Structural evolution of the Reserve graben, New Mexico:

Extensional tectonics at the junction of the Rio Grande Rift, Basin and Range, and Colorado Plateau

Samuel Martin[1], Gary Axen[1], Jolante van Wijk[2], Daniel Koning[3], Matthew Heizler[3], Connor Whitman[1]

[1]New Mexico Institute of Mining and Technology, [2]Los Alamos National Laboratory, [3]New Mexico Bureau of Geology and Mineral Resources

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- Gary Axen
- Dan Koning

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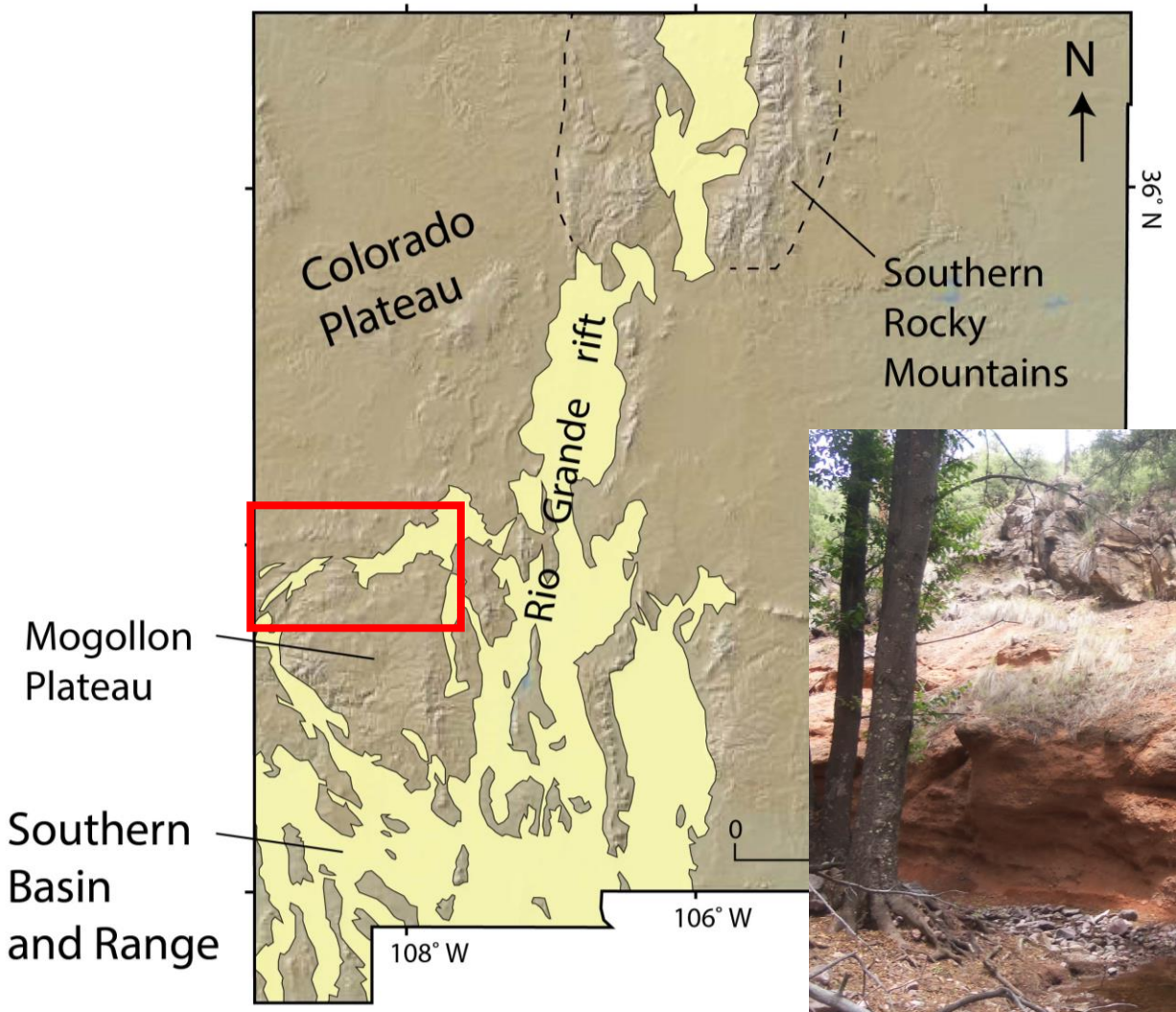
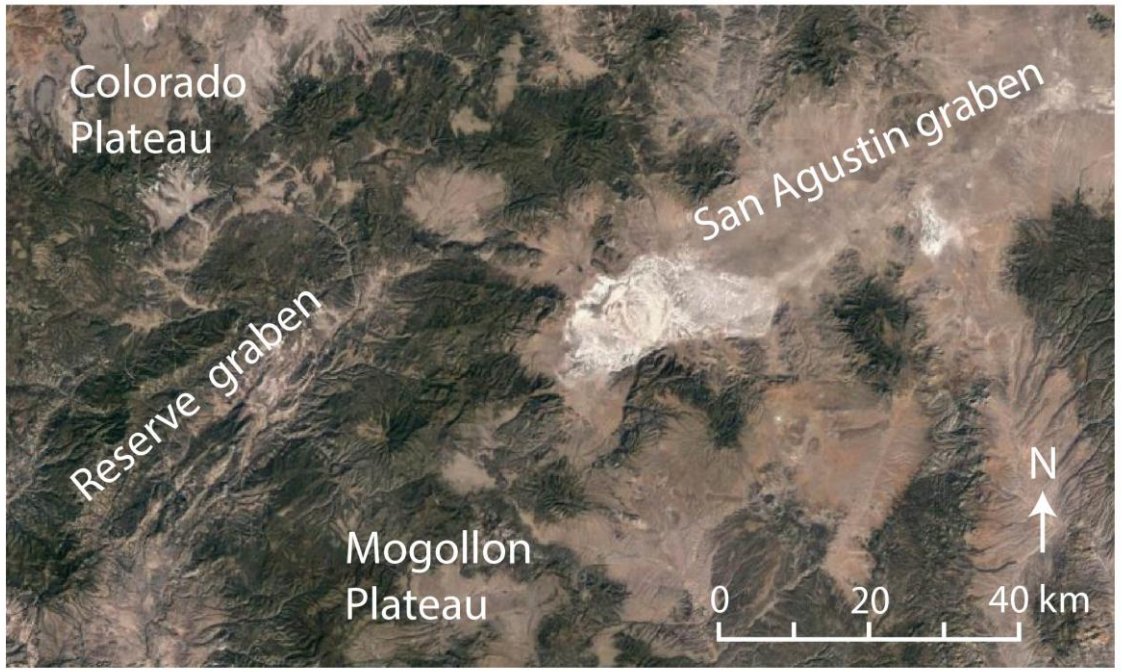
Geologic setting



