LANDSCAPE EVOLUTION IN THE CITY OF ROCKS NATIONAL RESERVE, SOUTHERN IDAHO

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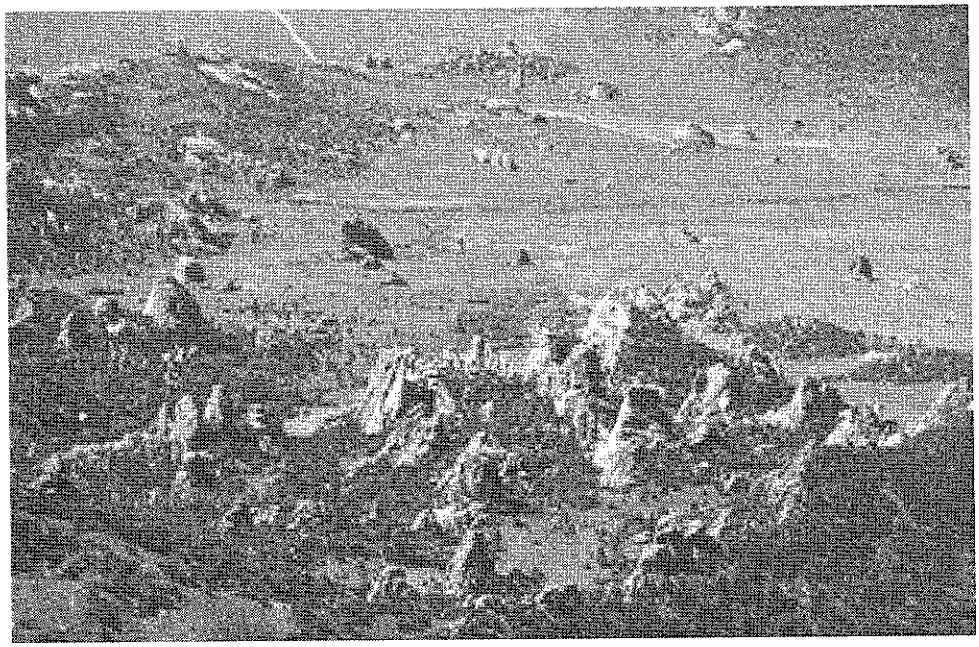


GEOLOGIC SETTING

The City of Rocks National Reserve lies within the core of the Albion Range metamorphic core complex, part of the belt of highly-extended Cordilleran core complexes within the Basin and Range Province. Rocks exposed in the Albion Range record most of the major tectonic events that affected the western United States. The oldest rocks are basement gneiss and schist of the Green Creek Complex, part of the Archean Wyoming Province (Armstong and Hills, 1967; Armstrong, 1968). These are overlain by low-grade Proterozoic metasediments deposited during the rifting event that led to the formation of the Cordilleran passive margin. Shallow water sedimentary units were deposited along the new margin during the Paleozoic and Mesozoic, prior to Late Jurassic to Cretaceous compressional deformation associated with the Sevier orogeny. This part of Idaho was in the hinterland of the Sevier thrust belt and shows evidence of both compression and extension during the late Mesozoic (Wells, 1977). In the Oligocene, the Almo pluton was emplaced as the region was dramatically uplifted and extended. Before and after emplacement, the rocks overlying the pluton were extended along large scale low-angle normal faults (Miller and Bedford, 1999). Extension continued throughout the Cenozoic and the rocks were uplifted to form three large-scale structural domes (Miller, 1980). Bimodal volcanics associated with the passage of the Yellowstone hotspot blanketed the region during the Miocene. The most recent extension is along high-angle late Quaternary range-bounding normal faults. The highest points of the Albion Range, Mt. Harrison (9,600') and Cache Peak (10,200') hosted alpine glaciers during the Pleistocene. Deep erosion by streams and glaciers along the crest of the range has exposed the Archean Green Creek Complex and the Almo pluton in the core of the structural domes. The granitic rocks of these units have been eroded into a spectacular landscape of fins and spires.

HUMAN HISTORY

The eroded granitic rocks of the Albion Range were first observed by Europeans in the mid-1800's when the California trail, the main path to the gold mining districts, was routed through the area. The pioneers referred to the area as the "Silent City of Rocks" in their journals and left axle-grease graffiti on many of the rock towers to mark their passing. The City of Rocks later became a popular sightseeing and picnicking location for people in southeastern Idaho and northern Utah. Visitation increased dramatically during the 1980's when word of the spectacular spires reached a broader audience via several guidebooks and magazine articles. In order to address the increased visitation and its impacts, the Idaho State Parks Department approached the National Park Service with a proposal for co-management. Negotiations between the agencies eventually resulted in the establishment of the City of Rocks National Reserve in the early 1990's. The park is presently being managed primarily to promote its historical significance. Information concerning geology of the park is essentially unavailable to visitors.

