The Elko Basin: An Unconventional Basin in the Hinterland of the Sevier Orogenic Belt

Andrew Canada[1], Elizabeth J. Cassel[1], Daniel F. Stockli[2], Michael E. Smith[3], Brian R. Jicha[4], and Brad S. Singer[4]

[1]University of Idaho, Moscow, ID
[2]University of Texas, Austin, TX
[3]Northern Arizona University, Flagstaff, AZ
[4]University of Wisconsin, Madison, WI

ABSTRACT

In the Sevier hinterland, from eastern Nevada to western Utah, Eocene terrestrial strata record the crustal and mantle dynamics of a high-elevation landscape prior to its collapse during Basin and Range-style extension. New decimeter-scale stratigraphy of the Elko Formation coupled with single-crystal sanidine 40Ar/39Ar geochronology and isotopic analysis of hydrated volcanic glass (δDglass), both extracted from tuffs deposited within the Elko Basin of northeastern Nevada, show a long-lived lacustrine system in this area hosted a wide variety of depositional environments while it formed atop a Paleogene orogenic plateau with elevations of ~2.5-3 km. Assessments of carbonaceous shales within the Elko Formation indicate the formation contains good to excellent source rocks with the potential to generate large amounts of oil and gas (TOC ~1.5-3.5). Oil and gas production, however, is hindered by difficulties in estimating the spatial extent, volume, and depositional timing of hydrocarbon source rocks in the Elko Formation. Here we use a multidisciplinary study of Eocene fluvial and lacustrine strata in northeastern Nevada to reconstruct the stratigraphic architecture of the Elko Basin through time and improve the predictive potential of this region. Lacustrine lithofacies across the Elko Basin show two general lake-type progressions from overfilled to balanced- fill conditions between 49 and 41 Ma and are capped by proximal volcanic detritus from the ~40-39 Ma Tuscarora volcanic field. Preliminary XRD, δ13C, and δ18O analysis of the Elko Formation reveals shifts in carbonate geochemistry and mineralogy are correlative with increased Fischer assay oil yield as well as lake-type boundaries. Lake-type facies shifts are further highlighted by implementation of δDglass values for tuffs intercalated with lacustrine intervals, which show a strong correlation between geochemical measurements of lake water chemistry and independent lithostratigraphic estimates. Fluctuating profundal lithofacies that are indicative of saline waters have enriched δDglass values (-65 to -120‰), whereas fluvial lithofacies have distilled δDglass values (-150 to -180‰) that are consistent with regional paleoprecipitation waters. Chronostratigraphic correlations show an up-section increase in δDglass values and synoptic basin-wide lake-type changes suggesting middle Eocene lakes were regionally extensive and not confined to incised paleovalleys or isolated grabens. U-Pb-He double dating of detrital zircon and apatite from multiple stratigraphic levels within the Elko Formation shows the preponderance of Mesozoic-Precambrian cooling ages that signify minimal-no surface- breaching extension occurred during basin formation. These detrital minerals can also record burial reheating, providing further constraints on regional maturation trends prior to exhumation along Miocene normal faults. Double dating shows outcrop exposures of Eocene strata did not exceed the zircon closure temperature (~180°C), but locally surpassed the apatite closure temperature (~70°C) within parts of the Lamoille and Huntington valleys. In addition, isopach contouring shows these portions of the Elko Basin contain >75 m of finely-laminated kerogen-rich mudstones and marls that are correlative with high oil yield in fluctuating profundal zones across the basin. Further refinement of this basin evolution will greatly improve models of intermontane basin formation throughout the Rocky Mountain region.