Supplemental Material

GSA Today, v. 31, <https://doi.org/10.1130/GSATG509A.1>: The Origin and Tectonic Significance of the Basin and Range–Rio Grande Rift Boundary in Southern New Mexico, USA: Jason W. Ricketts, Dept. of Earth, Environmental and Resource Sciences, The University of Texas at El Paso, 500 West University Ave., El Paso, Texas 79968, USA, jricketts@utep.edu; Jeffrey M. Amato, and Michelle Gavel, Dept. of Geological Sciences, New Mexico State University, Las Cruces, New Mexico 88003, USA.

THERMAL HISTORY MODELING

Forward modeling efforts use the zircon radiation damage and annealing model (ZrDAAM) of Guenthner et al. (2013). Models are created by assuming a hypothetical thermal history that is based on available geochronologic, thermochronologic, and geologic datasets. For each thermal history, a resulting ZHe date-eU curve is calculated using the ZrDAAM model and an average zircon spherical grains radius. Forward models are used to test sensitivity to certain segments of the thermal history and compare resulting ZHe date-eU curves to available data.

Compilation of ZHe data show dramatic differences across the transition zone in southern New Mexico. ZHe dates from west of this transition are all younger than 31 Ma, except a single outlier at 150 Ma, for a wide range of eU values (120–1381 ppm). East of the transition ZHe dates vary from 2–731 Ma across eU values of 1–2708 ppm, and collectively show a well-defined correlation with eU. In ZHe date-eU space, these data define a steep negative trend up to 400 ppm eU, followed by a flatter trend from 400–2000 ppm. The preservation of ZHe dates that are much older than Cenozoic extension indicates that these data are also sensitive to older tectonic and/or magmatic events, which must be accounted for in modeling. We use this collective ZHe date-eU trend and a general thermal history for southern New Mexico to investigate the effect of Oligocene magmatism.

Our forward models begin at a crystallization age of 1.6 Ga, which is characteristic of Mazatzal-age juvenile crust (Karlstrom and Bowring, 1988; Amato et al., 2008). In southern New Mexico, Mazatzal-age rocks were overprinted by the 1.4 Ga granite-rhyolite province (Whitmeyer and Karlstrom, 2007); these younger rocks are not modeled because they would produce nearly identical results. Forward models cool through 350 °C at 1.45 Ga based on $^{40}\text{Ar}/^{39}\text{Ar}$ muscovite cooling ages of rocks from the Burro Mountains (Amato et al., 2011). The low-temperature cooling history of rocks prior to deposition of the Bliss Formation and

formation of the Great Unconformity is relatively unconstrained. Figure 3 includes two end-member cooling histories to test how this portion of the cooling history affects resulting ZHe date-eU curves. Both paths include multi-stage cooling that coincides with known geologic events. One path includes two separate cooling pulses coeval with 1300-900 Ma assembly of Rodinia (Whitmeyer and Karlstrom, 2007), and the other includes one pulse of cooling during assembly of Rodinia, and a separate pulse of cooling to surface temperatures during 770–570 Ma break-up of Rodinia (Yonkee et al., 2014). Both paths remain at surface temperatures until 500 Ma deposition of the Bliss Formation, are reheated to maximum temperatures of 150 °C at 80 Ma during accumulation of Paleozoic and Mesozoic strata, and cool to surface temperatures by present time. ZHe date-eU curves are calculated using a spherical grain radius of 50 μm , which is the average of all ZHe dates.

Resulting ZHe date-eU curves for each path are similar, suggesting that ZHe data alone are not very sensitive to Proterozoic final cooling of rocks without additional data. For example, both paths yield ZHe date-eU curves with a similar slope and inflection at an eU value of 500 ppm (Fig. 3). The biggest difference between the two curves is the maximum predicted ZHe date at low eU values. Alternatively, Oligocene reheating during 37–26 Ma magmatism (McIntosh and Bryan, 2000) has a profound effect of ZHe date-eU curves. As seen in Figure 3B, varying degrees of Oligocene reheating affects the maximum ZHe date at low eU values, as well as the inflection point from a steep negative slope to shallow slope. ZHe dates in the southeastern Basin and Range overlap with the time of Oligocene magmatism in southwestern New Mexico, and these young ZHe dates across a wide eU range are only consistent with a major reheating event at this time.

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