Basin Reconstruction and Dissecting Vein Population: Implications for Exploration of Sedimentary-Hosted Copper Deposits

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In Western Australia, sedimentary-hosted copper (Cu) deposits such as Nifty can be found within the Neoproterozoic Yeneena Basin. The Yeneena Basin formed as an extensional basin that was subsequently inverted during two shortening events: the Miles Orogeny (ca. 680–650 Ma) and the Paterson Orogeny (ca. 580–530 Ma). The mineralisation at the Nifty Cu-deposit is stratabound and vein-hosted and interpreted to have formed as a result of multiple pre-shortening and syn-shortening mineralisation events, corroborated by geochronological data.

This study aims to determine (1) the basin's three-dimensional structural architecture during the different mineralising events, (2) the different vein sets, and (3) the genetic link between vein sets and basin evolution. We have compiled pre-competitive geological and geophysical datasets and collected new structural, mineralogical, geochemical, and isotopic data of veins and host sequences from 17 regional drill holes. Integrating these datasets, we constructed four regional balanced cross-sections to decipher the basin's structural evolution.

Basin reconstruction suggests that the basin was segmented into smaller sub-basins separated by basement highs during the extensional phase. During the basin inversion, the shortening was accommodated primarily by folding, followed by reverse faulting. We have identified four dominant vein sets: Set I (high-angle to bedding), Set II (bed-parallel), Set III (vein strike parallel to hinge lines), and Set IV (vein strike parallel to the shortening direction). There are variable vein compositions, including quartz-vein assemblages and a set of veins associated with different carbonate mineralogy. The dominant geochemical signature of carbonate veins indicates a seawater-brine origin in diagenetic- and epigenetic-related (folding) vein sets, suggesting fluids remobilisation from within the basin under variable temperature regimes.

Linking vein structural, mineralogical, geochemical, and isotopic data with basin evolution suggests that Set I formed during basin development, while Sets II (pre-folding), III and IV (syn- to post-folding) formed during basin inversion.