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Tectonic Environment of Shale-Hosted Massive Sulfide Pb-Zn-Ag Deposits of Proterozoic Northeastern Australia

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Abstract

The large shale-hosted massive sulfide Pb-Zn-Ag deposits of the North Australian craton occur within basins that evolved in a continental setting in the overriding plate of a major subduction zone. The evolution of these basins is characterized by ~140 m.y. (ca. 1800–1660 Ma) of lithospheric thinning, elevated heat flow, and the development of a complex network of extension-related normal and strike-slip fault systems. During this interval there were transient episodes of accelerated extension and basin inversion associated with crustal shortening. The shale-hosted massive sulfide Pb-Zn-Ag deposits are hosted within the Isa superbasin (ca. 1660–1590 Ma). The dominant process in the evolution of this superbasin was thermal subsidence (sag) of the lithosphere, resulting in the development of anoxic subbasins in an environment of long-term elevated heat flow. However, transient episodes of lithospheric extension maintained elevated geothermal gradients and drove the migration of hydrothermal fluids in the upper crust. We speculate that the basin evolution before ca. 1660 Ma preconditioned the upper crust for mineralization. Prerift and synrift felsic volcanism and clastic successions beneath the Isa superbasin were suitable metal sources and aquifers during deformation events, when basinal fluids were able to migrate as the result of pulses of deformation-induced dilatancy. Reactivation of the basin fault architecture associated with far-field stresses imposed by plate boundary conditions focused fluid movement and mineralization in the upper parts of the basin. We propose that far-field, continental back-arc environments are favorable for the development of shale-hosted massive sulfide Pb-Zn-Ag mineralization because they often have relatively protracted extensional histories and they are more susceptible to tectonic reactivation, reestablishment of elevated thermal gradients, and changes in regional stress regimes during postextensional basin evolution.

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