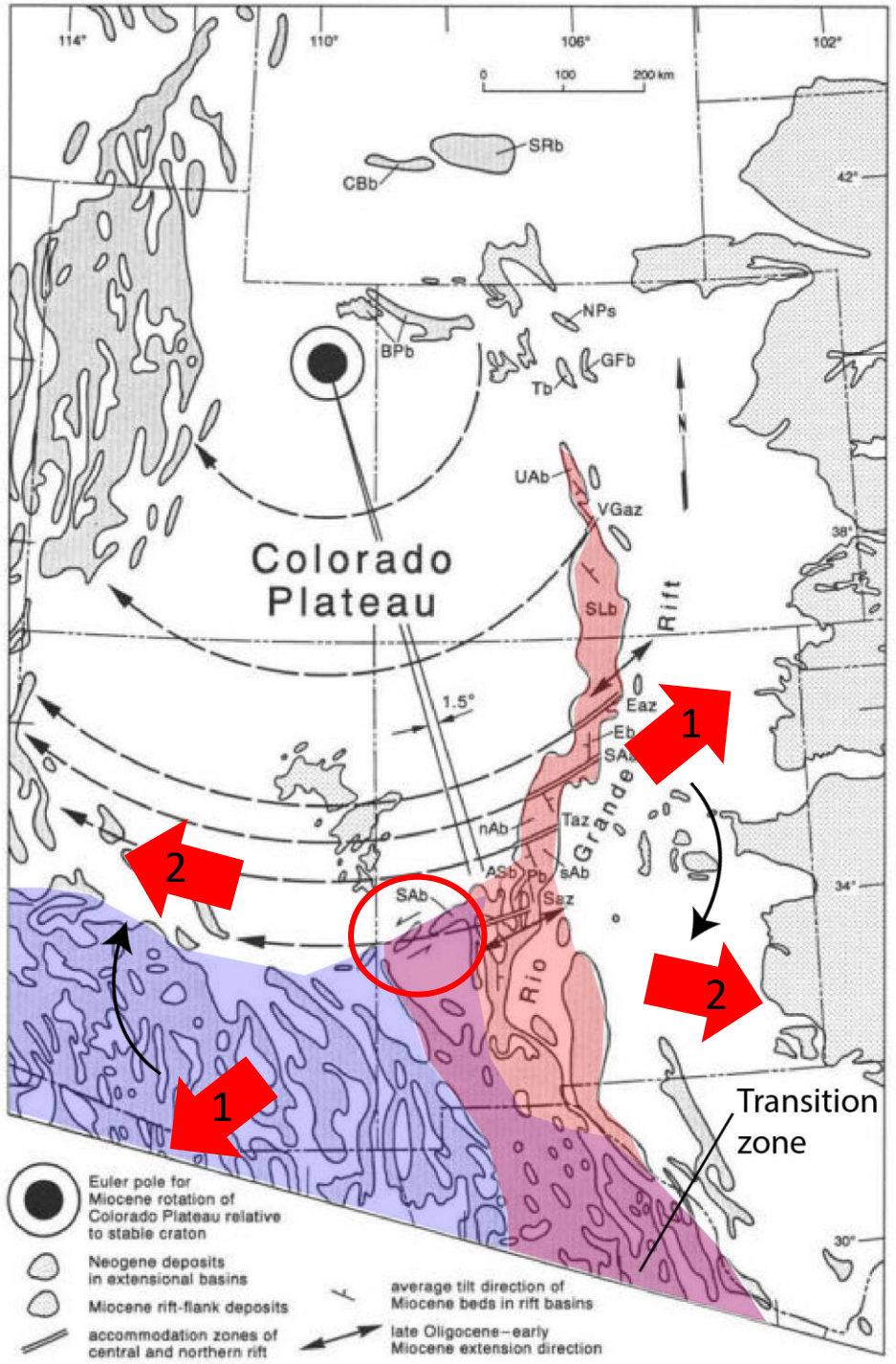


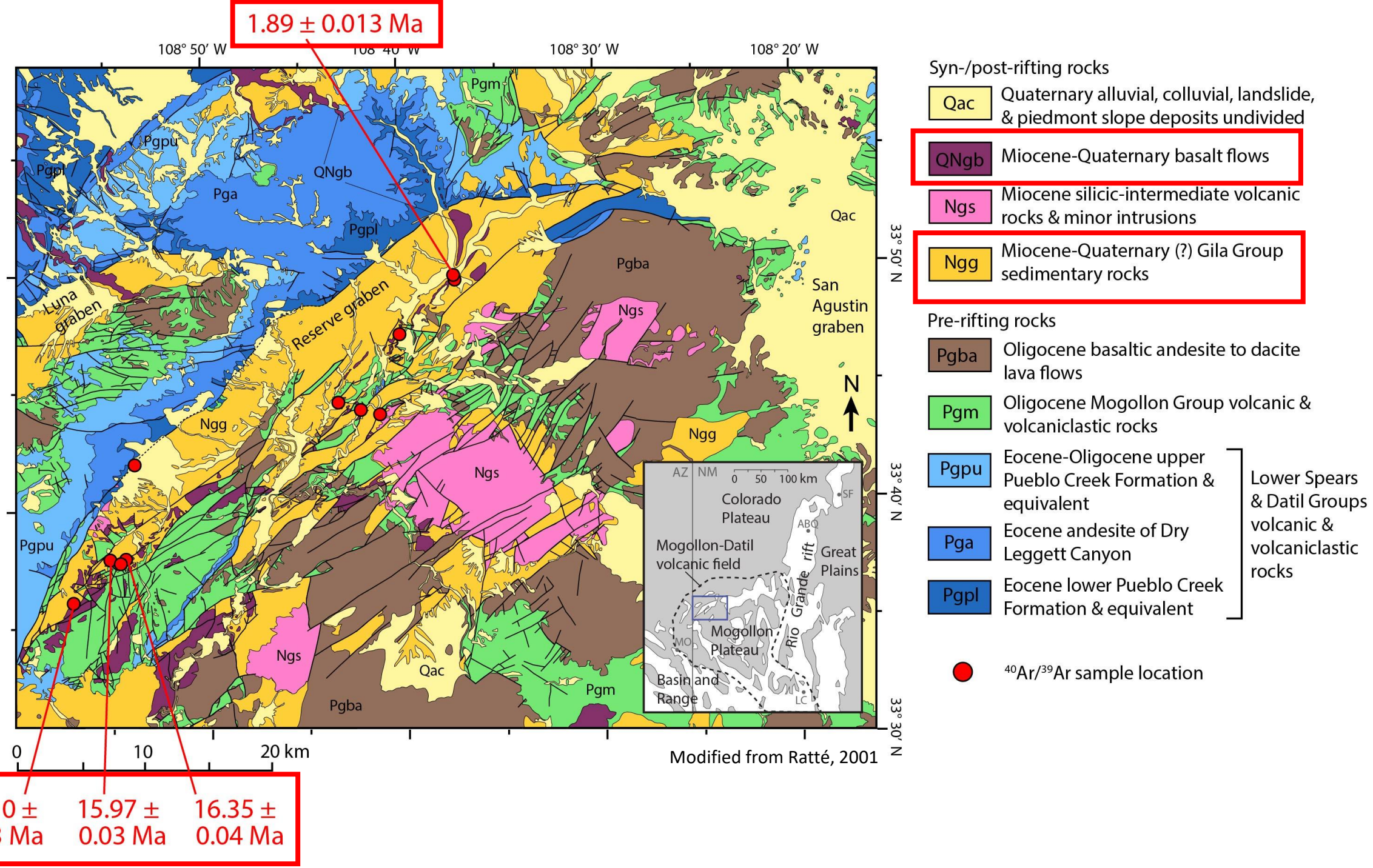
Motivation & Objective

- Determine how well existing regional tectonic models apply to the Rio Grande rift-Basin and Range