PREVIOUS GEOLOGIC INVESTIGATIONS

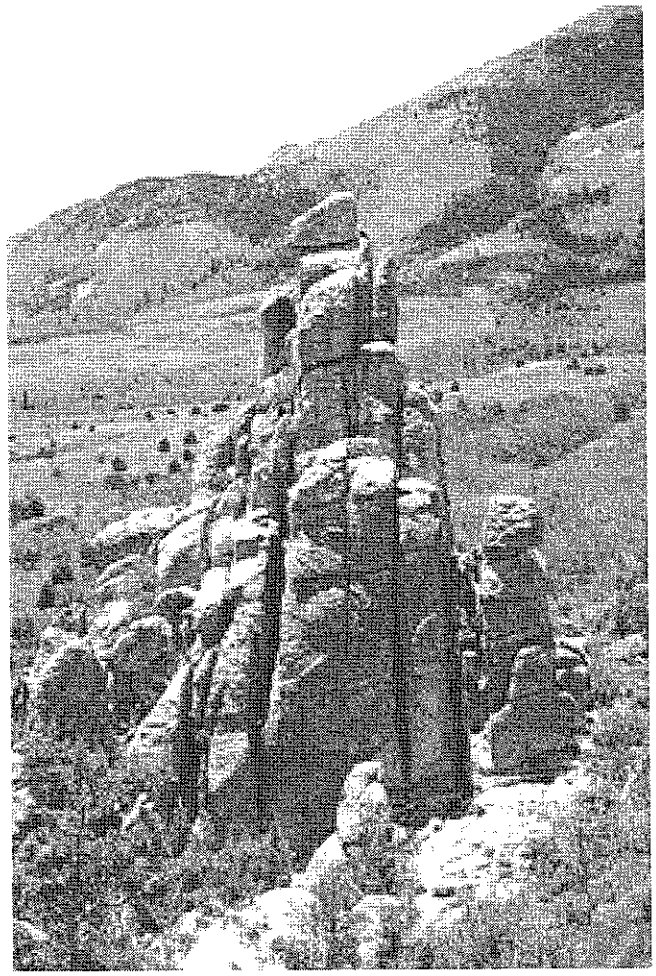
The deformational history of the Albion Range and nearby Grouse Creek-Raft River metamorphic core complexes has been the subject of many published papers. Armstrong (1968) was the first to describe, name, and date the major units of the Albion Range. Compton (1983), Covington (1983), and Todd (1980) focused on the regional-scale structures and the timing of deformation in core complexes of the Idaho-Utah border region. Miller (1980) concentrated on the detailed structure of the structural domes of the northern Albion Range. The general geomorphology of the City of the Rocks was described by Cunningham (1971). Richard Armstrong mapped the entire Albion Range at a scale of 1:24000 during the 1970's and early 1980's. Unfortunately, he died before his field maps could be compiled and published. Using data gathered during two recent field seasons, David Miller of the USGS and Marsha Davis of the National Park Service have produced a revised version of Armstrong's map of the Almo Quadrangle, which includes the City of Rocks.

GEOLOGIC PROBLEMS AND GOALS

The City of Rocks is a bizarre landscape that includes fins, spires, hollow boulders, deep weathering pits, natural arches, and other unusual features that have resulted from many processes including weathering along joints, faults, and dikes, case-hardening, "sapping" by groundwater, and wind erosion. Although there have been several hypotheses concerning the origin of these features, no systematic study has attempted to document and quantify which processes are responsible. The primary goal of this study is to increase the understanding of the formation of the unusual landscape of the City of Rocks. It is hoped that the results of the study will be incorporated into interperative literature that is available to park visitors so that they will better understand the geologic history of the National Reserve.

FIELDWORK

The City of the Rocks Keck project commenced on June 12, 2000 when participants arrived at the Mountain Manor Bed and Breakfast in Albion, Idaho. During the first week, orientation field trips were conducted in the southern Albion Range to introduce the students to the regional geology and point out the many geologic problems that could be addressed. At the beginning of the second week we were pleased to be joined by Dr. David Miller of the USGS who led several field trips for the entire group and pointed out some problems which he had discovered during recent field seasons. The second week featured visits by Dr. Laura Wetzel of Eckerd College, faculty advisor to Monica Wolfson and Dr. Eric Leonard of Colorado College, faculty advisor to Greg Shopoff.



STUDENT PROJECTS

Meredith Brislen studied the development of the Circle Creek Basin in the southern Albion Range. She recognized discreet terrace surfaces by mapping and correlating the heights of individual granite spires. Meredith related the evolution of the basin to periodic changes in base level that accompany tectonic events such as the passage of the Yellowstone hot spot.

Anne Hereford's project focused on the regional pattern of jointing in the granite and Precambrian basement of the City of Rocks. Anne correlated the formation of major joint sets with discreet tectonic events.

Jamie Levine studied granitic landforms and categorized them based on shape and size. For each landform she gathered a variety of structural and geomorphic data which was used to determine which factors were important in controlling their overall shape.

