Economic Geology
Vol. 97, 2002, pp. 145–157

$^{40}Ar/^{39}Ar$ Geochronologic Constraints on the Timing of Massive Sulfide and Vein-Type Pb-Zn Mineralization in the Western Meseta of Morocco

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Abstract

The Meseta domain of Morocco is located on the southern margin of the late Paleozoic Hercynian orogenic zone. $^{40}Ar/^{39}Ar$ ages of igneous and hydrothermal minerals (biotite and illite) were analyzed from a representative massive sulfide deposit at Hajar (1.5 Mt Zn, 0.45 Mt Pb, 0.11 Mt Cu, and 900 t Ag) and a vein-type deposit at Tighza (1.0 Mt Pb, 0.3 Mt Zn, and 1,000 t Ag) in the western Meseta.

A weighted mean age of hydrothermal biotite of the Hajar deposit is 300.9 ± 2.6 Ma (2σ uncertainty), identical to a hydrothermal illite age of 305.4 ± 4.8 Ma. These two ages are calculated from about 93 percent of the released ^{39}Ar. Another illite age, calculated from 74 percent of the released ^{39}Ar, 313.4 ± 9.1 Ma, overlaps with or is slightly older than these concordant ages. These $^{40}Ar/^{39}Ar$ results indicate that the biotite and illite alteration of the Hajar deposit formed almost simultaneously at 304 to 300 Ma. This age range is younger than the Visean age previously assumed on the basis of geologic setting. These $^{40}Ar/^{39}Ar$ ages are interpreted as the age of hydrothermal activity subsequent to massive sulfide mineralization. A magmatic intrusion beneath the deposit may have triggered this hydrothermal activity.

Three $^{40}Ar/^{39}Ar$ weighted mean ages and one plateau age from the Tighza deposit range from 280.6 to 267.7 Ma. Igneous biotite of the Kaolin granite and hydrothermal illite of the Ighrem Aouss and North veins in the deposit indicate ages of 280.6 ± 5.5 Ma, 280.6 ± 3.1 Ma, and 275.5 ± 3.4 Ma, respectively. These three ages are identical within 2σ uncertainties. The age of the hydrothermal biotite from the Mispickel granite, 267.7 ± 2.3 Ma, is slightly younger. This younger age may have resulted from two periods of magmatic-hydrothermal activity or from resetting of hydrothermal biotite by Ar loss. Regardless, these ages indicate that granite intrusion and hydrothermal alteration associated with galena- and sphalerite-bearing veins occurred mainly at 280 to 275 Ma in the Tighza deposit. The identical ages of the magmatic intrusion and hydrothermal alteration suggest that the vein-type Pb-Zn mineralization, as well as W mineralization, was associated with the magmatic intrusion.

The influence of the late deformation and metamorphic overprint may be related to the lowest-temperature steps of the analytical data. The dates obtained from the lowest-temperature steps from both the Tighza and Hajar deposits concentrate between 235 Ma and 220 Ma. This time range is compatible with the geologic constraints on the deformation, and these dates are thus attributed to the post-Visean regional metamorphism.