transition zone, and refine these models

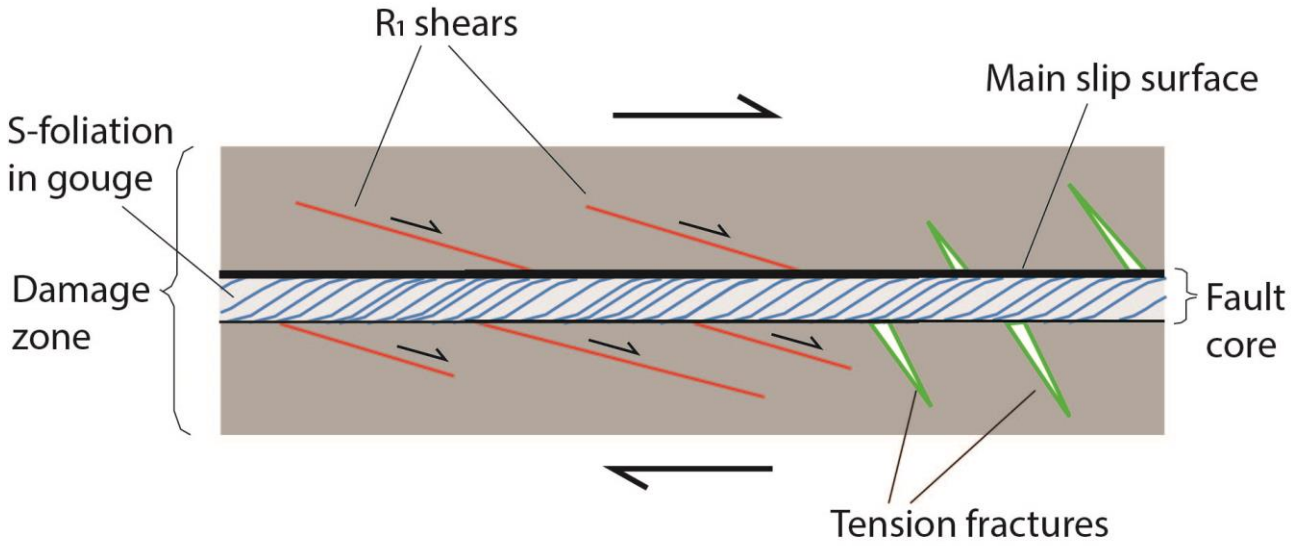
Change in extension direction: e.g. Aldrich et al., 1986; McQuarrie & Wernicke, 2005; Morgan et al., 1986; Liu et al., 2019

