Differentiating Climatic from Tectonic Influences on Shifting Depositional Environments using Detrital Zircon Geochronology

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Detrital zircon geochronology has been successfully used to determine provenance throughout many basins, including the western U.S. Colorado Plateau region where detailed information about the regional highlands and sources for the Western Interior Basin has been interpreted for the Mesozoic. However, a shift in depositional environment in southern Laurentia occurred during the middle to late Jurassic when the environment went from a predominately eolian setting that persisted throughout the early to middle Jurassic to hypersaline lake systems. The cause of this shift is presumed to be climatic, and this research tests this hypothesis as well as providing a novel way to utilize provenance data to differentiate climate from tectonic signals.

This case study focuses on the middle Jurassic Wanakah Formation, a hypersaline lacustrine unit that represents the time when the environment changed from eolian to lacustrine. This unit is deposited in the Central Colorado Trough and extends throughout western Colorado in the Paradox and Piceance Basins. U/Pb ages from detrital zircons are used to determine provenance. To help constrain the effects of climate on the depositional environment, this study pairs the provenance results with multi-geochemical proxies from bulk geochemistry of paleosol sequences, and stable isotopes of carbon and oxygen in pedogenic carbonates to assess local conditions at the time of their development.

This shift in depositional environment is accompanied by a distinct change in provenance with a sudden and significant input of Cambrian grains (~60% of all grains in some samples) interpreted to be from the denudation of a regional source in the Ancestral Front Range. A period of stream capture and drainage reorganization caused by tectonic uplift of the Ancestral Front Range during the Middle Jurassic could explain the observed change in detrital zircon U-Pb ages that accompanied the transition from eolian sedimentation to hypersaline lacustrine sedimentation. Paleoclimatic interpretation of paleosol chemistry supports the interpretation of an arid lacustrine system. This robust combination of techniques suggest tectonics and stream capture, rather than a change in climate, caused the dramatic change in depositional environment.