Characterization of Paleocene-Eocene Fluvial Deposition in the Piceance Creek Basin of western Colorado, USA

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More than 175 fluvial sand-bodes from the Wasatch Formation exposed across a broad (40 x 30 km) area of west-central Colorado, near the town of DeBeque, demonstrate secular changes in sand-body thickness and lateral extent, alluvial architecture, paleo-flow depths, prevalence of different lithofacies, and paleodrainage characteristics spanning the Paleocene-Eocene boundary. The formation is traditionally divided into three distinct members based upon the relative abundance (%) of fluvial sandstones versus floodplain deposits. The lowermost Atwell Gulch Member is dominated brown, gray, purple, and red mudstones and carbonaceous shales with relatively few, thin fluvial sandstones (~25%). In contrast, the overlying Molina Member is dominated by thick, laterally-extensive fluvial sandstones (~60%), and fine-grained facies that are dominated by gray and purple siltstones and mudstones. In the Shire Member fine-grained facies again become dominant, though pink and red in coloration, and fluvial sandstones are thinner and more laterally restricted (<10%). Ages of the three members are constrained by mammalian and plant fossils, which indicate a mid-Tiffanian (late Paleocene) through late Wasatchian (early Eocene) age for the formation. To date, no fossils have been found in the Molina Member for pinpointing its age, though preliminary carbon isotopic results from this study and others suggest the P-E boundary exists near its base.

Field measurements indicate that average sand-body thickness doubles between the Atwell Gulch and Molina Members from 3.4 m to 6.9 m, and decreases to 5.4 m in the Shire Member. Many Molina sand-bodies are laterally continuous (>1.5 km), whereas Atwell Gulch and Shire bodies range from 1.5 m to 182.0 m in width (average of ~30 m). In many cases Molina Member sand-bodies are clearly amalgamations of sand-bodies of slightly larger dimensions (3.0 m thicker and 10.0 m wider) to those observed in the Atwell Gulch and Shire members. Flow depths, taken from the relief along bar clinoforms and mud-plug thicknesses, are 50% greater and display twice the range in the Molina Member as compared to the other members. In addition, 100% of Molina sand-bodies were underlain by intervals of crevasse splay deposits, whereas only ~5% of Atwell Gulch and ~12% of Shire sand-bodies rest upon splay sequences. The Atwell Gulch and Shire sand-bodies are also commonly associated with well-developed levee deposits, which are absent among Molina sand-bodies. Furthermore, Molina sand-bodies are dominated by subhorizontal planar bedding (occasionally with mudcracks on parting planes), soft-sediment deformation, and minor amounts of small-scale trough cross-bedding. In contrast, Atwell Gulch and Shire sand-bodies are dominated by small- and large-scale trough cross-bedding and ripple laminations; planar bedding is rare. Paleocurrent directions show no significant variation among the three members and show a consistent drainage to the northwest (~345°).

These patterns indicate a transitory shift in river behavior and floodplain dynamics in the study area, potentially related to climate change associated with the Paleocene-Eocene Thermal Maximum. Upper flow regime sedimentary structures and more variable flow depths suggest greater seasonality of precipitation and peaked hydrograph during Molina Member deposition. The alternation between well-developed levee deposits and prevalence of crevasse splay deposits indicates weakened banks and more frequent flooding, and the more highly amalgamated and thicker nature of sand-bodies suggests a higher avulsion rate during Molina deposition. Overall these patterns are consistent with increased seasonality of precipitation and aridity in the mid-latitudes during the PETM hypothesized by previous studies.