SEG 100 Conference: Celebrating a Century of Discovery

B2

Sequence stratigraphy in stratiform sediment-hosted base metals exploration: An example from the ca. 1640 Ma Barney Creek Formation, McArthur Basin, Australia

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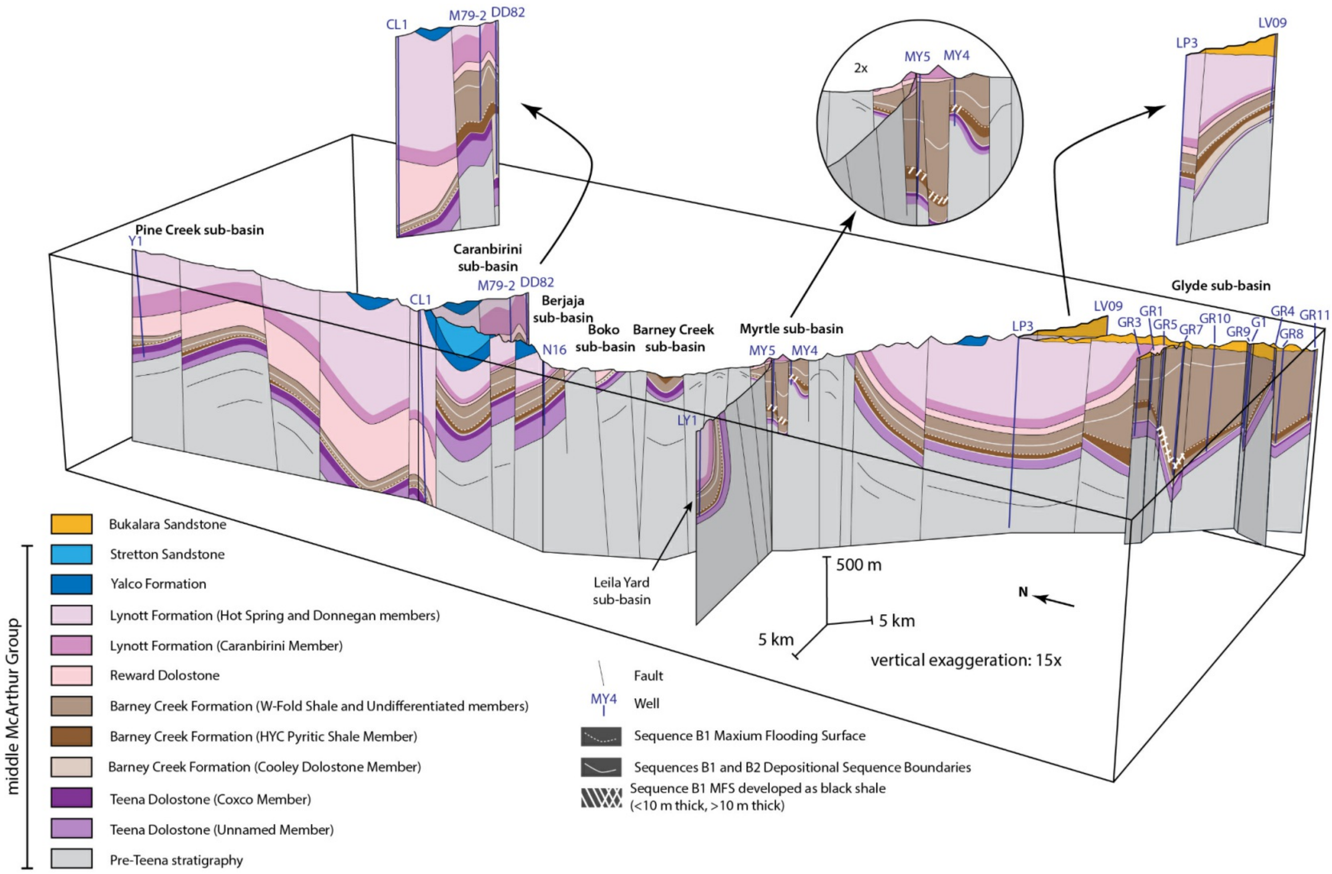
The McArthur Basin is part of a Proterozoic basin system on the North Australia Craton that represents one of the most prospective provinces for clastic-dominated Zn-Pb deposits in the world. The ca. 1640 Ma Barney Creek Formation is the most important target unit in the McArthur Basin, hosting the McArthur River and Teena Zn-Pb deposits. The Barney Creek Formation was deposited in a highly compartmentalized basin, characterized by sub-basins and paleohighs on the scale of mostly <10 km. The mineralization in the Barney Creek Formation is typically stratiform and hosted by pyritic, organic matter-rich, dolomitic siltstone deposited in sub-basin depocenters. The timing of mineralization is debated, with traditional SEDEX models favoring syngenetic mineralization on the seafloor, and emerging diagenetic-epigenetic models focusing on sub-seafloor replacement of carbonate laminae. The Barney Creek Formation is 10—900 m thick. Facies analysis indicates it was mostly deposited by turbidity currents below storm wave base, although shoaling to shallow subtidal carbonate environments locally occurred on paleohighs. The formation comprises one complete (B1) and one incomplete (B2) depositional sequence. The transgressive systems tract of depositional sequence B1 records deepening from peritidal carbonate environments of the underlying Teena Dolostone to offshore environments in the lower Barney Creek Formation. It culminates in a maximum flooding surface (B1 MFS), which is developed as organic-rich, weakly sulfidic dolomitic siltstone on paleohighs and in shallow parts of sub-basins. In contrast, it can be developed as highly organic-matter rich and strongly sulfidic black shale in sub-basin depocenters. Where the B1 MFS is a highly organic-rich and sulfidic black shale, it is expected to act as redox-chemical trap in traditional syngenetic models for mineralization. In contrast, following compaction due to burial, it would have acted as a seal to ascending metalliferous brines in recent diagenetic-epigenetic models for the McArthur River and Teena deposits. This scenario implies that the mineralization should occur in the transgressive strata below the maximum flooding surface. Regardless of the preferred model for mineralization, the relationship between the transgressive strata, maximum flooding surface, and mineralization, demonstrate that it is critical to I) map this maximum flooding surface across the basin, and II) create facies maps that show where in the basin this surface is developed as mudrock (i.e., chemical trap or seal). Integration of these data with the modern-day structural architecture of the basin, and with information on the distribution of the metal source, suitable aquifer facies, and potential fluid flow conduits, can significantly improve targeting (Fig. 1). The principles observed from sequence stratigraphic analysis and the mineralization in the Barney Creek Formation can be generalized for other sediment-hosted ore deposit types. Fig. 1: Three-dimensional cross-section across the southern McArthur Basin connecting all facies and gamma-ray logged drill cores of this study. Shown is also the B1 MFS and whether it is developed as black shale (i.e., ideal trap or seal facies).



