Architectural Analyses of Laterally Accreting Paleoforms in the Cretaceous Eagle Formation, South-Central Montana

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Paleo-fluvial systems are important water and hydrocarbon reservoirs worldwide and give rise to complex reservoir geometries, spatial patterns, and internal heterogeneities. This study examines the detailed architecture, sedimentology, and connectivity of exceptionally well-exposed paleoform channels within the Santonian-Campanian (Late Cretaceous) Eagle Formation at Calamity Jane Horse Cache (CJHC) 26 km west of Billings, Montana. The CJHC is a 1.2 km^2 butte with an average cliff height of 15 m and approximately 5 km of three-dimensionally exposed cliff face.

The study's focus is on quantifying the character and changes of architectural elements and geometries within the channelized sandstone package and use of this data to determine the relative influence of fluvial vs. tidal processes on sedimentation. Facies and architectural analyses were performed by documenting the detailed sedimentology using twenty-four measured sections, spaced about 30 m apart along several of the outcrop faces, and from detailed photomosaic analysis between these measured sections.

An exceptionally well-preserved paleochannel is exposed on several closely-spaced outcrop walls near the NW-corner of the butte that forms the center point of this study. Architectural elements of a single point-bar enabled us to quantify the dimensions of the paleo-fluvial system and to determine the main depositional processes. Lateral accretion sets range from 35 to 60 m in width and 1.5 to 5 m in height. The width-to-depth ratios of the mud-filled channel, evident of the abandonment stage of the system, range from 12 to 24 and suggest a relatively broad, deep channel. No obvious spatial trends in dimensional changes have been observed. Using published equations the sinuosity of this system was calculated to range between 1.4 and 1.7 (moderate to highly sinuous) based on the lateral accretions' average width-to-depth ratios. The long-axis channel trend orientation as indicated by the lateral accretion dip direction, which is transverse to the mean paleoflow, indicates that transport was to the SE.

Sigmoidal cross-bedding in several of the accretion beds combined with an increase of silt and mud drapes between these accretionary layers is interpreted to reflect the episodic influence of tidal currents in the system. The sigmoidal cross-beds are gently dipping, have well preserved reactivation surfaces and are interpreted to represent stage fluctuations and reversals in flow direction. The preserved inclined heterolithic strata (intervals with well-developed mud draped accretion sets) are interpreted as lateral accretion deposits on point-bar surfaces within a tidally influenced fluvial system.