Refining the age of the Reserve Graben, West-Central New Mexico, with 40Ar/39Ar dating.

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Abstract:

The Reserve Graben is a small rift basin situated between three major tectonic features of the Southwestern United States: the Rio Grande Rift to the east, the Colorado Plateau to the northwest, and the Basin and Range Province to the southwest. The graben's location at the junction of these three features suggests its formation can be tied to their relative motions (Martin et al., this meeting). However, more data are needed on the age and duration of rifting within the graben. In order to refine older, mainly K/Ar ages of graben fill, 11 samples taken from igneous intrusive and extrusive units interlayered with the basin fill have been dated using the 40Ar/39Ar radiometric method. Dated materials include groundmass from 10 basalt flows and biotite/sanidine from a quartz diorite volcanic plug. The oldest basalt, within the deepest sediments near the floor of the basin, yields an age of 16.35 ± 0.04 Ma while the youngest basalt age is 1.89 ± 0.01 Ma. The latter flow crosses the master fault of the graben without offset, providing a minimum age for fault activity, which is slightly older than the previous K/Ar age of 1 Ma (Marvin et al., 1987). Another basalt, previously dated by K/Ar at 19.2 ± 2.5 Ma (Ratté 1980), yields a precise 40Ar/39Ar age of 16.02 ± .04 Ma, consistent with other basalts in the area. These findings suggest that rifting in the Reserve Graben began significantly later than the previously estimated 21 Ma (Crews, 1994). Onset of Reserve Graben subsidence around 16 Ma corresponds closely with a rapid pulse of subsidence in the nearby Rio Grande Rift during early and middle-Miocene time (Chapin & Cather, 1994). This also occurred during the transition from southwest-directed to west-northwest-directed extension in the Basin and Range Province (McQuarrie & Wernicke, 2005). Additional samples are being dated to determine sedimentation rates and better constrain the youngest sedimentation history within the basin.

Methods:

Samples were crushed and sieved, and basalt samples were treated with HCl to remove carbonate material. Sanidine and biotite were separated from a single sample (RFZ1) with standard magnetic and heavy liquid techniques. All samples were washed in an ultrasonic cleaner and dried. Basaltic groundmass was hand-picked from all samples except RFZ1, from which sanidine and biotite were picked. Samples were irradiated at the Oregon State University TRIGA reactor, with Fish Canyon Tuff Sanidine as a standard, and analyzed for 40Ar/39Ar ratios on mass spectrometers at the New Mexico Geochronology Research Laboratory. All basalt and biotite samples were baked and then step-heated, producing age spectra (Figure 2, C). Three sanidine grains from RFZ1 were also step-heated, producing concordant age spectra; the remaining sanidine grains were degassed via single crystal laser fusion.

