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## UNUSUAL GALENA FROM THE BOULDER BATHOLITH, MONTANA[1]

WILLIAM P. SHULHOF
*AC Spark Plug Division, General Motors Corporation, Flint, Michigan*
AND
HAROLD D. WRIGHT
*Department of Mineralogy, The Pennsylvania State University, University Park, Pennsylvania*

During studies of some uranium-bearing veins in the Boulder batholith, Montana, a mineral of unusual appearance was encountered in polished sections of ore from the Lone Eagle mine. This mineral was ultimately proven to be galena, and it was called galena "B" (Wright and Shulhof, 1957) to distinguish it from the associated ordinary galena "A." In polished section the unusual galena resembled uraninite, so much so that it proved impossible to identify the two by simple observation. Because of the importance of uraninite in these studies the impostor had to be carefully worked out. Further, a comparison of the isotopic composition of a possibly radiogenic galena with that of associated common galena could have important bearing on the interpretation of age and origin of the "siliceous reef" and the "base metal" uraniferous deposits of the batholith (Wright, 1956).

Galena "B" is in formless, somewhat rounded blebs ranging from a few microns to 0.5 mm. in length. In polished sections it appears as a soft (hardness B), seemingly sectile, opaque mineral having a tan to gray color and low but variable reflectivity resulting in a faintly mottled appearance. Some of the galena "B" is intergrown with other ore minerals, especially uraninite, although most is in isolated blebs in the microcystalline quartz gangue. Etch tests with the usual reagents suggested galena, and microchemical tests confirmed lead and silver. The lack of the characteristic cleavage pits, high polish and white color of galena masked its identity for some time.

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A qualitative spectrographic analysis of carefully selected material indicated the following approximate composition for the unidentified mineral:

| | | | |
|---|---|---|---|
| Pb | 10% | Mg | <0.1% |
| Ag | 0.1–10% | Fe | <0.1% |
| Mo | 0.1–10% | Ca | <0.1% |
| Si | 0.1–10% | Cu | <0.1% |
| Al | <0.1% | V | Not detected |
| Sb | <0.1% | Th | Not detected |

A qualitative wet-chemical analysis showed roughly 10% of sulfur. Selenium was not detected.

Alpha autoradiographs of several polished sections showed no appreciable activity in blebs of microscopically pure galena "B." They did prove useful for differentiating the mineral from uraninite by direct comparison of the polished section and autoradiograph using a comparison eyepiece.

Powder *x*-ray diffraction photographs confirmed galena conclusively, with quartz the only determinable impurity.

Fine crystal size seemed a possible explanation for the unusual appearance and properties of galena "B." Randomly oriented crystallites of a few microns' diameter should result in a lower polish and variable reflectivity, and a gray rather than white color in vertical illumination. This would also account for the lack of characteristic cleavage pits. A Laue *x*-ray photograph showed concentric circles, some continuous, others of closely spaced spots. The pattern confirmed the fine crystal size of the galena and suggested an approximate diameter for individual crystallites on the order of $10^{-4}$ cm. (Taylor, 1952).

The presence of uranium as a source of lead was considered in connection with the association of very sparsely distributed, minutely crystalline galena, with rather abundant ordinary galena. J. Laurence Kulp and Donald S. Miller of the Lamont Geological Observatory, Columbia University, provided lead isotope analyses of the two galena varieties. The isotopic analysis of the ordinary galena "A" is as follows:

| $Pb^{204}$ | $Pb^{206}$ | $Pb^{207}$ | $Pb^{208}$ |
|---|---|---|---|
| $1.362 \pm 0.008$ | $24.77 \pm 0.07$ | $21.28 \pm 0.06$ | $52.60 \pm 0.08$ |

Galena from six other mines in the Boulder batholith has a similar isotopic composition. No significant difference was reported* in the analysis of galena "B," and the presence of uranium as a source of lead appears to have had little to do with its composition.

Two other explanations of galena "B" were considered: (1) colloidal

* Dr. Donald S. Miller, oral communication.

deposition and (2) grain for grain replacement of the uraninite. The possibility of colloidal deposition receives a little support from the close association of galena "B" with microcrystalline quartz gangue containing small grains of cryptocrystalline uraninite and microscopic grains of pyrite, sphalerite and some other sulfides (Wright and Shulhof, 1957). This association represents a second stage of mineralization in the Lone Eagle Mine, apparently contemporaneous with the introduction of the "siliceous reef" uraniferous veins having an essentially identical assemblage. The ordinary galena "A," on the other hand, occurs with megacrystalline quartz and base metal sulfides of an apparently earlier mineralization stage related to the large base metal deposits of the batholith (Wright, 1956).

Objections to the colloidal idea are the lack of any textural evidence (botryoidal outlines, syneresis cracks, etc.) in the galena itself, or in the associated minerals (except uraninite).

Grain-for-grain replacement of uraninite by galena appears to agree most nearly with the observed facts. The formless rounded blebs of galena resemble the associated uraninite both in shape and in their generally isolated occurrence in microcrystalline quartz. The crystallite diameter of the galena "B" lies within the range ($<10^{-3}$ cm.) observed for pitchblende (Croft, 1954). More direct evidence is found in the intimate association of uraninite with galena "B" in a few grains.

It appears that the intriguing thought of radiogenic galena of unusual habit occurring with galena of normal habit and isotopic composition, must be discarded in favor of a more commonplace process, replacement.

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