UNUSUAL AND INTERESTING GEOLOGIC FEATURES OF THE ALMO PLUTON IN CASTLE ROCKS STATE PARK, CASSIA COUNTY, IDAHO

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INTRODUCTION

Cassia County, Idaho is famous for City of Rocks National Reserve, a park dominated by spectacular granite spires. Nearby and inaccessible to visitors for many decades is a region of spires equally as spectacular, and equally as seductive to rock climbers (fig.1). This area is slated to be open to the public as Castle Rocks State Park in May of 2003. The research described below was conducted during the summer of 2002 to describe and document the locations of unusual or visually appealing geological phenomena that may be of interest to park vistors or that might need protection from them**.**

Figure1. Typical Landforms of Castle Rocks

The Castle Rocks are located in the southern Albion Mountains which are part of the Raft River/Grouse Creek/Albion Mountains metamorphic core complex of the Basin and Range province. The following history is principally derived from Miller and Bedford (1999). The oldest rocks in the area belong to the Archean Green Creek Complex (approximately 2.5 billion years old). Porphyritic granite of the Green Creek Complex weathers and erodes to form spires that are very similar to spires composed of the much younger equigranular granite of the Almo pluton which intruded during the Oligocene (approximately 27 million years ago). Intermediate in age between these two spire-forming granites are approximately six other units including the distinctive Elba Quartzite. All rocks older than the Almo pluton have undergone deformation and metamorphism related to orogenic (mountain-building) events.

All of the features I studied at Castle Rock State Park are composed of granite of the Almo pluton. Granite of the Green Creek Complex does not crop out within the proposed park boundaries.

I noted one hundred unusual and interesting landforms during the course of my research, all of which are either geologically unusual, visually interesting, delicate, or precious (e.g. large well-formed quartz crystals). Information about the locations of these features can be used by Idaho State Parks to guide land-use decisions such as protection of delicate and rare features through appropriate signage and by directing trails and roads away from those areas. Conversely, visitation can be encouraged to more robust geologically unusual or visually interesting features by directing trails, roads, and informational papers to highlight them.

Methods

The research was conducted in a very straightforward manner. The relevant tools ~~I~~ used were air photos of the park and a Brunton Global Positioning System (GPS) unit. My basic methodology was to walk wherever terrain permitted and look for features that were interesting or unusual. Specifically, I was looking for illustrative examples of characteristic and unusual features associated with granitic landforms as described by various authors (e.g. Twidale et al., 2001 and Campbell and Twidale, 1995). These features are all either visually striking, geologically unusual, or excellent examples that of common granitic weathering phenomena. I only documented the most illustrative examples of features. I also noted the regions which contained the highest concentration of certain features.

At each feature, I would stand as close as terrain permitted, take a Global Positioning System (GPS) reading, mark the location on the air photo, and document it. Documentation included written descriptions of features and photographic documentation. I tried to document as many features as possible in the park, but the cliff-like nature of the terrain rendered many inaccessible.

FEATURES

My research yielded the documentation of 100 examples of 12 types of features in seventy-one locations a brief description of the probable origin of each type of feature.

Evidence of structural processes in the park can be seen in open fractures called **joints**. Joints are formed by the pressure generated by tectonic forces, unloading action, or cooling processes.

Tors are formed when the excessively fractured edges of a granite mass fall away, leaving behind blocky towers.

Case hardening is formed by the movement of ions within the rock by hydrological processes (Ollier, 1969). At Castle Rocks, case hardening is rich in silica and iron oxides.

Polygonal cracking is of controversial origin. The basic principle behind the cracking is that there is a difference in expansion of the core and the outer case-hardened layer. This difference causes extensional stresses. The controversy of polygonal cracking lies in determining exactly what causes the differential expansion of the exterior and the core of the rock. One theory suggests that the case hardening processes of accumulating minerals on exposed surfaces causes a tightening of the case hardened surface which elicits an extensional stress (Campbell and Twidale, 1995). Another theory suggests that there is an expansion of the core due to a volume change of minerals as they change chemical composition when they are exposed to the environmental conditions of the earth's surface.

Flared slopes form at the weathering front from a moisture attack on the subsurface granite (Mueller and Twidale, 2002; Campbell and Twidale, 1995). When the water and acids accumulate in the soil horizon just below the surface, the result is that the middle of the granite wall is weathered more than the top and the bottom as the top does not have regolith to trap soil and acids next to it, and the bottom does not have the same accumulation of water and acids. The result is a wave-shaped feature (fig.2).

scale:--------1m

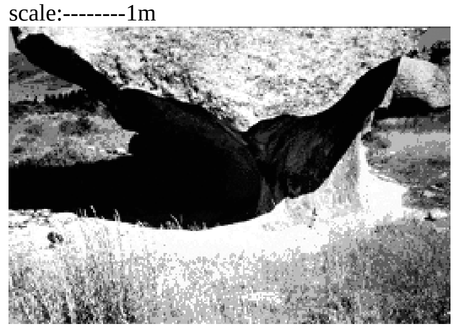

Figure 2. Flared Slope

Cavernous weathering is also of controversial origins. It is believed that granitic cavernous weathering begins as a small indentation in the rock caused by the same moisture attack that forms flared slopes (Mueller and Twidale, 2002**;** Campbell and