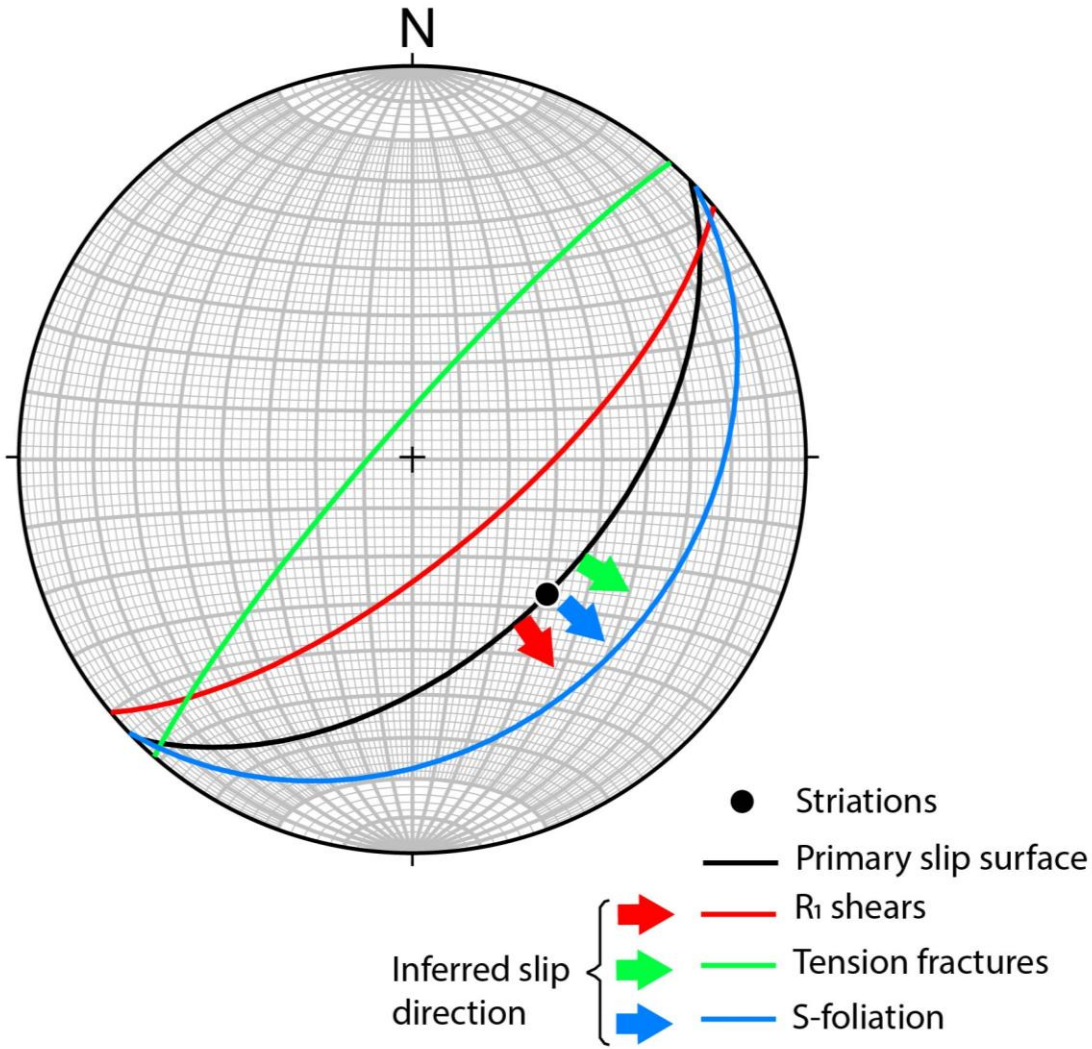
Chapin and Cather, 1994




1.89 ± 0.013 Ma
108° 50′ W
108° 40′ W
108° 30′ W
108° 20′ W
33° 50′ N
33° 40′ N
33° 30′ N
Pgm
Pgpu
Pgpl
QNgb
Pga
Qac
Pgba
Ngs
Ngg
Luna graben
Reserve graben
San Agustin graben
N
0
10
20 km
16.10 ± 0.03 Ma
15.97 ± 0.03 Ma
16.35 ± 0.04 Ma
AZ
NM
0 50 100 km
Colorado Plateau
SF
ABQ
Mogollon-Datil volcanic field
Great Plains
Rio Grande rift
Mogollon Plateau
MO
Basin and Range
LC
Modified from Ratté, 2001
Syn-/post-rifting rocks
Qac
Quaternary alluvial, colluvial, landslide, & piedmont slope deposits undivided
QNgb
Miocene-Quaternary basalt flows
Ngs
Miocene silicic-intermediate volcanic rocks & minor intrusions
Ngg
Miocene-Quaternary (?) Gila Group sedimentary rocks
Pre-rifting rocks
Pgba
Oligocene basaltic andesite to dacite lava flows
Pgm
Oligocene Mogollon Group volcanic & volcaniclastic rocks
Pgpu
Eocene-Oligocene upper Pueblo Creek Formation & equivalent
Pga
Eocene andesite of Dry Leggett Canyon
Pgpl
Eocene lower Pueblo Creek Formation & equivalent
Lower Spears & Datil Groups volcanic & volcaniclastic rocks
40Ar/39Ar sample location

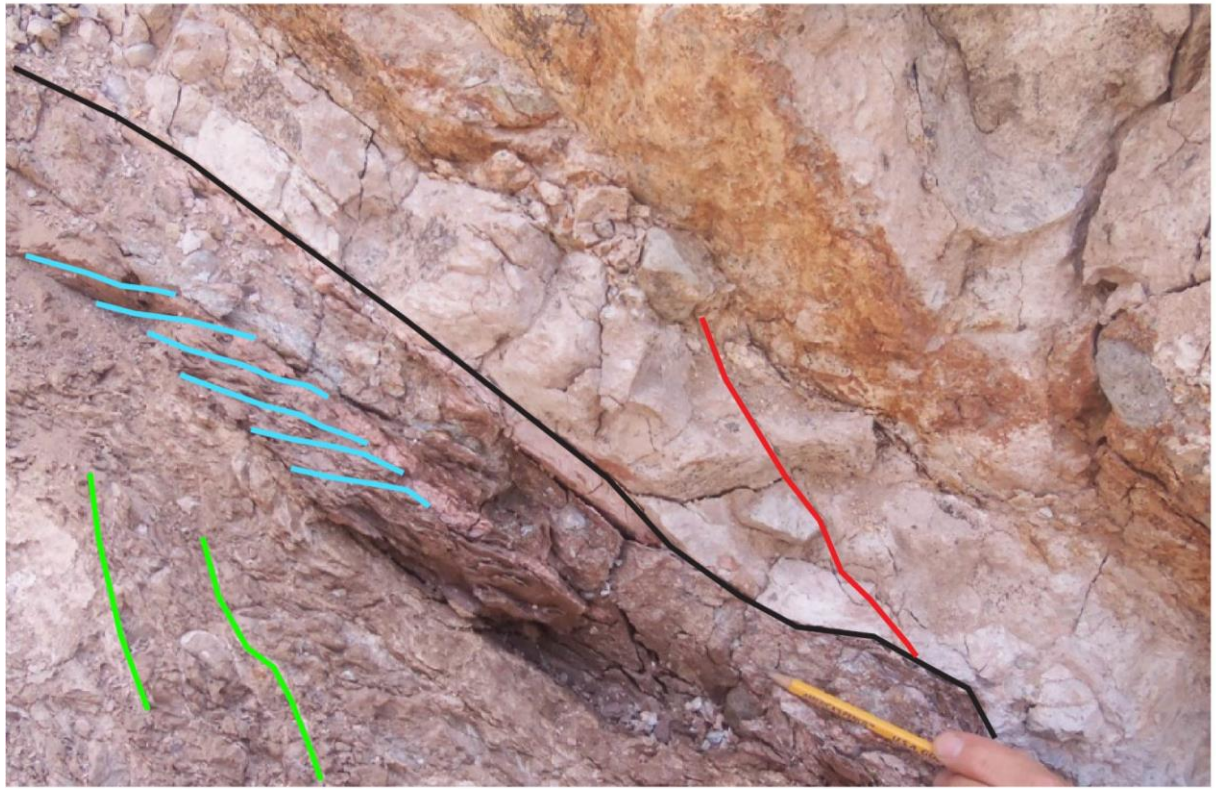
Fault kinematics: Striations & slip-sense indicators





