

Exploration for SEDEX-Style Base Metals in the Lower McArthur Basin: Sniffs in the Tawallah Group, Northern Territory, Australia

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The Paleoproterozoic sediments of the mid McArthur Basin (McArthur Group) are known to host sedimentary “exhalative” (SEDEX) McArthur-type Zn-Pb deposits, such as the supermassive Here’s Your Chance (HYC) orebody. The HYC deposit is hosted within the 1.64 Ga Barney Creek Formation, a sequence of pyritic carbonaceous dolomitic shales, which was deposited in an extensional rift setting during active tectonism. Base metal sulfide deposition occurred as oxidizing metal-bearing brines were expelled from underlying sediments into unconsolidated reduced sediments via synsedimentary faults. McArthur-type mineralizing fluids are thought to have been sourced from oxidized volcanic-bearing stratigraphy of the lower McArthur Basin, with sulfide deposition occurring in the Barney Creek Formation due to the strongly reducing geochemistry, unique to the McArthur Group. The older Tawallah Group sediments in the lower McArthur Basin have a similar depositional setting to their younger counterparts in that they were deposited in extensional basins with syndepositional tectonism. Thus, if similar oxidized, metal-bearing basinal brines were introduced to reducing facies in the Tawallah Group in a similar way to the Barney Creek Formation, it raises the prospect for SEDEX-style mineralization in the lower McArthur Basin.

The ~1.78 Ga McDermott and ~1.73 Ga Wollongorang formations (Tawallah Group) both contain carbonaceous dolomitic siltstones deposited in subtidal and supratidal shallow marine environments, with later near-shore fluvial clastic sandstones. Our observations suggest the carbonaceous facies of the Wollongorang Formation were deposited under intermittently euxinic conditions, with periodically high concentrations of sedimentary pyrite deposition. The carbonaceous shales in the older McDermott Formation contain considerably less early pyrite, and we suggest a sulfide-poor, anoxic depositional environment. Localized fault-bound subbasins likely facilitated lateral facies variation, which is evident from synsedimentary breccias.

The presence of evaporitic oxidized facies within the McDermott and Wollongorang formations along with evidence for synsedimentary brecciation in reduced shales are good criteria for SEDEX-style base metal deposition. Both formations overlie intrusive basaltic/doleritic units, which could have been an effective source of base metals to oxidized brines required for base metal sulfides. Detailed X-ray petrography and new assay data from historical drill cores indicate multiple horizons of stratiform and sediment breccia-hosted base metal sulfide within carbonaceous shale units, with ore-grade Zn concentrations. A close association between sphalerite and ferromanganese dolomite alteration draws comparisons with the younger SEDEX mineralization in the McArthur Group. Additionally, SEDEX alteration indices, used demonstrably as a vector to the orebody at HYC, indicate the sediments analyzed in this study are marginally below the ore window when compared to those at HYC.

Although our interpretations are constrained by limited drilling, our observations suggest there was at least localized active circulation of metalliferous brines in the Tawallah Group basin. High-grade sulfide deposition in reduced facies and concomitant carbonate alteration may represent distal expressions of larger, hitherto undiscovered SEDEX-style deposits. Furthermore, abundant pyrite and high molybdenum in the Wollongorang Formation suggest the global oceanic sulfate concentration was

sufficient by ~1.73 Ga to engender intermittent but strong bottom-water euxinia during shale deposition, thus providing a robust chemical trap for base metal sulfide mineralization.