Is the Arc Accretion Model for the Crustal Evolution of Southern Laurentia Correct? Let's Look at the Rocks!

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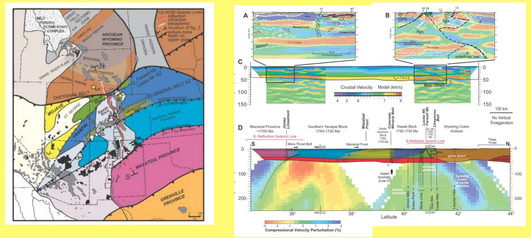
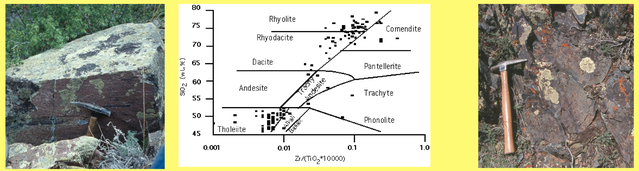
1. The arc accretion model for evolution of southern Laurentian crust has been prevalent for the last 20 years. Recent structural and seismic studies have been interpreted in terms of this model, identifying dipping reflectors as fossil subduction zones.



Figures are from ""Structure and evolution of the lithosphere beneath the Rocky Mountains: Initial results from the CD-ROM experiment" by Karlstrom et al. (2002): GSA Today, v. 12, p. 4-10

2. But, ***Paleoproterozoic rocks of the southwest are dominantly bimodal basalt-rhyolite assemblages***. Andesite and basaltic andesite, major components of modern island arcs, are almost entirely absent, as are ophiolites, accretionary melanges, and other arc-related features.

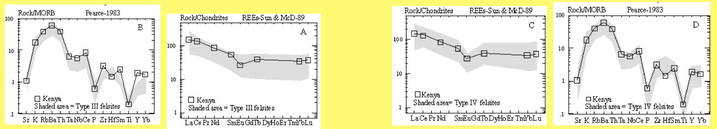


Field photos of high-silica rhyolitic ash-flow tuff and pillowed basalt from Gunnison, CO area. Center diagram is SiO_2 vs. Zr/TiO_2 plot (Winchester and Floyd, 1977) showing distinctly bimodal chemistry for volcanic rocks in this area.

Major examples of bimodal volcanic assemblages in the southwest include:

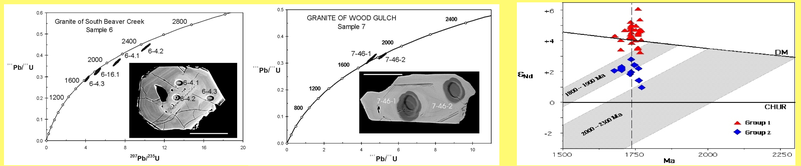
- The Gunnison-Salida area of central Colorado
- The Needle Mountains of southwestern Colorado
- Farwell Mountain in the Park Range of northern Colorado
- The Green Mountain Formation of southern Wyoming
- Basalt-dominated bimodal successions of north-central New Mexico
- Rhyolite-dominated bimodal assemblages in the Tusas and Picuris Mtns of New Mexico
- Big Bug Group of Yavapai Supergroup of northern Arizona

3. Trace element data for felsites from Gunnison-Salida area compare favorably with similar data for rhyolites from the Kenya Rift.



Type III felsites have no Eu anomaly; Type IV felsites have pronounced negative Eu anomaly (data from Hill, 2004).

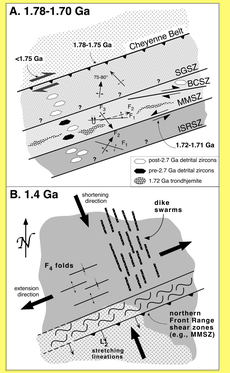
4. Inherited zircons and Nd data from bimodal rocks in the Gunnison-Salida area of Colorado indicate derivation from older, ca. 1850 Ma Trans-Hudson/Penokean (THO/P) rocks. The occurrence of the1840 Ma Elves Chasm pluton in the Grand Canyon (Hawkins et al., 1996) confirms that rocks of THO/P age are present in southern Laurentia.



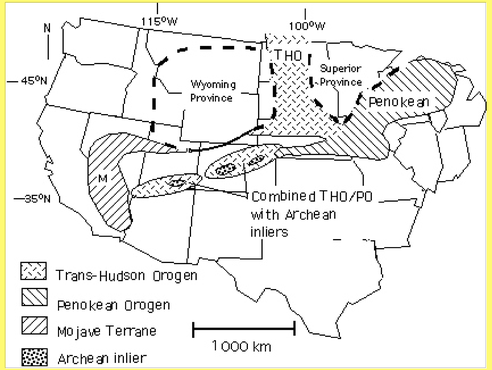
SEM images and concordia plots for zircons from plutons in Gunnison, CO, area. Ages ($^{207}Pb/^{206}Pb$; Ma) are 6-4.1, 2224+/-21; 6-4.2, 2521+/-14; 6-4.3, 1664+/-36; 7-46.1, 1879+/-20; 7-46.2, 1708+/-20. (Hill and Bickford (2001).

Nd vs age plot for Gunnison, CO, volcanic and plutonic rocks. Group 1 rocks appear juvenile at 1750 Ma, whereas Group 2 rocks are consistent with derivation from 1800-2500 Ma crust. From Hill (2004).

5. These data suggest that arc accretion occurred ca. 1850 Ma and that subsequent, ca. 1750-1710 Ma rifting of the accreted basement produced the observed bimodal volcanic sequences. This proposal is consistent with the suggestion of Selverstone et al. (2000) that the Proterozoic lithosphere, at least in Colorado, may have been assembled piecemeal along major transcurrent shear zones.



Schematic diagrams summarizing Proterozoic strains within northern Front Range, CO. After Selverstone et al. (2000).



Proposed distribution of lithosphere at about 1850 Ma. Combined THO/Penokean likely extended even farther to the south than shown because bimodal, rift-related volcanic assemblages occur in northern New Mexico. We believe that the ca. 1780-1700 Ma bimodal volcanic assemblages, and associated plutons, were formed during rifting of this crust as blocks were assembled on major transcurrent shears. These rocks, now exposed at the surface, thus overlie somewhat older THO/Penokean age crustal rocks. The 1840 Ma Elves Chasm pluton is presumably a surface exposure of mostly buried THO/Penokean crust (after Hill, 2004).

References cited: For citations, please contact mebickfo@syr.edu or bhill@syr.edu