Revising the Geochronologic Framework for the Upper Carboniferous-Lower Permian Cutler Group of the Paradox Basin, Southeastern Utah, U.S.A.

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Abstract

The upper Paleozoic sedimentary succession of the Paradox Basin in southeastern Utah is important both economically as an oil and gas reservoir and source of critical minerals, and as a record of late Paleozoic sea level, environmental, and biotic change. Because it was deposited near the paleoequator, these strata provide a key window into tropical responses to the Late Paleozoic Ice Age (LPIA), the last time the Earth experienced permanent polar ice caps prior to the Quaternary. Whereas the predominantly marine Hermosa Group is well-dated by marine biostratigraphy, the age of the overlying largely non-marine Cutler Group remains poorly resolved. This diverse succession of thin marine limestones, fluvial redbeds, pond and sabkha deposits, and eolian sandstones is an important record of long-term aridification and terrestrial fossil assemblages across the Carboniferous-Permian boundary. A principal aim of the PERMIA Project (Paleozoic Equatorial Records of Melting Ice Ages) is to refine the geochronology of the Cutler Group so that its sedimentary, paleoenvironmental, and paleobiologic archive can be better placed within the global context of the LPIA. We have examined and sampled both legacy core (Elk Ridge #1) and multiple outcrops (Valley of the Gods, Indian Creek, and Hurrah Pass areas) to create a testable framework across the Paradox Basin. Preliminary conodont and fusulinid biostratigraphy and 87Sr/86Sr chemostratigraphy from marine horizons suggest a mid-Gzhelian (mid-Virgilian) age for the base of the lower Cutler beds (including the base of the Halgaito Formation), a late Gzhelian (late Virgilian) for the middle portion of the lower Cutler beds, and a latest Gzhelian to early Asselian (early Wolfcampian) age for the uppermost lower Cutler beds. Paleomagnetic analysis of outcrop samples from the lower Cutler beds reveals a thick sequence of reversed magnetic polarity, with the exception of a thin interval of mixed to normal magnetic polarity in the middle part of the lower Cutler beds (middle Halgaito Fm). This may be evidence of the latest Carboniferous Kartamyshian Normal Event (~299.3 ± 0.3 Ma). Taken together, these biostratigraphic, chemostratigraphic, and magnetostratigraphic data suggest the Carboniferous-Permian boundary is located close to the lower Cutler beds – Cedar Mesa Sandstone contact, with further refinement possible using cyclostratigraphic calibration. This integrated geochronologic approach not only refines the age of the lower Cutler Group, but will also improve correlation to other well-studied North American successions, including those from New Mexico, Texas-Oklahoma, and the Midcontinent cyclothems.