Fault kinematics: Striations & slip-sense indicators

San Francisco Mountains fault zone – Pueblo Creek



Primary slip surface

R_1 shears

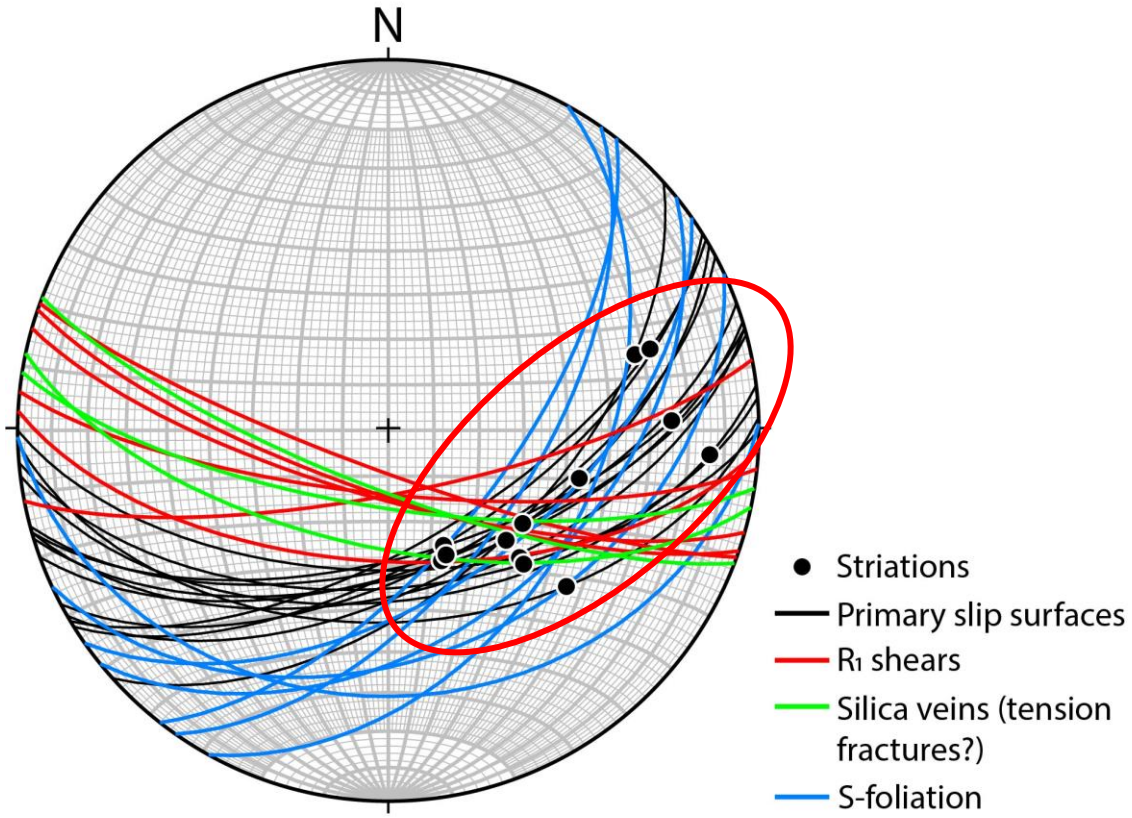
Silica veins (tension fractures?)

S-foliation

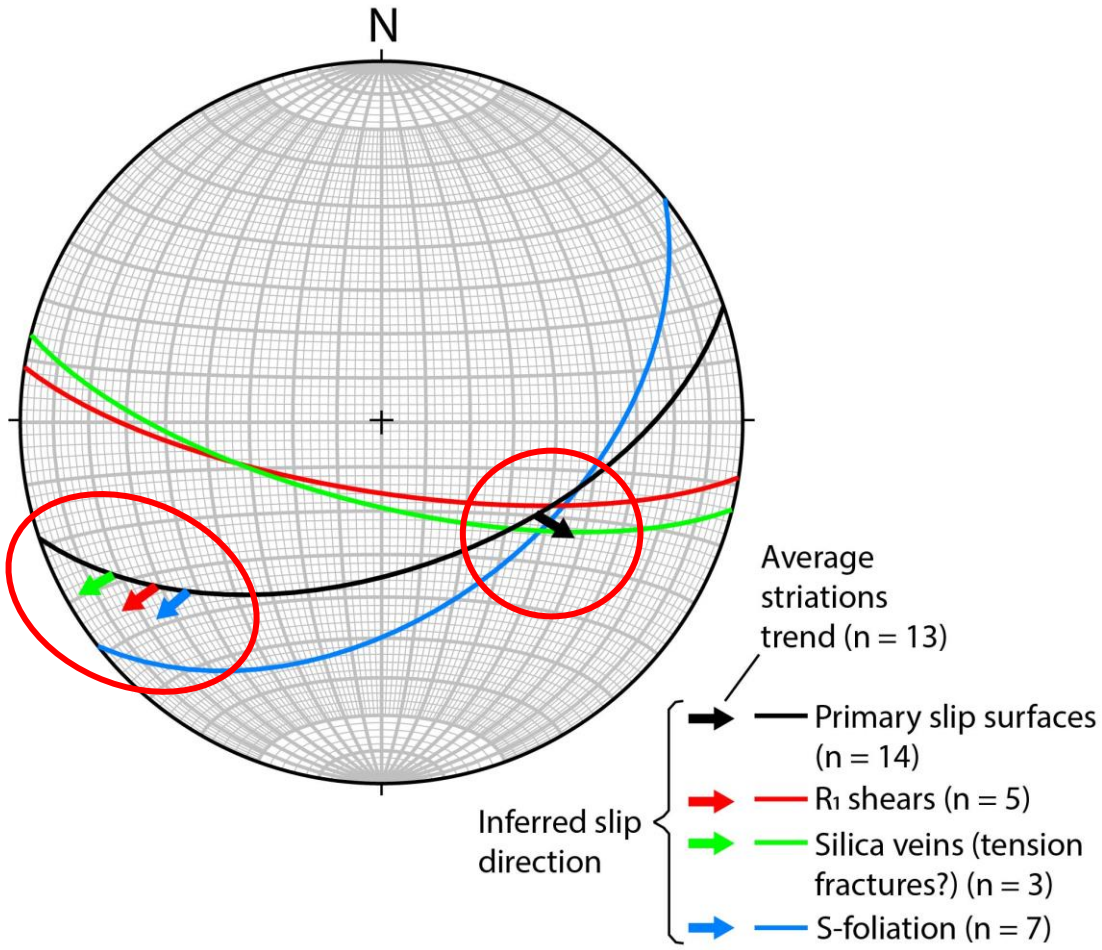
Fault kinematics: Striations & slip-sense indicators

