Correlating Bentonites Spanning the Cretaceous-Paleogene Boundary in the Hell Creek Region of Northeastern Montana Using Electron Microprobe Analysis of Tephras

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The Williston Basin arguably contains the richest terrestrial record of faunal, floral, and paleoenvironmental change across the Cretaceous-Paleogene boundary. The fluvial Hell Creek (mostly Cretaceous) and Tullock (mostly Paleocene) formations contain dinosaur and mammalian fossil records, as well as coal beds that preserve distinct ash layers. These coal beds have been used to define a regional stratigraphy, however, the depositional heterogeneity implicit in fluvial environments makes lateral correlations difficult. A relative chronostratigraphic scheme based on coal beds has been employed for decades but is problematic because assumptions of lateral continuity and time-correlativity are unproven in many cases and demonstrably incorrect in some. Virtually all of the coal beds, however, preserve volcanic ashes that can be used as a chronostratigraphic scheme and for regional correlations.

More than 40 distinct ashes have been identified in the ~200 m composite thickness of these two formations. The ashes are commonly less than 1 cm thick and as many as eighteen have been found in a single ~1.5 m coal bed. The ashes thus provide a robust basis for high-resolution regional correlations. Original glass shards in the ashes are ubiquitously altered to clays, hence conventional tephrochemical characterization is impossible. Instead we are performing electron microprobe analysis of feldspar and titanite, using major and selected trace elements. Phase compositional data are subjected to principal component analysis (PCA) and combined with geochronological data, phase presence/absence data, paleomagnetic polarity, and relative stratigraphic position to yield a matrix that allows discrimination of many of these ashes. The resulting chronostratigraphy will enable regional correlations with age resolution better than the ~10 ka best case afforded by $^{40}Ar/^{39}Ar$ dating. Results thus far clearly show that correlations of individual ashes over distances of tens of km between isolated outcrops is possible.