

is less than 0.005° . In the present work this permitted the determination of the unit cell dimensions of zircon to approximately 1.5 parts in 10,000.

At the moment it appears doubtful that this technique can be improved appreciably. The main residual error now lies in the measurement of the 2θ values on the strip chart. This in turn is probably controlled mainly by fluctuations in the count rate of the spectrometer. The present technique therefore probably represents the extreme of accuracy to which x -ray powder spectrometry can be carried with the Norelco instrument.

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BEYRICHITE, A DISCREDITED SPECIES*

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Inasmuch as many museums and private collections possess specimens labeled beyrichite and there seems to have been no unambiguous statement in the literature concerning its status, it is hoped that this note may remove whatever uncertainty or confusion may exist in regard to beyrichite. To summarize the following data, the original description probably referred to what we now term violarite, and all specimens of so-called beyrichite which we have been able to examine have been shown to be well-known minerals or artificial substances.

Beyrichite was first described by K. Th. Liebe (1871) from "Lammerichs Kaul Fdgrb," Westerwald, Germany. Its specific gravity was 4.7 (millerite sp. gr. 5.9), color lead gray, and composition determined as $3\text{NiS} \cdot 2\text{NiS}_2$ or $2\text{NiS} \cdot \text{NiS}_2$. A loss of sulfur on heating was construed by Liebe as indicating change of beyrichite into millerite; he also held that beyrichite, by addition of nickel from solution, forms millerite. Liebe's views were adopted by Laspeyres (1892), who went so far as to assert that all millerite is an alteration product of beyrichite and that the change involves only the physical properties—color and density—with no chemical or crystallographic change. Hintze (1904) summarizes the early literature, and accepts beyrichite as a dimorph of millerite. He notes that unchanged beyrichite is known from only one locality—Altenburg near Oberlahr (Grube Lammerichskaule) in Rhenish Prussia.

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We have tried to obtain all specimens labeled beyrichite and have examined six such specimens. X-ray and other studies of these six specimens have given the results tabulated below.

COMPOSITION OF "BEYRICHTES"

| Source | Locality | Found |
|--|--|---|
| Brush Collection, Yale University, Brush Collection 5330 | Dillenburg, Germany | Millerite (and a very little unidentified material) |
| U. S. Geological Survey | Etna mine, Napa County, Calif. | Violarite (on cinnabar) |
| U. S. National Museum | Roebing Collection 617, Westerwald, Germany | Iron carbide with iron |
| | Canfield Collection 520, Eisleben, Saxony | Bismuth, bismuthinite, and niccolite, etc. |
| Harvard Museum | Holden Collection 82029, Eisleben, Saxony | Goethite |
| | Holden Collection 82030, Lammerichskaule mine, Westphalia, Germany | Emplectite |

In answer to an inquiry, G. F. Claringbull, Acting Keeper of Mineralogy, The British Museum, wrote as follows ". . . B. M. 1913348 was originally labeled millerite with beyrichite, linnaeite and copper pyrites . . . locality . . . Victoria Mine, Littfeld, Westphalia. The specimen consists of an intergrowth of chalcopyrite, galena, and linnaeite shot through with needles of millerite. . . ."

H. Strunz (personal communication) has written that having been for some years dubious as to the nature of beyrichite, he had sought specimens in the Humboldt University of Berlin, and on receiving our request for the loan of material had further gone through the collection of the Technische Hochschule in Berlin and the Hochschule at Regensburg, without finding any. A similar reply was received from H. Schneiderhöhn of the Mineralogisches Institute of the University of Freiburg. Other attempts to obtain specimens, as by a notice in this journal (vol. 39, p. 151, 1954), were also unsuccessful.

In a study, now in progress, of the mineralogy of the nickel mineralization in southwestern Wisconsin, we have noted extensive replacement of millerite, NiS, by violarite $(\text{Ni, Fe})_3\text{S}_4$, also perhaps by bravoite $(\text{Fe, Ni})\text{S}_2$, and, rarely, by chalcopyrite. The properties of violarite (including specific gravity, 4.79) agree reasonably well with those re-

ported by Liebe, Laspeyres, and others for beyrichite. Where a nickel sulfide is actually in question, it is probable that, in most instances, violarite is present replacing millerite. Violarite, it may be noted, was not established as a species until 1924, when it was described by Lindgren and Davy; although it had been noted by Calkins (1916) and by Hudson (1922) as "polydymite," by Tolman and Rogers (1916) as "pentlandite," and by Buddington (1924) as an unknown "not pentlandite-bravoite?." Short and Shannon (1930) identified it correctly as violarite; but shortly thereafter Schneiderhöhn and Ramdohr (1931, p. 173) confused violarite with bravoite. Although Schneiderhöhn and Ramdohr (1931, p. 177-178) rejected Short and Shannon's correct confirmation of Lindgren and Davy's violarite and proposed that the name violarite be dropped, they nevertheless in a discussion of millerite (Schneiderhöhn and Ramdohr, 1931, p. 145-146) were undoubtedly referring to violarite, as follows (in translation): "Formerly it was generally believed that millerite formed by replacement of a mineral 'beyrichite,' of similar or identical composition. No support for this is found by microscopic study. But several specimens of millerite are crusted with an extremely delicate coating of a soft, gray-white, strongly pleochroic mineral, which appears quite different from the millerite needles in the same specimen." Unquestionably Schneiderhöhn and Ramdohr are describing violarite. In view of this history of violarite, it is not surprising that as "beyrichite" it was so misunderstood by the early workers.

It might be suggested that the name beyrichite should have priority over violarite, and this suggestion is made specifically with the idea of discouraging it. After many vicissitudes, the name violarite is now in good standing for a well-defined mineral species, and beyrichite is not.

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LLAMA BONES WITH LEAD-COPPER MINERALIZATION FROM BOLIVIA*

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In assembling materials for a paper dealing with the preservation of fossils being prepared by a member of the U. S. Geological Survey, it was learned that there were some mineralized and supposedly fossil bones in the paleontological collections at Harvard College. The bones were reported to be replaced by copper or copper compounds. Through the kindness of Dr. Alfred S. Romer of the Museum of Comparative Zoology, the bones (Fig. 1) were borrowed for examination. They are labeled in German: "Vertebrae impregnated with copper—mineral collection of Friedrich Ahlfeld."

The bones are notably heavy and show perfectly preserved bone structure. They consist of calcium phosphate largely replaced by green and red oxides (massicot and litharge) and also probably by lead phosphate, with metallic lead, copper, and probably traces of silver. Figure 2 shows a polished section of the bone. Figure 3 is of another polished section showing replacement of bone by lead oxide.

The observed relations of the metallic lead and copper are in all respects those that would follow from the cooling of a melt consisting of lead with some copper, as may be seen from consideration of the equilibrium diagram for the Pb-Cu system (Fig. 4). It is possible that in a cupellation process bones were used for some reason, instead of the customary bone ash. Molten lead then would seep down, with its dissolved copper (and perhaps silver), to lodge eventually in the bone pores and there crystallize. At the same time oxide compounds of these metals would crystallize as illustrated.

To confirm or disprove this hypothesis of the mineralization of the bones, inquiry was made of Señor Ahlfeld, who, under date of May 4, 1954, stated that "the bones were those of the modern llama collected from the surface near an old copper smelter in the Corocoro district."

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