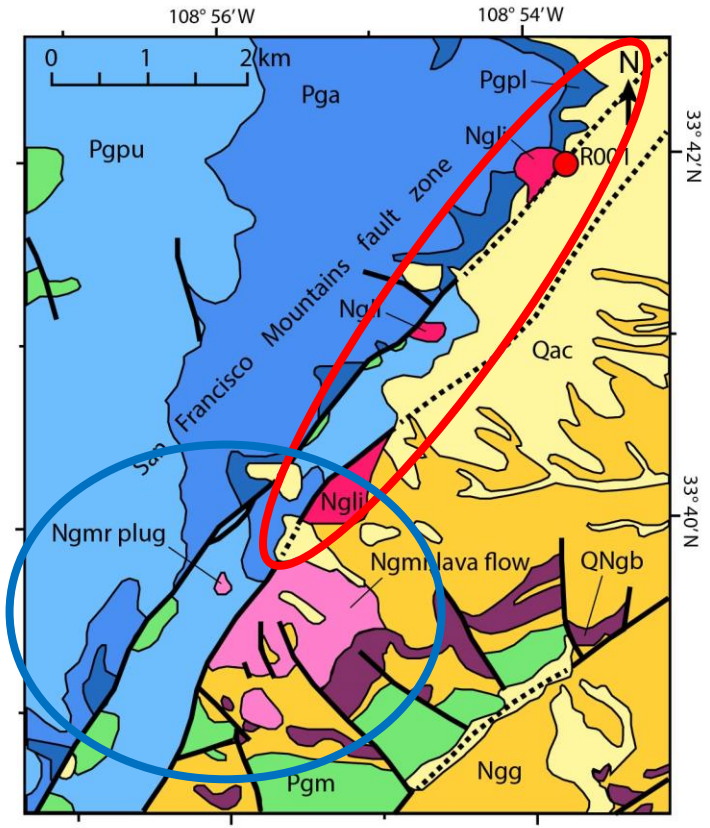
San Francisco Mountains fault zone – Pueblo Creek

All planes and striations



Average planes and striations





Modified from Ratté, 2001

Syn-/post-rifting rocks

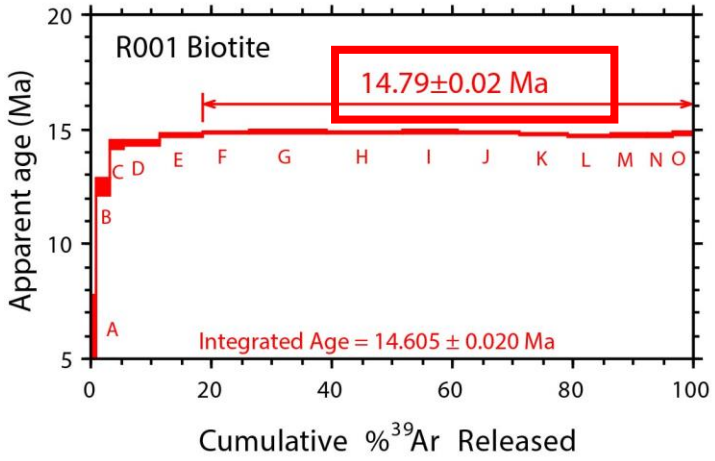
- Qac — Quaternary alluvial, colluvial, landslide, & piedmont slope deposits undivided
- QNgb — Miocene-Quaternary basalt flows
- Ngmr — Rhyolite near Maverick Peak
- Ngli — Quartz diorite intrusions near Wet Leggett Spring
- Ngg — Miocene-Quaternary (?) Gila Group sedimentary rocks

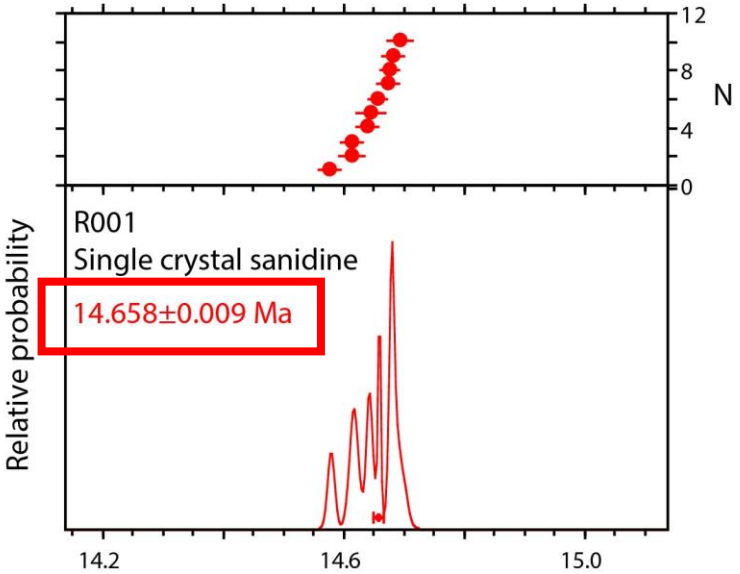
Pre-rifting rocks

- Pgm — Oligocene Mogollon Group volcanic & volcaniclastic rocks
- Pgpu — Eocene-Oligocene upper Pueblo Creek Formation & equivalent
- Pga — Eocene andesite of Dry Leggett Canyon
- Pgpl — Eocene lower Pueblo Creek Formation & equivalent

(Pgpu, Pga, Pgpl: Lower Spears & Datil Groups volcanic & volcaniclastic rocks)