Twidale, 1995). This indentation is then exacerbated by either evaporation or core-softening to form cavernous weathering (fig.3). The evaporation model theorizes that the environment within the small indentations and outside of the small indentations (different because of sun-controlled humidity) is significant enough to encourage increased

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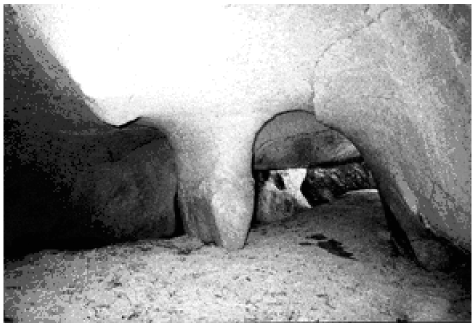

Figure 3. Inside a Cavern Formed by Cavernous Weathering

weathering within the indentations relative to the rock exposed to sun (Hazlett and Trent, 2002). The core-softening theory says that the transport of ions from the core of the rock to the exterior which occurs during case hardening weakens the inside at the same time that it strengthens the exterior (Ollier, 1969). This softening allows for a degradation of the interior at a much faster rate than the case-hardened exterior (Conca, 1984). What is left is a case-hardened exterior with a hollowed-out interior. The occurrence of cavernous weathering in Castle Rocks State Park supports the evaporation model.

Panholes are somewhat mysterious (fig.4).

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Figure 4. Large Panhole

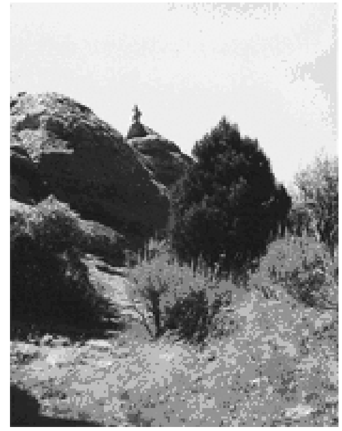

Figure 5. Pickelhaube Atop Spire

They are a weathering phenomenon that is formed by physical and chemical processes enlarging a small indentation on the top surface of an exposed spire, but it is not known exactly what initiates the indentation. It could be that some physical weathering process (such as grains loosened by lichen) displaces one grain leaving an indentation that is further aggravated by weathering. It appears that the size of panholes is dierectly related to the time of subaerial exposure of the surface on which they lie.

Pickelhaubes, German for "spike-helmets" are not established, studied geologic features (fig.5). The name has only recently been suggested by Kevin Pogue. They are only found on or near the summits of spires and probably represent the last remnant of a surface that has been largely destroyed through the enlargement of adjacent panholes (Pogue, 2002).

Xenoliths are pieces of the country rock which are incorporated into the plutonic rock during plutonic intrusion as the country rock slowly stopes its way upward.

Pegmatite and **aplite** are coarse- and fine-grained dikes that form when magma intrudes cracks in the granite while it is still deep in the subsurface. The magma eventually crystallizes into pegmatites and aplites. The crystal size of the dike rock depends on cooling rate and/or presence of volatiles in the liquid (Jahns and Burnham, 1969; Park and MacDiarmid, 1970). Larger crystals are promoted by slower cooling rates and an increased volatile component.

Vugs, also known as miarolitic cavities, are small cavities in the granite that contain well-formed crystals. They are formed in the subsurface during the cooling phase of the magma. If the magma cools around a gas bubble, a cavity is left in the rock. The minerals in vugs crystallize from a water-rich component of the magma (Jahns and Burnham, 1969). This liquid is found in the pore spaces between grains around the vug. When the magma/rock material is under pressure and as it cools, crystals form. Because the gas bubble has left a cavity, the crystals have sufficient space to form euhedrally.

CONCLUSIONS

Castle Rocks State Park is certain to attract many visitors when it is opened to the public in May of 2003. These visitors will be astounded by the unusual and interesting geology of the park. Landforms sculpted by cavernous weathering are sure to attract particular attention. Its beautiful forms, large-sized caves, and enigmatic formation make cavernous weathering one of the most interesting features of the park. Less prevalent, but also very interesting in appearance and formation is polygonally cracked case hardening. All visitors will note joints in the park because they are such common geologic features. Joints can be used to describe the formation of almost every major feature in the park. Tors, boulders, blocks, fins, and spires all owe their size and shape to networks of joints formed through a variety of processes. Visitors are also sure to observe panholes and their late-stage cousins pickelhaubes (oneword) as they scramble and climb over the rocks. Panholes form on surfaces that have long been exposed to the elements. If their origin is considered in conjunction with flaredd slopes, which provide evidence of relatively recent exhumation, they provide a means to understand the processes of weathering and erosion that have produced this unique landscape. Xenoliths also give clues about the history of the park and are dramatic evidence of the once-liquid nature of the Almo pluton.

Visitors might find well-formed crystals in the vugs and pegmatite dikes of the park or be tempted to test the strength of delicate landforms. This study can help the park service protect those features that are delicate and irreplaceable and to explain the origins of these interesting and unusual features to visitors.

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