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Benleonardite, a new mineral from the Bambolla mine, Moctezuma, Sonora, Mexico

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ABSTRACT. Benleonardite, ideally $Ag_8(Sb,As)Te_2S_3$ with Sb > As, is a new mineral species that occurs in ore specimens collected from the dumps of the disused Bambolla mine, Moctezuma, Mexico. The associated minerals are acanthite, hessite, an unnamed Ag_4TeS phase, pyrite, sphalerite, and native silver. Together with benleonardite, these form thin black crusts in fractures filled with quartz and dolomite in highly altered, tuffaceous, andesitic and rhyolitic rocks. Benleonardite is an opaque mineral and, in reflected plane-polarized light in air, it is weakly bireflectant from very pale light blue to slightly darker blue. It is not pleochroic. Luminance values (relative to the CIE illuminant C) for R_o and R'_e computed from visible spectrum reflectance data for the most bireflectant grain, are 33.6 and 31.7% in air, and 18.3 and 16.5% in Zeiss oil (N_D 1.515) respectively. Vickers micro-indentation hardness is 105-125 (VHN_{25}). The X-ray powder diffraction pattern could be indexed on a tetragonal cell with a 6.603(5) and c 12.726(6) Å; for $Z = 2$, the calculated density is 7.79 g/cm^2 for the average analysis. The strongest five lines in the X-ray powder pattern are [d in Å (I) (hkl)]: 12.7 (70) (001); 3.188 (30) (021,004); 2.936 (100) (022); 2.608 (35) (023); 2.158 (35) (124).

KEYWORDS: benleonardite, new mineral, Bambolla mine, Moctezuma, Mexico, reflectance data, X-ray data.

BENLEONARDITE, $Ag_8(Sb,As)Te_2S_3$, is a new mineral species found in a polished section of one of a number of ore specimens collected (by AJC) from the spoil tips of the abandoned Bambolla mine (also known as Mina La Bambolla and Mina La Moctezuma; Gaines, 1970), Moctezuma, Sonora, Mexico (29° 41′ N. 109° 43′ W.). It is associated with native silver, acanthite, hessite, an unnamed Ag_4TeS mineral, pyrite, and sphalerite. These occur as thin black powdery crusts (1-2 mm thick) which, together with gangue quartz and dolomite, occupy irregular fractures in a highly altered rock described by Williams (1982) as an intensely silicified rhyolitic vitrophyre. Gaines (1965) suggested that other volcanic rocks in the vicinity were andesitic and probably of Late Cretaceous age.

Benleonardite is named in recognition of the contribution to ore mineralogy of Dr Benjamin Franklin Leonard (b. 12 May 1921) of the United States Geological Survey, Denver; Vice Chairman of the Commission on Ore Microscopy, International Mineralogical Association 1982-6. The mineral and the name benleonardite have been approved by the Commission on New Minerals and Mineral Names, International Mineralogical Association.

Type material is preserved at the British Museum (Natural History) in polished mount E.1161; BM 1985, 354.

Qualitative optical properties. The section containing benleonardite was polished using the method of Criddle *et al.* (1983). Benleonardite takes a perfect polish and its polishing hardness is low, although greater than that of hessite.

Benleonardite forms monomineralic crusts (< 1 mm across) around hessite and around partially altered acanthite and it is intergrown with hessite, acanthite, an unnamed Ag_4TeS phase and an unidentified gangue mineral (fig. 1). It is fine-grained, the largest grains being no more than 40 μm wide. Typically, these form aggregates in which the anhedral grains show random growth impingement boundaries. Where benleonardite is closely associated with hessite and the unnamed Ag_4TeS phase it shows a strong tendency to form laths 5-20 μm by 50-60 μm (fig. 1).

In plane-polarized light (colour temperature about 3200 K), in air, benleonardite is weakly bireflectant from very pale light blue to slightly darker blue. It is not pleochroic. In immersion oil (N_D 1.515), it is moderately bireflectant and apparently pleochroic from light grey to pale bluish grey (but see below). Benleonardite appears darker and blue against the creamy, slightly pink, hessite. Between crossed polars its anisotropy in air is moderate to strong. The sequence of anisotropic rotation tints is: dark brown, dark blue, blue-grey, dark brown, light brown. With the polars uncrossed by 3° the tints are: mid-greenish brown, light brown-grey, muddy brown, steel blue. The tints are darker but unchanged in hue in immersion oil. Simple twinning is common.

