CRUSTAL EVOLUTION OF EARLY PROTEROZOIC ROCKS, CENTRAL COLORADO

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INVESTIGATIONS OF THE PROTEROZOIC GEOLOGY OF CENTRAL COLORADO

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Introduction

Interest in the Proterqozoic crustal evolution of the Southern Rocky Mountains has grown tremendously during the past decade and great strides have been made in constructing an integrated geologic history of this part of the North American continent. Since three of the faculty members of the Keck-Colorado geology group have been doing research with our students in the area for many years we were confident that there were numerous problems involving the igneous and metamorphic history of the area suitable for Keck student projects.

The group included eight students from five of the Keck schools, four faculty, two student helpers and a camp steward. Our base was the Mountain Campus of the Fountain Valley School, a large log cabin with complete bath and kitchen facilities located about 30 km northwest of Salida. From our base we went on two several-day excursions to field check the areas around Cottonwood Pass and the northern Sangre de Cristo Mountains, areas A and C respectively on Figure 1. Day trips were also made by the entire group to the well-preserved metavolcanic sequences near Salida and Mount Ouray (area B).

After becoming familiar with the local geology, students defined individual research projects which they worked on during the last week in the field. We spent the final week at Colorado College in Colorado Springs where students studied the literature, prepared samples for thin sectioning and chemical analysis, and wrote proposals for the research they planned to continue back at their home campuses.

Regional Geology

South of the Cheyenne Belt, a major northeast-trending shear zone in southern Wyoming, all Precambrian rocks are Proterozoic in age. They consist of supracrustal metavolcanic and metasedimentary rocks that have been intruded by several generations of granitic plutons. The supracrustal rocks comprise two distinct groups: 1. mafic and felsic volcanics and volcaniclastics, found mainly in northern Colorado and adjacent Wyoming and in southcentral and southwestern Colorado and 2. pelitic metasedimentary rocks situated between the two volcanogenic terranes. Metamorphism typically reached the middle to upper amphibolite facies, within the stability fields of andalusite or sillimanite. Migmatization was common within the metasedimentary rocks. In several places, especially near Salida, Mt Ouray and Gunnison, deformation was insufficient to destroy primary structures and textures and, in the Salida area, almost 4000 m of stratigraphic section have been preserved (Boardman, 1986). U-Pb dating of felsic volcanic rocks indicates that the supracrustal sequences were deposited between about 1780-1720 m.y. ago (Bickford and Boardman, 1984).

Granitic intrusive rocks of three broad age groups intrude the metamorphic rocks. The oldest range from almost 1800 to about 1670 m.y. They are typically calc-alkaline, synorogenic and moderately- to well-foliated. According to Reed *et al.* (1987) much of the metamorphic deformation of the supracrustal rocks was due to emplacement of these plutons. This conclusion is supported by the increase in metamorphic fabric and grade within 2-5 km of the 1670 m.y. old granitic pluton north of Salida (Boardman, 1976). The second generation of plutonism involved anorogenic granites emplaced throughout Colorado mostly between 1470-1420 m.y. ago. Additional metamorphism and pegmatite formation appears to be associated with this intrusive event (Bickford (1988). The most recent Precambrian igneous

