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Constraining the Burial and Geomorphic Evolution of the Appalachian Plateau Using Pennsylvanian Sedimentary Rocks

Multiple thermometric and thermochronologic techniques were used to constrain the burial and exhumation histories of Carboniferous strata in the central Appalachian basin. Core-collected sandstones, mudstones and coal from the New River Formation (Lower Pennsylvanian) were recovered from 100 to 400 meters present depth.

Fluid inclusion and vitrinite reflectance data indicate that, for lower Pennsylvanian sandstones, maximum burial depths exceeded 4 kilometers (approximately 145 ºC) during the Permian (estimated burial rate: 100 m/m.y.). Published apatite fission track dates indicate slow exhumation (~ 13 m/m.y. to a depth of 3 km) from the Permian to mid-Mesozoic. Radiogenic helium dates range from 100 to 70 Ma, indicating the average exhumation rate from 3 km to present depth (0.3 km) was approximately 30 m/m.y. The difference in early and late exhumation rates could reflect significant geodynamic changes in the Appalachians during the late Phanerozoic or could be related to incorrect assumptions concerning the maximum burial history.

Results from this work establish a framework that aids interpretation of sandstone diagenesis, because diagenetic processes are controlled by temperature, pressure, and residence time within certain depth/thermal windows. This study also addresses outstanding questions concerning the geomorphic evolution of the Appalachian orogen using (U-Th)/He techniques. Reconstructing the burial and exhumation histories, using the thermometric and thermochronologic techniques described above, is possible only because coarse-grained detrital rocks, especially sandstone, are associated with all of the components analyzed, including quartz cement, organic matter (coal and black shale) and apatite.