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The Teena Zn-Pb deposit (McArthur Basin, Australia): Carbonate Replacement Sulfide Mineralization During Burial Diagenesis

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Lindgren first discussed the principal of balancing volumes in mineral replacement reactions more than a century ago (Lindgren, 1912). This work is now being revisited in recent genetic models of the largest Zn deposits (clastic dominant; CD-type), which involve host-rock replacement. In the Proterozoic Carpentaria Zn Province, there are a number of world-class CD-type deposits. The Teena deposit is hosted by an exceptionally well preserved subbasin in the Carpentaria Province and in the same stratigraphic unit as the nearby McArthur River (HYC) deposit. A combination of data sets (geophysical, structural, geochemical, sedimentological, and petrographic) have been combined to produce a model for subbasin development that addresses key aspects of the structural and hydrothermal evolution of the Teena mineral system. Petrographic data show that sulfide mineralization postdated the formation of fine-grained diagenetic pyrite (py1) and dolomite nodules and resulted from lateral subsurface fluid flow at least several hundred meters below the most reducing sedimentary facies. To evaluate the deposit-scale role of mineral replacement reactions, a large whole-rock lithogeochemistry data set (n = 2,705) was developed in the Teena subbasin. The unmineralized protolith (dolomitic siltstone) and mineralized end members have been defined and evaluated in a chemical mass balance analysis. The results clearly show the addition of hydrothermal sulfides (and associated trace elements) and corresponding loss of dolomite. Although key assumptions relating to lithofacies variability should be carefully considered, the extent to which molar volumes are balanced in a dolomite replacement reaction indicates that this was the primary mineralization pathway in the Teena subbasin. As metals were likely transported in an oxidizing fluid, disequilibrium with the host rock and in situ acid generation potential would have been important factors for reaction permeability and preferential replacement of carbonate units. High-grade mineralization formed at the stratigraphic redox boundary between an oxidized footwall sequence and a host-rock facies that contained the necessary components (dolomite, organic matter, reduced sulfur) for effective subseafloor replacement.