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K-Ar dating of clay in paleoweathering environments: a case study from weathered granite beneath the Great Unconformity in Manitou Springs, Colorado

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We test whether K-Ar dating of pedogenic clays can constrain the ages of paleosols and paleosurfaces. K-Ar dating of clays has been used to determine the age of faulting and diagenetic events, but its utility as a geochronometer in weathering environments has not been fully explored. The $1M_d$ polytype of the K-rich clay illite only forms at temperatures < ~200 °C, often in the early stage of weathering environments in granites. Illite age analysis (IAA) is a method to date the authigenic formation of $1M_d$ illite utilizing clay size fraction separation and X-ray diffraction analysis. This study uses IAA to constrain the age of basement weathering under the Great Unconformity in the Colorado Front Range. Friable Pikes Peak Granite from Manitou Springs, CO has a clay assemblage of high and low temperature illite, smectite, kaolinite, and minor lepidolite. IAA on these clay samples gives an authigenic age of 974 ± 122 Ma. This suggests the Pikes Peak Granite reached temperatures below ~200 °C by the early Neoproterozoic for $1M_d$ illite polytype to form. The presence of smectite and kaolinite in the sample points towards the sample weathering under near-surface conditions at the time of illite formation. This age agrees with the temperature-time history from zircon (U-Th)/He data in the region. It points towards an early initial stage of continental erosion leading to the Great Unconformity in Colorado, possibly related to tectonism during the assembly of the supercontinent Rodinia. This study displays the utility of clay dating to constrain the timing of paleoweathering. Future work will focus on developing methods to date smectite-rich clay samples, which are much more common in weathering environments than illite-rich samples.