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Technical Session 3: Terrestrial Ecosystems – Early Cretaceous (Saturday, June 10, 2023, 10:00 AM)

GEOLOGICAL REVISION OF THE EARLY CENOMANIAN MUSSENTUCHIT MEMBER, CEDAR MOUNTAIN FORMATION, CENTRAL UTAH (USA)

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An ongoing exploration of sedimentary successions within the uppermost Cedar Mountain Formation, namely the Mussentuchit Member, is providing unprecedented refinement for addressing questions of biotic responses to tectonism, landscape modification, and climate change before the Cretaceous Thermal Maximum (CTM). Here, we present results of combined facies and chronostratigraphic analyses for exposures of the Mussentuchit Member between Willow Springs and Emery North, north of the Fish Lake Plateau and southeast of the Wasatch Plateau along the western San Rafael Swell. We present a novel paleoenvironmental model for the emplacement of volcaniclastic and volcanilithic-rich sediment into this depocenter. Utilizing facies analysis and architectural reconstruction, we conclude that the Mussentuchit Member was a landward paralic depocenter, forming a sink for suspension settling fines enriched with volcaniclastics and volcanic detritus, with a vast majority undergoing pedogenic alteration, analogous to the modern coastal plain of French Guiana (Anthony et al., 2010, 2014; Augustinus et al., 2002; Tucker et al., 2022).

Previously, we theorized that varied sedimentary processes and entombment of fossil assemblages in the Mussentuchit Member were influenced by volcanilithic-rich detritus. We corroborate this pattern by identifying four regionally extensive, stratigraphically separable ash fall horizons. Our analysis coupled LA-ICPMS (sn=14), which identified the most youthful populations (identified to be autocrystic), with secondary analysis of youthful populations via CA-TIMS (sn=12). Once completed, we combined the resulting grain ages based on stratigraphic correlation and termed these horizons "Mussentuchit Ash Zones" (MAZ 1-4). Our results demonstrate that MAZ1 was emplaced no later than 99.550 $\pm$ 0.023 Ma; MAZ2 at 99.537 $\pm$ 0.024 Ma; MAZ3 at 99.313 $\pm$ 0.026 Ma; and MAZ4 at 98.931 $\pm$ 0.054. We also reassessed historically dated ash samples by revisiting and freshly sampling these horizons (WS10 [V695] and WS19 [V826]) (Cifelli et al., 1997, 1999). We determined that both displayed sedimentological disturbance and clear detrital histories.

Based on geochemical analysis (XRD and XRF), we interpret these ash fall units as dacitic (borderline tholeiitic to medium-K calc-alkaline). Coupled XRD and XRF analysis diagnosed moderate levels of an amorphous clay fraction (39–53%) and high SiO_2 values, which we interpret as preserved glass. Despite this, we identify each of these four MAZ ash falls as tuffaceous bentonites due to low but meaningful levels of smectite present (13-20%) along with infield observations, including; 1) haystacks weathering with co-occurring popcorn textures; 2) jigsaw puzzle clay fractures; and 3) nodular masses ("eggs"). With closer examination, we note significant amounts of Mg (mixing of brackish waters), mineral content (anhedral biotite and euhedral zircon), whole-rock abundances of Al, Fe, Mg, K, and quantities of Ti inversely proportionate with Si, along with variation in internal layering, layer charge, variable clay ratios, and wet color modification. Thus, we can identify MAZ1–4 as K-bentonites (Huff, 2016). Based on the above geochemical assessment, we can also extrapolate an evolutionary history of the ash falls based on two factors of multivariate correspondence analysis, encompassing 99.9% of all variation between 13 oxides (above detection limits). We recognize MAZ1 and MAZ4 as more primitive than the remarkably similar and evolved MAZ2 and MAZ3. Thus, we link MAZ1 and MAZ4 to magma chambers' rejuvenation and eruption phases, whereas MAZ2 and MAZ3 are successive eruptions coupled with chamber depletion.

Based on our sub-million-year temporal framework (99.550 ± 0.023 to 98.931 ± 0.054 Ma), the Mussentuchit correlates to the Mowry Shale and subsequent Greenhorn cycle of the Zuni Sequence (between the SB3.1, TS3, and SB3.2) or between the Kiowa transgression at 104 Ma and the Thatcher Limestone at 95.78 Ma based on Oboh-Ikuenobe et al. (2008) and Haq (2014). Lithostratigraphically to the south, the Mussentuchit Member, correlates to the uppermost Mesa Rica Sandstone and Romeroville Sandstone; and to the north, the Arrow Creek bentonite (Bootlegger Mbr) of the Blackleaf Formation at 99.12 and 100 Ma, the Shell Creek Shale and Mowry Shale of Montana, Wyoming, and the Denver Basin of Colorado to the north and northeast (Rosenblume, 2021; Rosenblume et al., 2022; Singer et al., 2021).

In-field observations noted disparities concerning the concentrations of vertebrate fossils within the Mussentuchit Mbr. Notably, most fossils are closely associated with MAZ1–2, and the middle sandstone. Other macrovertebrate fossil sites are clustered around MAZ3 in the upper Mussentuchit Mbr. In contrast, zones lacking ash fall within the lower and upper Mussentuchit Mbr. are relatively depauperate of well-preserved macrovertebrate fossils. Our findings support the findings of a recent study by Ramenzani et al. (2022), extending their observed relationship between fossil abundance and volcanic sedimentation across >20 Myrs of tectonic evolution of the WIB.

The landward paralic setting of the Mussentuchit Mbr would have simultaneously been a collection point for volcaniclastic ash and volcanilithic detritus and a distributary system to outboard distal shelf and slope depocenters (Lee et al., 2018; Tucker et al., 2022). If correct, the Mussentuchit Mbr played a minor role in the fertilization of nutrients into the WIS, resulting in a carbon sink, reflected in the global cooling trend between OAE1d and OAE2 (Wang et al., 2014). Eventually, this lowered oxygen content resulted in an antecedent trigger for the OAE2 (Barral et al., 2017; Lee et al., 2018; Wang et al., 2014).

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Theme Session: Laramidia to Asia: Biota and Biogeography of Interconnected Iconic Late Cretaceous Ecosystems (Saturday, June 10, 2023, 5:20 PM)

VERTEBRATE PALEOFAUNA OF THE CAMPANIAN ALMOND FORMATION OF WYOMING: HISTORY OF STUDY, BIOGEOGRAPHIC SIGNIFICANCE, AND EARLY RESULTS OF AN ONGOING PALEONTOLOGICAL SURVEY.

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The Upper Cretaceous of Western North America includes some of the most well studied terrestrial Mesozoic ecosystems known. Still, significant temporal and geographic gaps remain in this record. Terrestrial vertebrates have been well documented from the Campanian of Alaska, Alberta, Montana, Utah, Colorado, New Mexico, Texas, and Mexico, whereas diagnostic material from the Campanian of Wyoming is limited. The Campanian Almond Formation of Southern Wyoming is located in this biogeographic gap. The Almond Formation constitutes a transgressional sequence of the Western Interior Seaway which is bounded by the Ericson Sandstone below and the Lewis Shale above. Ammonite biozones constrain the unit, with *Baculites reesidei* occurring in the bottom of the deposit and *B. baculus* at the top, suggesting an age of 72.94-70.00 Ma (Cobban et al., 2006; Gates & Farke, 2009; Roehler, 1990), although a recent recalibration has proposed somewhat older dates of ~71.9-73.5 Ma (Fowler, 2017). So far, vertebrates have only been reported from the lower half of the formation,