$^{40}Ar/^{39}Ar$ sample location





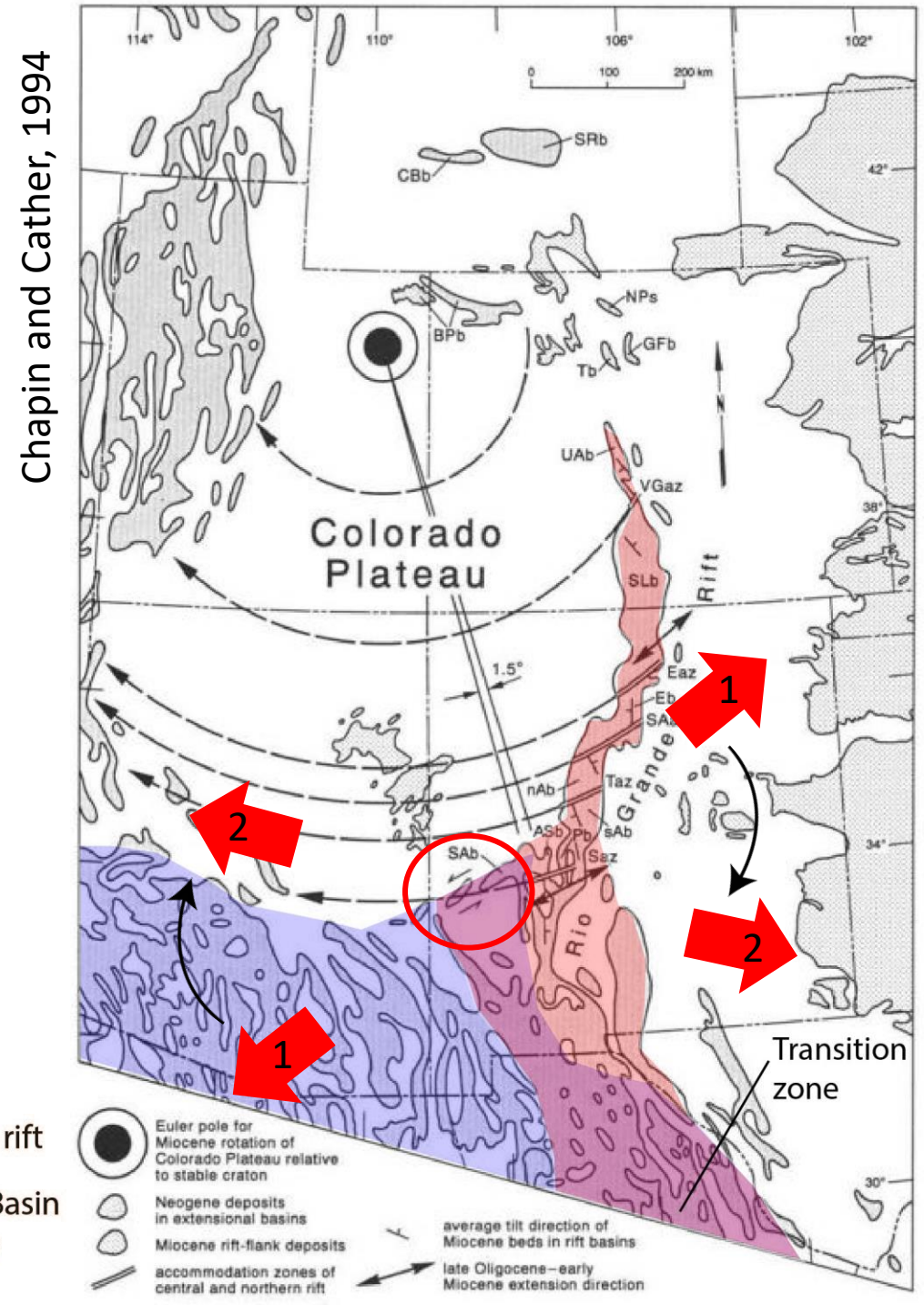
Offset markers?

- ~ 4 km of apparent right-lateral offset of Ngli
- No apparent lateral offset of Ngmr
- Right-lateral slip continued past ~14.7 Ma?
- No apparent left-lateral slip

Regional tectonics

- Shift from mostly right-lateral to mostly dip-slip consistent with change from NE-SW to ESE-WNW extension in middle Miocene
- This change may have occurred here after 14.7 Ma

Change in extension direction: e.g. Aldrich et al., 1986; McQuarrie & Wernicke, 2005; Morgan et al., 1986; Liu et al., 2019