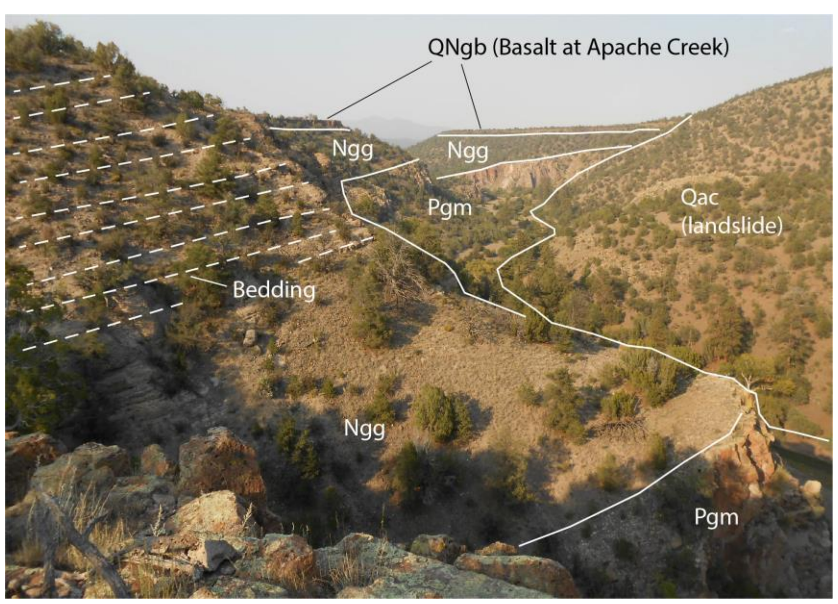

Figure 1:
Angular unconformity at the base of the Quaternary basalt flow at Apache Creek, New Mexico (Sample RFZ21, dated at 1.89 +/- 0.13 Ma, this study). This basalt flow crosses the master fault of the Reserve graben without offset. The uniformly tilted Gila Group beds beneath this flat-lying flow suggest the uppermost preserved basin fill sediments may be significantly older than the basalt. See Figure 2 for unit abbreviations.

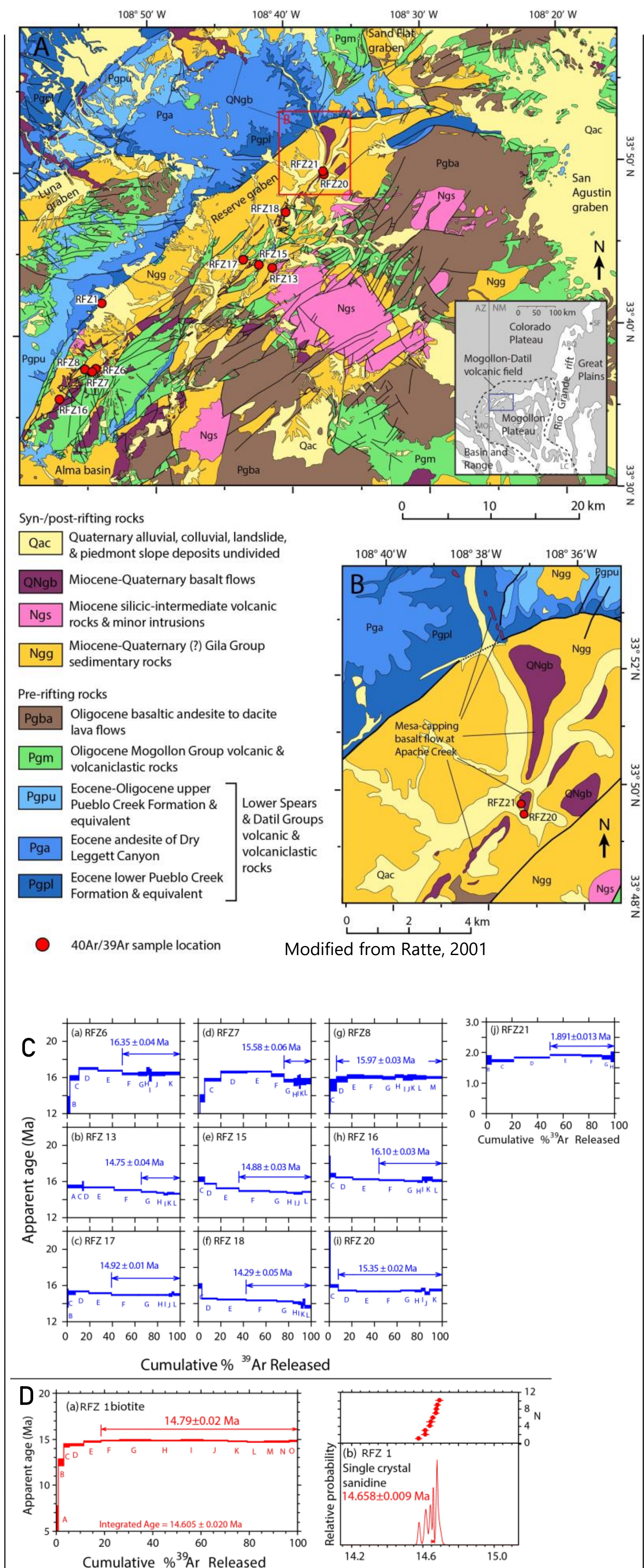

Figure 2:
Geologic map of Reserve Graben area (A) sample areas are marked in red. Inset (B) is a more focused geologic map of the Apache Creek area containing the youngest Quaternary basalt flows (Figure 1). (C) Age spectra for all basaltic groundmass samples. Because early heating steps were commonly discordant, the plateau age was selected as the preferred age for all of these. Note the different vertical scale for RFZ21, the Quaternary basalt at Apache Creek. (D) Age spectrum for biotite, and age probability distribution diagram for sanidine, from sample RFZ1, a quartz diorite intrusion cut by the graben's master fault. Note the improvement over previous ages for this sample (Figure 3).