Greg Shopoff concentrated his efforts on a statistical analysis of the morphology of the enigmatic panholes which pock-mark the surface of the granitic landforms. Greg took very detailed measurements of over 100 of these features. His results detail how the shape of the panholes evolves through time.

Monica Wolfson studied the flare structures that occur along the bases of many of the granitic landforms. She gathered data on height, aspect, and distribution of these structures throughout the southern Albion Range. Her results contribute significantly to a model of the processes that create and exhume the landforms.

Charlie Woodruff's studies focused on strongly mineralized joints and faults that exert a major control on the distribution and orientation of the granitic landforms. These fractures are characterized by sericitic and silicic alteration and sulphide mineralization. Charlie located, mapped, and measured as many of the mineralized zones as possible. He collected samples from the Castle Rocks for geochemical analysis

and radiometric dating. His results describe the timing and type of mineralization and its affect on landscape evolution.

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GEOMORPHOLOGY AND EVOLUTION OF THE CIRCLE CREEK BASIN, SOUTH-CENTRAL IDAHO

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INTRODUCTION

This study is an interpretation of drainage basin development in the Circle Creek Basin of the City of Rocks National Reserve. The basin currently exhibits two separate pediment surfaces: the existing basin floor and an historical erosion surface. This proposed erosion surface has been witness to regional geologic activity and portrays a record of previous events including activity related to the Yellowstone plume, which was situated north of the field area about 10 Ma. The increased heat and geothermal activity associated with the mantle plume influenced basin erosion and development due to uplift and crustal thickening.

The purpose of this study is to relate the deformation and erosion of the Circle Creek Basin to the migration of the Yellowstone Hot Spot, as well as present a topographic map of a proposed erosional surface that was present during the time that the hot spot was active in the Albion Mountain region.

REGIONAL GEOLOGY

The City of Rocks National Reserve is located in south-central Idaho, in the southern part of the Albion Mountain Range (Fig. 1). The north-south trending Albion Mountains are in the northern Basin and Range Province, east of the Antler orogenic belt, west of the Sevier orogenic belt, and south of and partially surrounded by the Snake River Plain (Armstrong, 1968). The Albion Mountains are a metamorphic core complex containing four northeast-trending mantled gneiss domes composed of 2.5 b.y. old Archean crystalline basement rocks (Armstrong, 1968; Miller, 1983). The City of Rocks dome is the largest of the four.

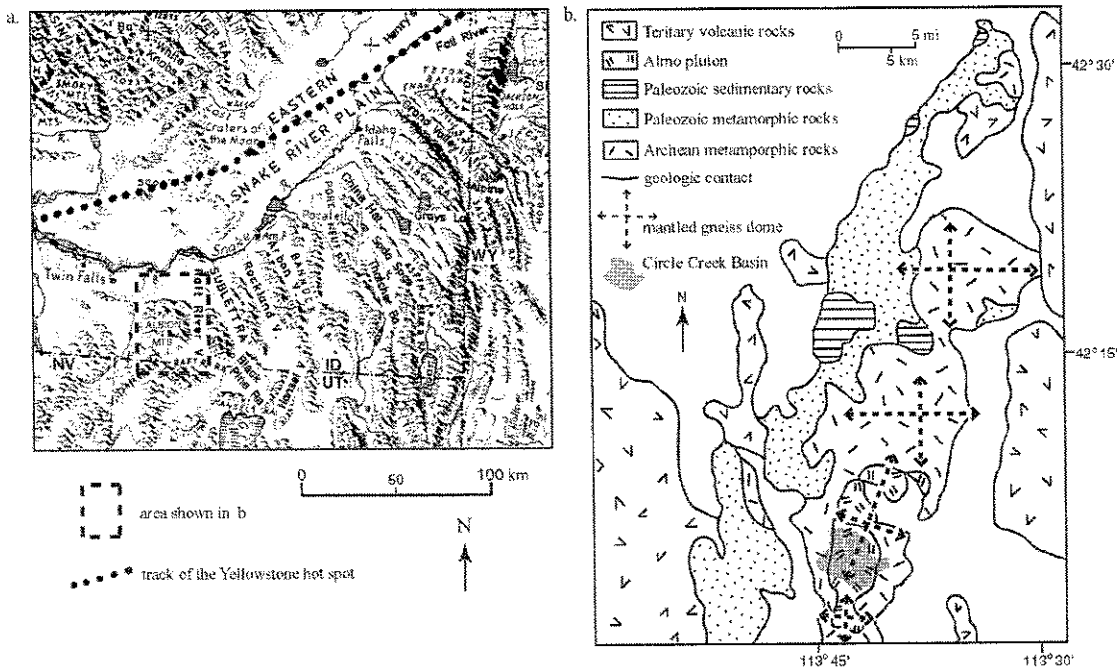

Figure 1. a. Regional map of southeastern Idaho (adapted from Pierce and Morgan, 1992).
b. Generalized geologic map of the Albion Mountains, showing shaded Circle Creek Basin area and mantled gneiss domes (adapted from Armstrong 1968; Miller, 1983).