Rio Grande, from which electrical power is transmitted to the several mines and the mill, and water is piped in a 4 inch spiral riveted pipe under a 350 ft. head.

The gross value of the crude ore containing 1%, or a unit of

vanadic acid is \$8 per short ton. Eastern and foreign market quotations for vanadiferous ores are: 40¢ per lb. vanadic acid contained F. O. B. New York, minimum content 10% per short ton. The commercial product is ferro-vanadium alloy, for which there is a price of \$4 to \$5 per lb. of metallic vanadium. The annual production of metallic vanadium is about 200 tons.