

Geology of the Beltana Willemite Deposit, Flinders Ranges, South Australia

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Abstract

Beltana is a high-grade hypogene willemite deposit hosted in Lower Cambrian carbonate rocks in the Arrowie basin, northern Flinders Ranges, South Australia. It is situated adjacent to a major growth fault on the basin margin. Ooid grainstone units of the Woodendinna Dolomite and units of *Archaeocyathid*-rich Wilkawillina Limestone are the main host lithologies. Lead minerals in subeconomic quantities are also present in karstic collapse breccias surrounding the willemite orebodies.

Mineralization is structurally controlled and associated with brecciation and extensive hematite-rich hydrothermal zincian dolomitization. Ore minerals include willemite and coronadite with lesser mimetite, hedyphane, and smithsonite. Late-stage gangue minerals include manganocalcite, dolomite, and minor quartz. The texture of willemite is heterogeneous, resulting from various depositional mechanisms such as partial to massive replacement of the carbonate host rock, internal sedimentation, fracture fill, brecciation, and vein fill. On the periphery of the deposit, smithsonite formed by weathering of willemite.

Beltana is centered on a karstic collapse breccia that extends at least 100 m vertically, formed in part through corrosion by acidic ore solutions. The geochemical signature of the orebody includes high levels of Zn, Pb, Cd, As, and Mn. Notably, silver is absent from the deposit and sulfur concentrations are low (<20 ppm). Fluid inclusion studies yield a low minimum temperature range of ore deposition between 50° and 170°C. K-Ar dating of coronadite associated with the willemite orebody indicates an age of formation of $\sim 435 \pm 5$ Ma.

Premining resources of willemite ore were 850,000 t at 36 percent Zn, and an associated body of subeconomic lead contained more than 800,000 t at 8.9 percent Pb, 3.9 percent Zn and 1 percent As. The deposit has some similarities with Mississippi Valley-type deposits but differs in ore and alteration mineral assemblages.

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