Some geochemical aspects of the cedar tree laccolith, Gallatin Canyon, Southwestern Montana
by Daniel B Hawkins

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Chemistry
Montana State University

Abstract:
An attempt has been made to determine how the silts in connection with a particular laccolith gained space for themselves. She study was restricted to a small area where the andesite porphyry in the form of sills and elliptically shaped bodies referred to by the author as "eyes", of the neighboring laccolith has intruded the' Meagher limestone.

Chemical and petrographic analyses, as well as specific gravity and structural measurements were utilised in ah effort to find a solution. Chemical analyses for calcium, magnesium, and carbonate were used as a measure of possible assimilation of the limestone by the intrusive.

She specific gravity and structural measurements were used to estimate the amount of space gained through brecciation and Mechanical displacement. The analyses for calcium and magnesium were carried out by means of a Beckman Model DU spectrophotometer with any oxy-hydrogen flame attachment. The carbonate content of the samples was determined by titration.

The results of the chemical analyses and the specific gravity measurements were expressed graphically so as to observe the variation of the samples in relation to their position within the sills.

Assuming that the sample showing the lowest amount of calcium represents most closely the original uncontaminated magma, and that the original magma was homogenous throughout the amount of limestone assimilated was calculated. On the basis of the calculation it appeared that from 0.3 to 2.5% of the volume of the sill had been gained by assimilation. The remaining space had been gained by purely mechanical means.

Many problems remain before a more exact Solution can be arrived upon.

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INTRODUCTION

One of the major problems in geology today is in regard to the implacement of large bodies of igneous rock. This problem reaches the height of its complexity in regard to batholiths, yet remains on a smaller but more accessible scale in regard to laccoliths and associated intrusive bodies. The problem is essentially this: How did the igneous bodies gain space for themselves: Did the material, which we refer to as igneous rock, form from some molten magma originating beneath the crust of the earth, well up and thrust aside the overlying sediments? Or did the magma stope out blocks of these sediments which settled into the magma reservoir and presumably became incorporated, or sank to the bottom? Or did solutions emanate from some small body of magma, and move through the overlying sediments and convert them to a material similar to igneous rock? This problem is especially "knotty" because of the size of the bodies involved, and of the complex relationships both physical and chemical which exist within them. The fact that man has been unable to observe the emplacement of any of these bodies is a further complicating factor.

Thus we have a problem which is extremely complex, and which probably defies exact solution, yet remains intriguingly interesting.

A. C. Peale, 1896, was responsible for the only other study made of the Squaw Creek sills. In his work, he simply indicated the presence of these sills at the junction of Squaw Creek and the West Gallatin River, and identified the rock composing the sills as an andesite porphyry. It was assumed from his work that these sills are part of the Lone Mountain laccolith system, because of the similar rock type, and fairly close proximity. The laccolith of which these sills are a part has been referred to by the author as a cedar tree laccolith, because of its similarity in appearance with a cedar tree laccolith by the Vlatava River in central Czechslovakia which was described by R. Kettner, (Hunt, 1953).

DESCRIPTION OF AREA

The area where this work was done is about 23 miles southwest of Bozeman, in Gallatin Canyon, at the junction of Squaw Creek and the West Gallatin River.

The Gallatin River in the process of cutting the canyon, has exposed about 2500 feet of sediments. The bulk of these sediments are limestone, ranging from the Meagher limestone (Cambrian) to the Mission Canyon formation of the Madison limestone (Mississippian). There are many andesite porphyry sills present in these sediments, and the biggest sills are associated with the various shale beds, either directly within them or on the contact between the shale and the limestone.

In the accompanying photograph (Plate I) only the lower-most cliffs formed from the Meagher limestone are shown. These cliffs rise vertically for some 250 to 350 feet. There are several sills and three large eyes of andesite porphyry present in the faces of these cliffs. It was upon