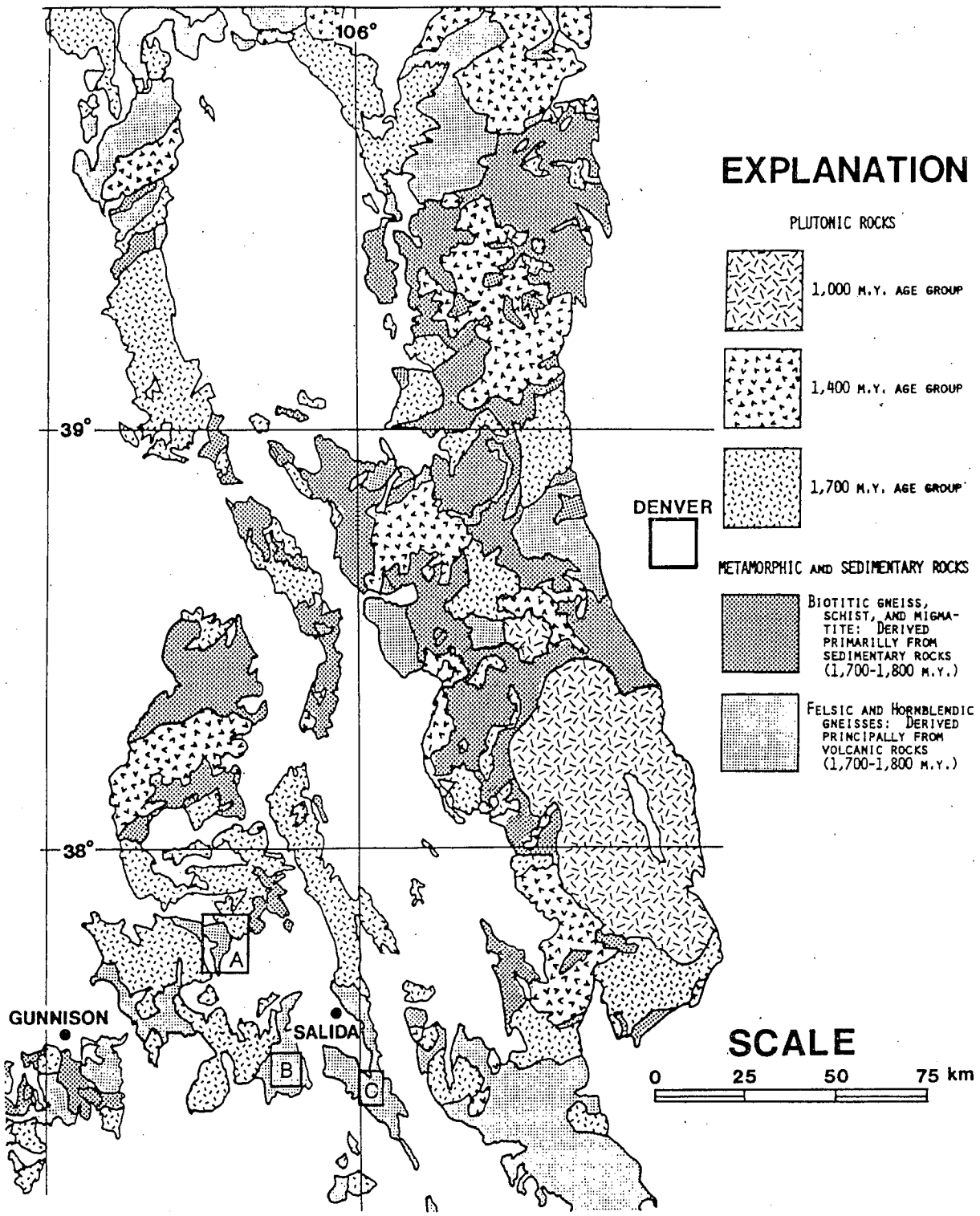

Figure 1. Precambrian geologic map of central and northern Colorado. Area A: Ptarmigan Lake, Cottonwood Pass and Mirror Lake. Area B: Little Cochetopa Creek and Mt. Ouray. Area C: Hunts Lake and northern Sangre de Cristo Mountains. Modified from the Preliminary Geologic Map of Colorado, compiled by Ogden Tweto, 1976.

activity occurred about 1000 m.y. ago with the intrusion of the Pikes Peak batholith in the southern Front Range west of Colorado Springs.

Tectonic Setting

Most tectonic reconstructions for southwestern North America during the Early Proterozoic call for a series of arcs and backarc basins to have been accreted to the southern edge of the Archean Wyoming province (Bennett and DePaolo, 1987; Bickford, 1988; Condie, 1986; Duebendorfer and Houston, 1987; Reed, *et al.*, 1987). Both U-Pb geochronology and Nd isotope systematics indicate that Proterozoic volcanic and plutonic activity shifted to the southeast with time. According to Reed *et al.* (1987) the northern volcanogenic terrane, along the Colorado-Wyoming border, represents the first arc to be accreted to the Wyoming craton and the southern volcanic terrane, including the areas around Salida, were the second. The broad band of intervening pelitic metasedimentary rocks represent a "composite backarc basin."

The Keck Projects

The area around Salida is an ideal one for studying many of the igneous and metamorphic rocks of the region. It is located near the boundary between volcanic and sedimentary terranes, it contains well-preserved supracrustal sequences, strongly-foliated metamorphic rocks and numerous intrusions of the 1700 m.y. age group (Fig. 1).

The goal of the Keck-Colorado program was to examine the igneous or metamorphic histories of several specific areas in order to learn more about the crustal evolution of this part of the continent and perhaps to evaluate the current models for the Proterozoic tectonic history of the region.

Four students, Karin Johnson, Becky Mellinger, Matt Owens and Stephie Pulaski, under the guidance of Bud Wobus and Stan Mertzman, studied the southern-most part of the Kroenke Granodiorite and the metamorphic country rock surrounding it in the vicinity of Ptarmigan Lake (area A, Fig. 1). Two students, Poppy Staub and Sarah Gramlich, supervised by Shelby Boardman and Jeff Noblett, worked on the petrology of two unusual igneous rock units in Little Cochetopa Valley (area C, Fig. 1). Two other students, working with Shelby Boardman, chose projects of a regional scope. The first was a geochemical comparison of the metabasalts from all three areas by Keith Schembs. The second was a comparative study of the metamorphic conditions of the three areas plus the Salida area by Kim Hannula.

All of us in the Keck-Colorado group are grateful to the W. M. Keck Foundation not only for the research opportunity provided to several promising young geologists, but also for the close interaction and collaboration of all the faculty and students from the several colleges involved.

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