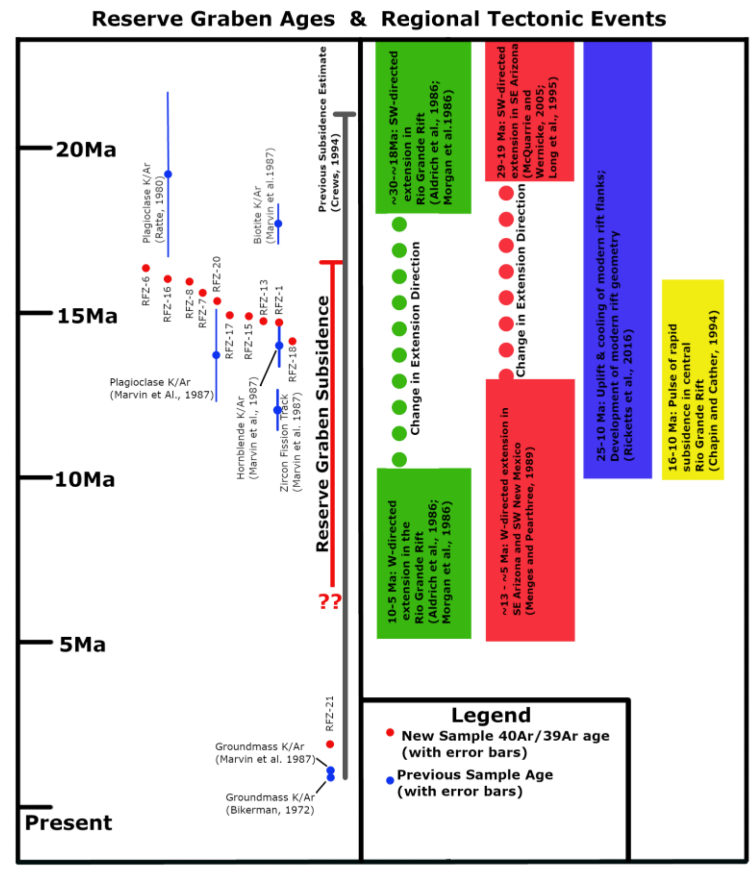

Figure 3:
Timeline of the Reserve graben's development, showing new 40Ar/39Ar ages obtained for this study, previous ages obtained for the same units, and the timing of regional tectonic events in New Mexico and Arizona for comparison. The blue data points with error indicators are aligned vertically with the sample and date collected in this study.

Discussion and Further Work:

The data collected so far show subsidence in the Reserve graben happened between ~16.5 Ma – 2 Ma. Previous estimates on the end of subsidence were approximately 1Ma younger; however, the Quaternary basalt flow sampled (RFZ21; QNgb in figures 1 & 2) showed no signs of offset by the master fault of the graben. This leads us to conclude that subsidence largely ceased before the 1.89 ± 0.01 Ma age of sample RFZ21. The flows interbedded with the lower basin fill are relatively close in age, but the age of the younger basin fill is less well-constrained. Some previous ages were quite inconsistent such as the three previous ages for RFZ-1 using different methods. The increased consistency and precision of our ages mostly stem from advances in mass spectrometer technology and Ar/Ar dating methods over the past several decades. The new age constraints we approximate for early rifting in the Reserve graben fall within a middle Miocene transition from southwest to west-directed extension in modern-day Arizona and New Mexico (Figure 3). This time frame also places the start of graben subsidence right alongside a period of rapid subsidence experienced in the neighboring Rio Grande Rift. Additional samples, which have been collected and await processing, will help determine subsidence rates, and planned detrital sanidine dating may help refine the age of the upper sedimentary basin fill.

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