Tectonic Evolution in the Rocky Mountain Region: 4-D Imaging of the Continental Lithosphere

An interdisciplinary study under way this summer and fall in the southern Rocky Mountains hopes to show that the lithospheric structure produced there during the formation of the southwestern United States profoundly influenced both physical and chemical modification of the continental lithosphere during all subsequent tectonism. Known as the Continental Dynamics-Rocky Mountain (CD-ROM) project, the study is focusing on understanding the assembly, growth, stabilization, reactivation, and present structure of the Rocky Mountain lithosphere.

The Rocky Mountain region of the western United States has experienced a complex geologic history that can only be unraveled by the integration of a broad range of geoscience data. This region is of great fundamental importance for understanding continental tectonics. Together these regimes are an outstanding field laboratory for studies of the continental lithosphere.

First, a 1500-km-wide juvenile Proterozoic orogenic belt records an episode of rapid accretion of continental material from mantle sources and the assembly of related terranes (Yavapai, Mazatzal) to southern Laurentia between 1.8 and 1.6 Ga. Second, the present high elevations of the regional orogenic plateau in the southern Rocky Mountain/ Rio Grande rift region in particular are the manifestation of Phanerozoic and still ongoing modification and disassembly of Proterozoic lithosphere. This area lies on a profound lateral velocity gradient in the mantle that marks the transition from high velocities under the core of North America to low velocities in the northwest眼角.

The hypothesis, if verified, would place profound constraints on developing theories of evolution of continental lithosphere by providing a comparison of Archean versus Proterozoic lithospheres, by delineating the process of growth of first-cycle continental lithosphere in the Proterozoic, and by analysis of the interplay between "active" and "passive" processes during lithosphere "disassembly." The target area is an ideal place to combine crustal and mantle geophysical, geological, and geochemical data to characterize the evolution of lithospheric provinces and boundaries in four dimensions from the time of accretion to the present.

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6.8 km/s to 7.0 km/s and show evidence of one main metamorphic reaction, involving growth of garnet and plagioclase ± clinopyroxene from earlier orthopyroxene and plagioclase. Textures suggest that the latter reaction occurred under progressively lower temperature conditions and is consistent with a history involving isobaric cooling of orthopyroxene-bearing igneous rocks in the deep crust.

The Nd isotopic compositions of the mafic granulites eNd at 50 Ma of -5.7 to -12.6 overlap the range of initial Nd isotopic compositions for Late Cretaceous/Early Tertiary mafic monzonites exposed in the Front Range of northern Colorado and are at least consistent with models that involve the mafic lower crust in the formation of the magmas parental to these rocks. Ongoing studies of the mafic xenoliths involve electron microprobe and laser ablation inductively coupled plasma-mass spectrometry studies of the major and trace element compositions of constituent mineral phases, which, along with mineral separate isotopic studies, will be used to further assess the age and metamorphic history of the lower crust represented by the mafic granulite xenoliths.

The fifth major component is integrated analysis of all available data, employing modern GIS, image processing, and visualization schemes. For example, gravity data coverage is good for the CD-ROM area, and analysis of these data constrained by seismic results can extend the seismic results both laterally and vertically [Snelson et al., 1998]. In addition, the act of simply overlaying different types of geological and geophysical information on images of remote sensing data can often reveal anomalous relationships that warrant further investigation.

One major goal of the project is to catalyze the next generation of collaborative studies of the Rocky Mountain lithosphere. In that regard, we welcome piggyback experiments, collaboration, and other interactions. Two topical sessions—one on orogenic plateaus and another on Cenozoic tectonics of the southern Rocky Mountains—at the Geological Society of America annual meeting in October 1999 will have CD-ROM contributions and also focus on related issues. A session at AGU's Fall Meeting will also take up the lithospheric structure and evolution of the Rocky Mountain region. Up-to-date information on the project and associated activities can be accessed at Web site: www.geo.utep.edu/CD-ROM.

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References


