Sorting or Salt Walls? Investigating the Controls on Ancient Fluvial Transport Conditions Using Detrital Zircon Geochronology and Paleohydraulics: Permian Cutler Group, Paradox Basin, Utah and Colorado

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Abstract

Reconstructing hydraulic conditions and provenance in ancient fluvial systems has implications for predicting reservoir connectivity, volumes, and rock mechanics. Provenance analysis of sediment, commonly by detrital zircon U-Pb geochronology, is used to reconstruct tectonic events, interpret the interactions between sedimentation and tectonics, and delineate catchments supplying sediment to depositional systems. Key challenges include disentangling the role of allogenic forcing, such as tectonics or climate variability, from autogenic processes, such as avulsion. However, the effects of sediment transport processes on detrital zircon age distributions are poorly understood. Several studies of modern fluvial systems have revealed that hydraulic sorting can fractionate detrital zircon age groups, implying that this signal could introduce bias in ancient systems. Here we present one of the first studies to investigate the role of hydraulic sorting on provenance reconstructions in an ancient system. We outline methods and results from detrital zircon provenance analysis and paleohydraulic reconstruction of the Permian Cutler Group fluvial system in the salt-deformed Paradox Basin of UT and CO. At 8 locations in a ~100 kilometer transect of the proximal to distal basin, we analyze 1) depositional facies, 2) paleocurrent direction using fluvial dune

crossbedding, 3) grain size and thickness of fluvial dune crossbed sets to calculate channel geometry, flow velocity, discharge, and flow competency, 4) size and age of detrital zircon grains from fluvial channel deposits, 5) relationships between decreasing flow competency and changes in detrital zircon age signatures. Results indicate that A) two distinct zircon age groups are present in the basin (1440 Ma and 1720 Ma), B) detrital zircon age signatures vary from unimodal to bimodal and abundance of each age group varies in bimodal signatures, C) the calculated decrease in flow competency from the proximal to distal basin is insufficient to sort out zircon grains, D) paleocurrent directions vary between SW, NW, and NE on the flanks of salt anticlines, and E) at some locations, detrital zircon age signatures switch up-section from bimodal (1440 Ma and 1720 Ma) to unimodal (1720 Ma) between two fluvial channel deposits vertically separated by ~10 meters at the Moab Fault location. The combination of methods used here reveals a new capability to disentangle allogenic and autogenic processes that acted on ancient fluvial systems. We demonstrate that autogenic hydraulic sorting of zircon grains does not affect age signatures of channel deposits in this relatively short gravel and sand bedded fluvial system, and instead attribute variation in paleocurrent direction and provenance signatures to the allogenic interaction between the fluvial system and coeval salt deformation.