CL1
M79-2
DD82
2x
MY5
MY4
LP3
LV09
Pine Creek sub-basin
Y1
Caranbirini sub-basin
CL1
M79-2
DD82
Berjaja sub-basin
N16
Boko sub-basin
Barney Creek sub-basin
Myrtle sub-basin
MY5
MY4
LY1
Leila Yard sub-basin
LP3
LV09
Glyde sub-basin
GR1
GR3
GR5
GR7
GR10
GR9
G1
GR4
GR8
GR11
500 m
5 km
5 km
N
vertical exaggeration: 15x
Bukalara Sandstone
Stretton Sandstone
Yalco Formation
Lynott Formation (Hot Spring and Donnegan members)
Lynott Formation (Caranbirini Member)
Reward Dolostone
Barney Creek Formation (W-Fold Shale and Undifferentiated members)
Barney Creek Formation (HYC Pyritic Shale Member)
Barney Creek Formation (Cooley Dolostone Member)
Teena Dolostone (Coxco Member)
Teena Dolostone (Unnamed Member)
Pre-Teena stratigraphy
middle McArthur Group
Fault
MY4
Well
Sequence B1 Maxium Flooding Surface
Sequences B1 and B2 Depositional Sequence Boundaries
Sequence B1 MFS developed as black shale
(<10 m thick, >10 m thick)