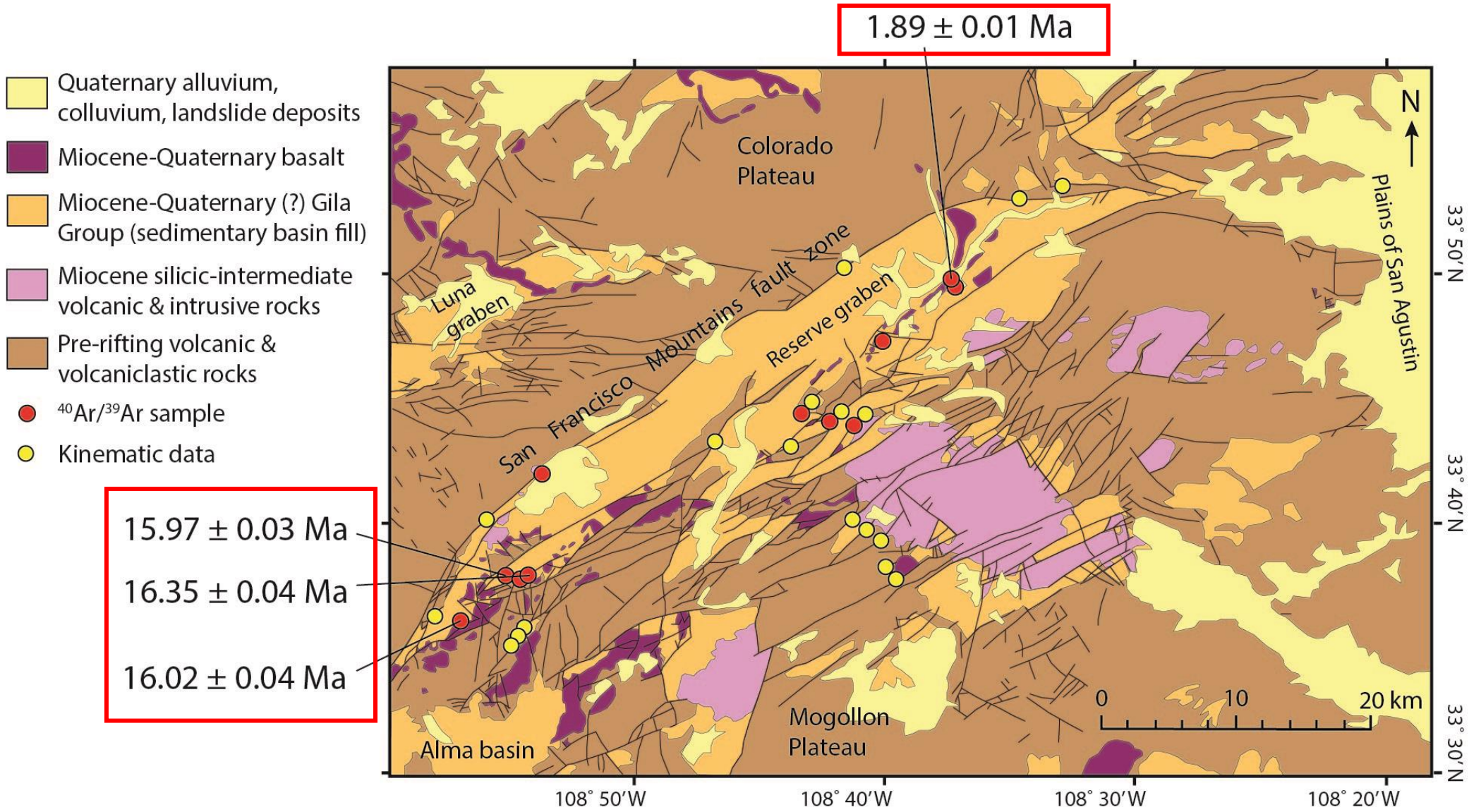


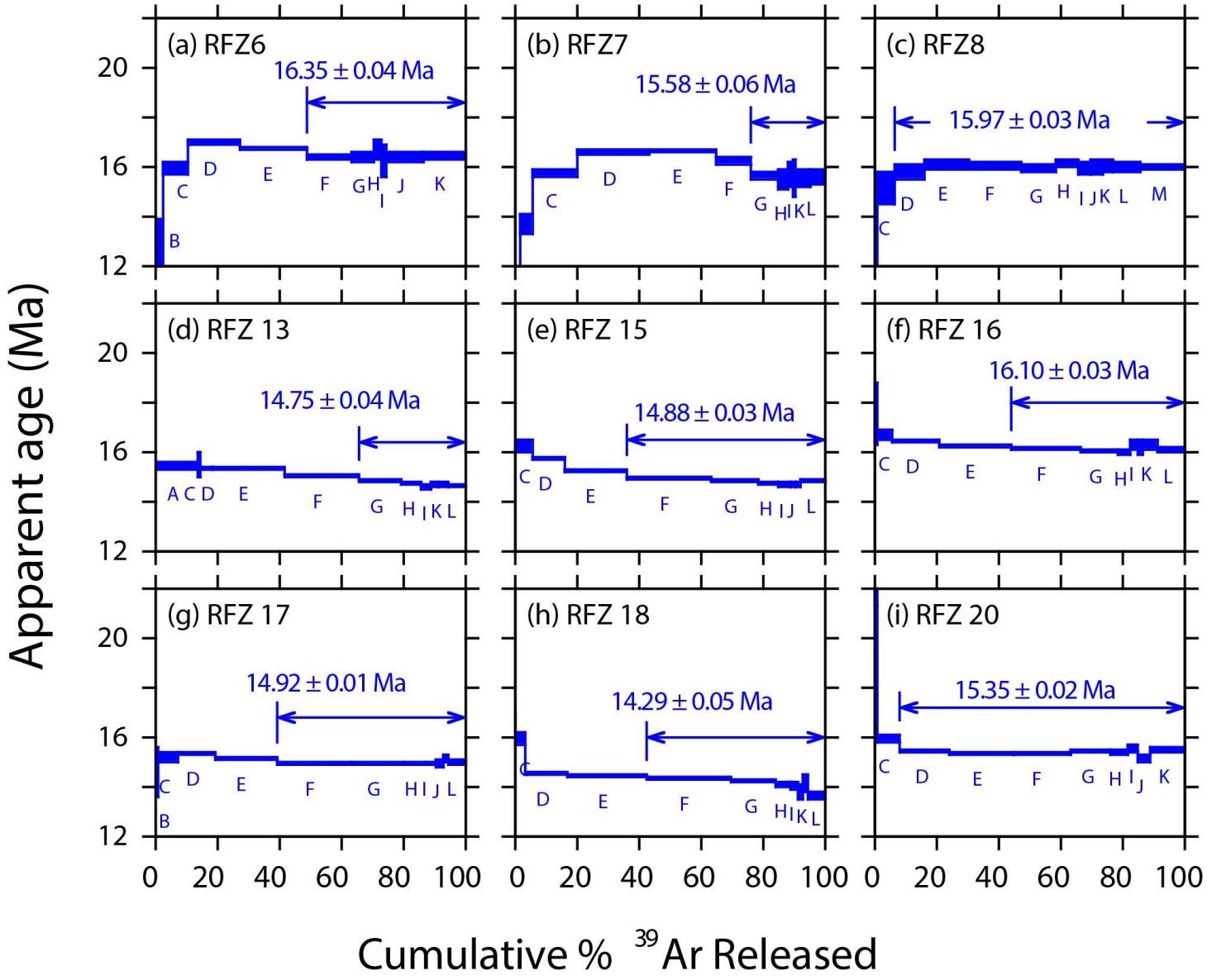
Conclusions

- Subsidence initiated around 16.4 Ma, ended before ~1.9 Ma
- Transition from mostly right-lateral slip to mostly normal dip-slip on graben's master fault
- Possibly up to 4 km of right-lateral slip after 14.7 Ma
- Slip history may reflect regional shift from SW- to W- or WNW-directed extension

Questions

$^{40}Ar/^{39}Ar$ geochronology




(a) RFZ6
16.35 ± 0.04 Ma
(b) RFZ7
15.58 ± 0.06 Ma
(c) RFZ8
15.97 ± 0.03 Ma
(d) RFZ 13
14.75 ± 0.04 Ma
(e) RFZ 15
14.88 ± 0.03 Ma
(f) RFZ 16
16.10 ± 0.03 Ma
(g) RFZ 17
14.92 ± 0.01 Ma
(h) RFZ 18
14.29 ± 0.05 Ma
(i) RFZ 20
15.35 ± 0.02 Ma
Apparent age (Ma)
Cumulative % 39Ar Released