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Abstract

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CONDITIONS FOR THE FORMATION OF RHOMBOHEDRAL (3R) MOLYBDENITE

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I became very interested in the recent work of Khurshudyan ([1]) on the conditions for the formation of rhombohedral molybdenite ($3R$) in some deposits of the USSR, and I should like to set forth here a number of considerations concerning the first natural occurrences of this modification of molybdenite, described in Yellowknife (Canada). Perhaps they will be useful to other geologists in clarifying the conditions for the formation of this modification of MoS_2.

The author' s attention was first drawn to $3R$-molybdenite because of a peculiar blue-steel tint that this mineral displayed when examined in the light of a miner' s lamp underground, in the Con mine. This tint differed from the color of the usual hexagonal ($2H$) form of molybdenite. Subsequently Dr. Trail ([2]) identified this blue-steel molybdenite as a rhombohedral ($3R$) polytype.

Molybdenite occurs in small amounts in the Yellowknife district under three types of geological conditions: in pegmatites, in quartz veins, and as disseminations in quartz-feldspar porphyry ([3]).

Some of the quartz-feldspar pegmatites occurring in the highly metamorphosed schists and gneisses of the Yellowknife deposits contain small amounts of molybdenite that gives a normal $2H$ X-ray pattern. This molybdenite is associated with tourmaline, beryl, spodumene, amblygonite, lepidolite, scheelite, and other typical pegmatite minerals.

In the greenstone belt of the district, small amounts of molybdenite occur together with pyrite, chalcopyrite, and bismuthinite in milky-quartz veins, which locally cut amphibolite facies rocks and granodiorites. Such molybdenite likewise gives a normal $2H$ X-ray pattern.

The third and most interesting occurrence of molybdenite was found in quartz-feldspar formations in the same mine. Here molybdenite occurs mainly as disseminations in the groundmass of the porphyry, although small amounts of it are also found in thin quartz veinlets. In all these occurrences the mineral is associated with pyrite and pyrrhotite, which is likewise disseminated in the porphyritic rock. The X-ray pattern of this variety of molybdenite corresponds to the $3R$ polytype. These are the only occurrences in which molybdenite is associated with pyrrhotite.

The age relationships of these three types of formations containing molybdenite cannot be determined precisely, since the relations between them are not cross-cutting in character. However, the veins of white quartz and the veins containing molybdenite in amphibolite and granodiorite facies locally cut the feldspar porphyry, and these veins, like the porphyries, are intersected in this district by veins of gold-bearing quartz. On the basis of this feature it may be concluded that the sequence of events was as follows: (1) crystallization of the quartz-feldspar porphyry with the $3R$-molybdenite contained in it, (2) fracturing accompanied by the deposition of quar-

with $2H$ molybdenite, and (3) shearing, accompanied by the deposition of gold quartz veins.

Spectrographic analysis of molybdenite taken from deposits of all three types shows no appreciable differences in the content of the elements. Perhaps the $3R$ variety contains somewhat more iron and somewhat less arsenic and lead than the $2H$ variety. In rhenium content, the two types of molybdenite differ little from one another, judging from chemical analyses of samples made many years ago. However, these analyses may no longer meet the requirements imposed on analysis for this element by modern methods.

The temperatures of deposition of quartz associated with both the $2H$ and $3R$ varieties of molybdenite were determined several years ago by the decrepitation and thermography method ([4]). In general, the temperature of quartz associated with the $3R$ variety was on the order of 330°C, although some samples gave lower values—about 190°. Similar values were also obtained for quartz in veins containing the $2H$ variety of molybdenite. The temperature of deposition of quartz in younger gold-quartz veins ranged between 135 and 275°. These data indicate that most of the molybdenite was probably deposited at temperatures from 275 to 330°, i.e., in the interval between medium and low temperatures of vein deposition.

The reasons cited in the literature to explain the formation of $3R$ molybdenite seem unclear to me. Khurshudyan ([1]) believes that the $3R$ polytype forms in the range between medium and low temperatures. This conclusion apparently agrees with the geological and geothermometric data obtained in Yellowknife. However, the synthetic data cited by Bell and Herfert ([5]) indicate that this polytype is stable at least up to 900°, which corresponds to the temperature at which they synthesized molybdenum disulfide. Other authors who have studied the problem of the formation of $3R$ molybdenite, mentioned by Khurshudyan, apparently believe that a high rhenium content is responsible for the formation of the $3R$ variety of molybdenite. This may be correct for some deposits, although Khurshudyan and others have shown that in certain deposits this is not the case. I rather suspect that the stabilization of molybdenite as its $3R$ polytype depends not on temperature, but on the presence in its structure of some, perhaps specific, trace or minor element. This may be either copper or iron, with the latter probably playing the predominant role.

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Note: Figure translations are in progress. See original paper for figures.