# Reactivation of Precambrian fault networks: A K-feldspar $^{40}Ar/^{39}Ar$ study

M.T. Heizler[1], K.E. Karlstrom[2], J.M. Timmons[1], and R.E. Sanders[1]

[1]New Mexico Tech, New Mexico Bureau of Geology, 801 Leroy Place, Socorro, NM, 87801 (matt@nmt.edu, mtimmons@gis.nmt.edu, sanders@nmt.edu)
[2]Department of Earth and Planetary Sciences, Univ. New Mexico, Albuquerque, NM, 87131

Our working hypothesis is that Ancestral Rocky Mountain (320-290 Ma) and Laramide (70-50 Ma) faults in New Mexico and Colorado reactivated zones of crustal weakness that formed during the Precambrian. We are testing this with $^{40}Ar/^{39}Ar$ K-feldspar thermochronology analyses. In Arizona, the Grand Canyon Supergroup sedimentary package is well exposed and provides an unambiguous example of development of a Laramide monocline due to reverse slip reactivation of a Neoproterozoic normal fault. However, because there are limited Precambrian sediments exposed or remaining in the more deeply exhumed Rocky Mountains it is difficult to directly observe reactivation of Precambrian structures. Because $^{40}Ar/^{39}Ar$ K-feldspar age data record the time when rocks cooled from about 300 to 150°C it is the only available thermochronometric system that allows quantitative evaluation of Neoproterozoic or Ancestral Rocky Mountain basement exhumation histories. The basement of New Mexico and Colorado is defined by a complex polygonal network of ~10 km scale blocks that were differentially exhumed between ~1.4 Ga to 0.5 Ga. Emerging K-feldspar data show that different blocks had distinct and variable cooling histories. Thermal histories of Precambrian basement rocks across specific Phanerozoic structures are revealing divergent exhumation histories that began during the culmination of the Grenville orogeny at about 1.1 Ga. These data support our hypothesis that many young fault systems are reactivating older structural weaknesses. Thermal history analysis also records a period of regional cooling (exhumation) between 850 to 750 Ma that coincides with the onset of Neoproterozoic rifting of the Rodinia supercontinent. Additionally, in Colorado the K-feldspar data appear to record cooling related to basement removal during the Ancestral Rocky Mountain orogeny. Continued work across distinct faults, with different orientations (NW versus NS) may reveal which segments of the Paleozoic to Laramide fault network were active at different times in the Proterozoic and hence may help decipher the geometry and kinematics of intracratonic Proterozoic fault systems.

# Constraining the slip history and initial dip of low-angle normal faults using $^{40}Ar/^{39}Ar$ K-feldspar thermochronology: A case study from the Sierra Mazatán core complex, Sonora, Mexico

M. S. Wong and P. B. Gans

Department of Geological Sciences, University of California, Santa Barbara, CA 93106, USA (mwong@umail.ucsb.edu, gans@geol.ucsb.edu)

## Introduction

Sierra Mazatán, located in northwestern Mexico, is the southernmost core complex in the Cordillera and accommodated large-magnitude extension in the Mexican portion of the southern Basin and Range. The core complex was primarily exhumed by top-to-the-WSW slip on a major low-angle (10-15°) normal fault. We present $^{40}Ar/^{39}Ar$ K-feldspar thermochronologic data from the footwall that yield insight on the slip history and initial dip of this low-angle normal fault and compare these results with geologic constrains.

## Results and discussion

Modeled thermal histories of the K-feldspar data reveal two distinct pulses of rapid footwall cooling implying a poly-phase slip history with early slip from 25-23 Ma followed by a major slip event from 21-16 Ma. Rapid hanging wall sedimentation from 18-15 Ma supports this later slip event. The footwall was rapidly cooled ~75 °C during the 25-23 Ma event and >200 °C during the 21-16 Ma event, implying slip of 3-7 km and 15-35 km for the earlier and later slip events respectively (depending on the geothermal gradient and fault dip). The low end of these slip estimates are supported by the offset of marker units across the fault that constrains the total slip to ≤20 km. These data imply average slip rates of ~3-4 mm/yr during major slip.

Finally, the thermochronologic data indicate that a ~300 °C temperature difference existed across 25 km of the footwall in the slip direction prior to major slip (21 Ma), implying 25-50° of footwall tilt depending on the paleogeothermal gradient (15-30 °C/km). Geologic data, including moderately NE dipping footwall sediments and moderately SW dipping footwall dikes, support ~40° of footwall tilt. This would restore the presently low-angle normal fault to a steep initial dip of 50-60°.

## Conclusions

Thermochronologic and geologic data demonstate that the Sierra Mazatán core complex was exhumed by poly-phase Oligo-Miocene extension involving 15-20 km of total slip at rates of 3-4 mm/yr on an initially steep normal fault. Poly-phase unroofing, moderate slip amounts, and initially steep faults may be common to some, if not many, core complexes.