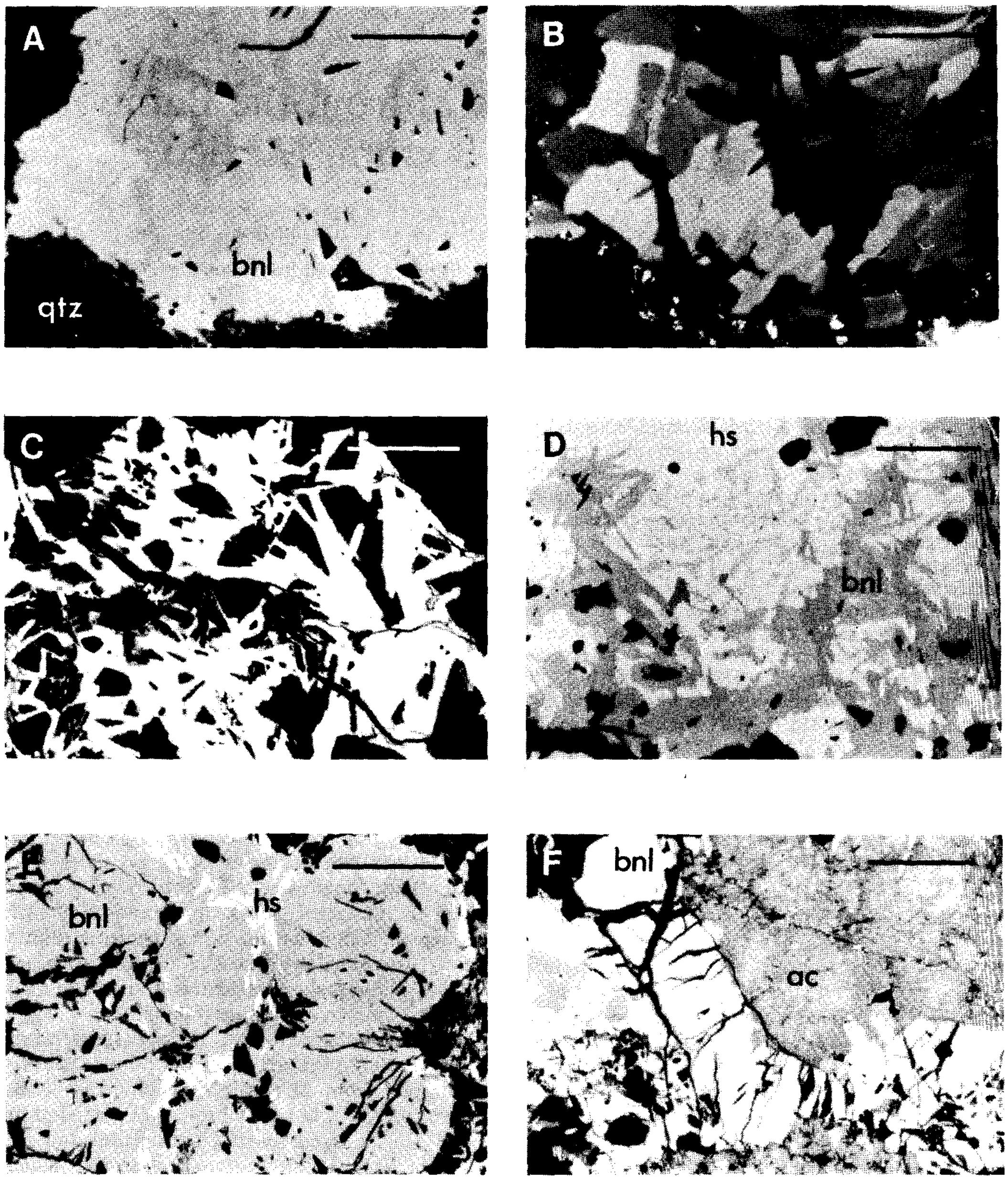

FIG. 1. Reflected light photomicrographs of benleonardite; plane-polarized light with oil immersion. A. Part of a crust of benleonardite illustrating its weak bireflectance. Scale bar: 30 μm. B. Same area as for A (but with crossed polars) illustrating the randomly oriented anhedral grains of benleonardite. Scale bar: 30 μm. C. Lath-like development of benleonardite with voids suggesting cavity infill. Scale bar: 60 μm. D. Laths and aggregates of benleonardite intergrown with hessite and the unnamed Ag_4TeS phase. Scale bar: 60 μm. E. Crusts of benleonardite with inclusions of hessite. Scale bar: 80 μm. F. Fractured rim of benleonardite surrounding acanthite, the latter extensively replaced by an unidentified gangue phase. Scale bar: 80 μm.