Evidence for Paleo-Fluid Flow Westward from the Appalachian Basin

E.L. Rowan, J.E. Repetski, R.T. Ryder, U.S. Geological Survey

We present a fluid and heat flow model of a cross-section through the Appalachian basin, extending from the deformation front in West Virginia to the Findlay arch in Ohio. The model was constructed to investigate the geologic conditions that produced elevated fluid inclusion (FI) temperatures on the Findlay arch. The passage of warm (>110°C) fluids is recorded by aqueous and hydrocarbon FI in fracture-filling and vuglining fluorite, sphalerite, calcite, and dolomite cements in Silurian-Ordovician strata, including saddle dolomite from oil/gas reservoirs in the Trenton Limestone. Erosional truncation of Pennsylvanian-Devonian coal and shale limits the availability of vitrinite reflectance (Ro) data at the Appalachian basin's western margin; however, conodont color alteration index (CAI) data from Ordovician carbonate strata, continuous over the Findlay arch, help to constrain thermal maturity. Low CAI values (<1.5) on the arch indicate that only a modest thickness, probably <1.5 km, of additional overburden (now eroded), was present at maximum burial. Burial alone appears incapable of explaining the elevated FI temperatures, however, burial combined with a relatively brief interval of fluid flow may be consistent with both the FI and CAI data. A pulse of updip groundwater migration onto the Findlay arch from deeper in the Appalachian basin is proposed and tested in our model. Paleomagnetic and radiometric age dating studies indicate a widespread, late Paleozoic episode of diagenesis in the Appalachian basin resulting from regional-scale groundwater circulation; it has also been shown that Alleghenian orogeny-related topography could plausibly have driven regional-scale groundwater flow through the Appalachian basin.