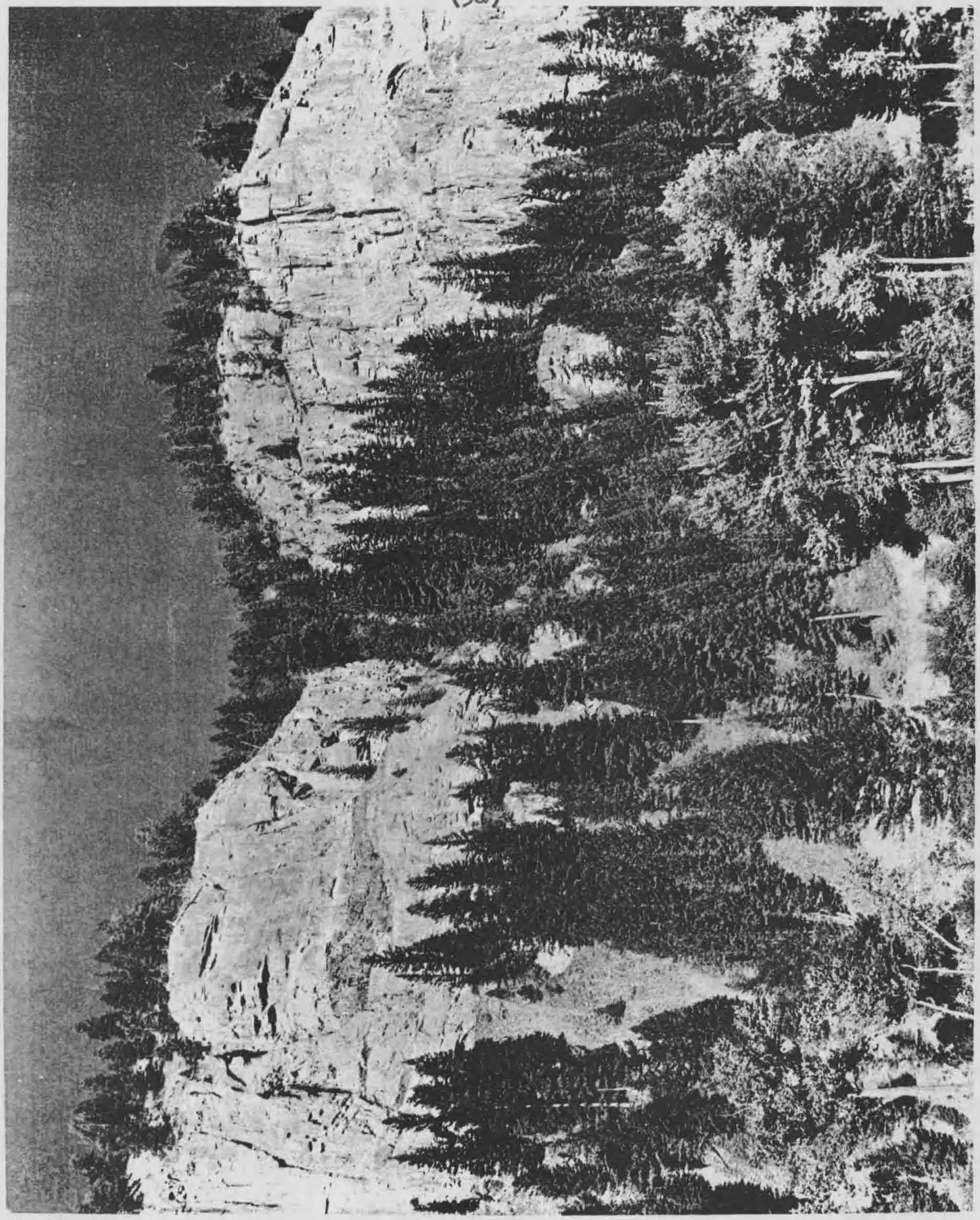

Plate I

these sills and eyes that this work was done.

SAMPLING AND PREPARATION OF SAMPLES

In order to estimate the part played by chemical assimilation as a means of gaining space, it was necessary to obtain suites of samples from each sill. These samples were taken from the limestone above the sill, the sill itself, and from the limestone below the sill. The problem of obtaining such suites of samples from the face of a large cliff proved to be somewhat difficult.

The first method used in sampling these cliffs was rapeling. In this method the rope is passed around ones' body in a particular way, and the friction thus created is used to control the rate of descent. This method was discarded, as it was not satisfactory.

The method which met with the most success involved the use of a "Bosun's" chair and a block and tackle. Figure 1 is a sketch of the "chair" and the rigging. The materials used in rigging the chair were 600 feet of 3/8 inch manila rope, 50 feet of 1/8 inch steel airplane cable, cable clamps, two blocks with a pulley diameter of 3 inches, and one <u>Lineman's Safety Belt and Harness</u>, style number 1306, manufactured by the Buckingham Manufacturing Company, Binghamton, N. Y.

The sampling chair was assembled as follows: the airplane cable was fastened to a small tree at the top of the cliff by passing one end of the cable completely around the tree and clamping this end to the rest of the cable by means of two cable clamps. The other end of this cable was fastened to one of the eyes on the block in the same manner. One end of the rope was now tied to the other eye on this same block and was taped with friction tape for several feet to help prevent wear of the rope against the cliff. The rope was then passed down through the lower block around the pulley and up through the pulley on the upper block and this free end was allowed to dangle. By attaching the seat to the eye in the lower block by means of a carabiner or snap link, and pulling on the free end of the rope, it was possible to lift oneself up the face of the cliff and sample with comparative ease.

This method overcame the difficulties incurred by the method of rapelling. That is, it was much more comfortable and to a certain extent, sampling under overhangs was possible. To sample under the overhangs pitons were driven into cracks on the rock face and by tying a rope to these pitons and then to the chair, the chair was anchored to the cliff. This method of sampling under overhangs by use of pitons was not too successful, since in driving in the pitons they had a tendency to stope out a large block of rock directly above ones' head. If the work were to continue this was to be avoided.

Another difficulty in using the chair was that the ropes had a tendency to tangle or wrap around one another. This made pulling oneself up the cliff a rather strenuous proposition.

In sampling the cliff the following procedure was carried out: an unweathered sample from 2 to 4 inches in diameter was obtained. This sample was then labeled with masking tape and given a number. The sample number along with its description and position in relation to the sill-limestone contact were recorded in a notebook.