Dacites of the northern Gallatin and western Beartooth Ranges, Montana
by Kenneth Charles Shaver

A thesis submitted, to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Earth Science (Geology)
Montana State University

Abstract:
The dacitic rocks of the northern Gallatin and western Beartooth Ranges are shallow intrusives of early to middle Eocene age. They have intruded folded Paleozoic and Mesozoic sedimentary sequences and members of the Absaroka-Gallatin volcanics with which they are contemporary.

The locations of the bodies evidently have been governed primarily by two major northwest-striking fault trends which seem to continue through the entire length of the Absaroka-Gallatin volcanic province. Northeast-trending high angle faults which are postulated to lie on both sides of the Yellowstone Valley probably provided some control over the locations of the intrusives in these areas, but this control was secondary to that of the northwest zones. Although faulting evidently preceded igneous activity in most of the province, the block faulting which produced the Gallatin Horst in the southern Gallatin Range probably followed intrusion of dacitic rocks into the sedimentary sequences in that area.

Several episodes of intrusive activity have been recognized in the northern Gallatins and western Beartooths. During the first of two long magnetically normal periods which prevailed during deposition of the volcanics in this area, several intrusive bodies were emplaced. The oldest recognized intrusive cuts Golmeyer Creek volcanic rocks and is overlain by Hyalite Peak volcanics at upper Dry Creek.

The Point of Rocks and north and south Moose' Creek dacites were evidently emplaced during middle or late Hyalite Peak time. These were followed by the Big Creek, Cinnabar-Mol Heron, and Little Trail Creek bodies which intruded during the magnetically reversed interval at the upper Washburn-lower Sunlight group interface. Still later, the normally magnetized Tom Miner and Mill Creek rocks invaded lower Sunlight group volcanics. It is not known whether the normally magnetized Emigrant Peak dacites pre or post-date the reversed magnetic interval.

The Intrusives of the northern Gallatin and western Beartooth Ranges are petrologically very similar; most of the differences between them are textural differences which seem to reflect slightly different rates' of magma ascent rather than radically different initial source material. Comparison of observed compositional and textural features of these rocks with published experimental studies of crystallization trends in similar rocks suggests that these magmas originated in the lower crust or upper mantle.

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor, or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature Kenneth Charles Shaver

Date June 3, 1974

DACITES OF THE NORTHERN GALLATIN AND WESTERN BEARTOOTH RANGES, MONTANA

by

KENNETH CHARLES SHAVER

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE

in

Earth Science (Geology)

Approved:

Milton J. Edie
Head, Major Department

Robert A. Chadwick
Chairman, Examining Committee

K. Goering
Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

August, 1974

ACKNOWLEDGEMENTS

Dr. Robert Chadwick first introduced me to the volcanic and intrusive rocks of the northern Gallatin Range, and discussed various aspects of the problem during the course of the investigation. The National Park Service kindly granted permission to collect samples in Yellowstone National Park, and many private landowners allowed access to their lands. Michael Kaczmarek assisted with field work in the back country of the Park. Dr. Chadwick critically reviewed the manuscript. Montana State University provided funds which helped to defray field and laboratory expenses.

CONTENTS

TABLES

ILLUSTRATIONS

ABSTRACT

The dacitic rocks of the northern Gallatin and western Beartooth Ranges are shallow intrusives of early to middle Eocene age. They have intruded folded Paleozoic and Mesozoic sedimentary sequences and members of the Absaroka-Gallatin volcanics with which they are contemporary.

The locations of the bodies evidently have been governed primarily by two major northwest-striking fault trends which seem to continue through the entire length of the Absaroka-Gallatin volcanic province. Northeast-trending high angle faults which are postulated to lie on both sides of the Yellowstone Valley probably provided some control over the locations of the intrusives in these areas, but this control was secondary to that of the northwest zones. Although faulting evidently preceded igneous activity in most of the province, the block faulting which produced the Gallatin Horst in the southern Gallatin Range probably followed intrusion of dacitic rocks into the sedimentary sequences in that area.

Several episodes of intrusive activity have been recognized in the northern Gallatins and western Beartooths. During the first of two long magnetically normal periods which prevailed during deposition of the volcanics in this area, several intrusive bodies were emplaced. The oldest recognized intrusive cuts Golmeyer Creek volcanic rocks and is overlain by Hyalite Peak volcanics at upper Dry Creek. The Point of Rocks and north and south Moose Creek dacites were evidently emplaced during middle or late Hyalite Peak time. These were followed by the Big Creek, Cinnabar-Mol Heron, and Little Trail Creek bodies which intruded during the magnetically reversed interval at the upper Washburn-lower Sunlight group interface. Still later, the normally magnetized Tom Miner and Mill Creek rocks invaded lower Sunlight group volcanics. It is not known whether the normally magnetized Emigrant Peak dacites pre or post-date the reversed magnetic interval.

The intrusives of the northern Gallatin and western Beartooth Ranges are petrologically very similar; most of the differences between them are textural differences which seem to reflect slightly different rates of magma ascent rather than radically different initial source material. Comparison of observed compositional and textural features of these rocks with published experimental studies of crystallization trends in similar rocks suggests that these magmas originated in the lower crust or upper mantle.

INTRODUCTION

The 150 mile long Absaroka-Gallatin volcanic province covers approximately 9,000 square miles between Bozeman, Montana and the Owl Creek Range in Wyoming. The province includes most of the Gallatin Range, the southwestern half of the Beartooth Uplift, the Absaroka Range, and the northern portions of the Washakie and Owl Creek Ranges (fig. 1). The main study areas cover approximately 150 square miles in the northern Gallatin and western Beartooth Ranges in the northeastern portion of the province.

Previous mapping largely by faculty members and students at Montana State University in portions of the study area north of Yellowstone National Park, and by the U.S. Geological Survey inside the Park have outlined numerous small intrusive igneous bodies which appear to be associated with the volcanics. Generally these rocks have received less attention than the extrusive rocks of the province. This investigation was designed to take a closer look at the intrusive bodies in the northwestern portion of the province in order to compare them petrogenetically. While some bodies in northern Yellowstone National Park were visited during the investigation, the major emphasis was directed towards the area north of the Park. This was

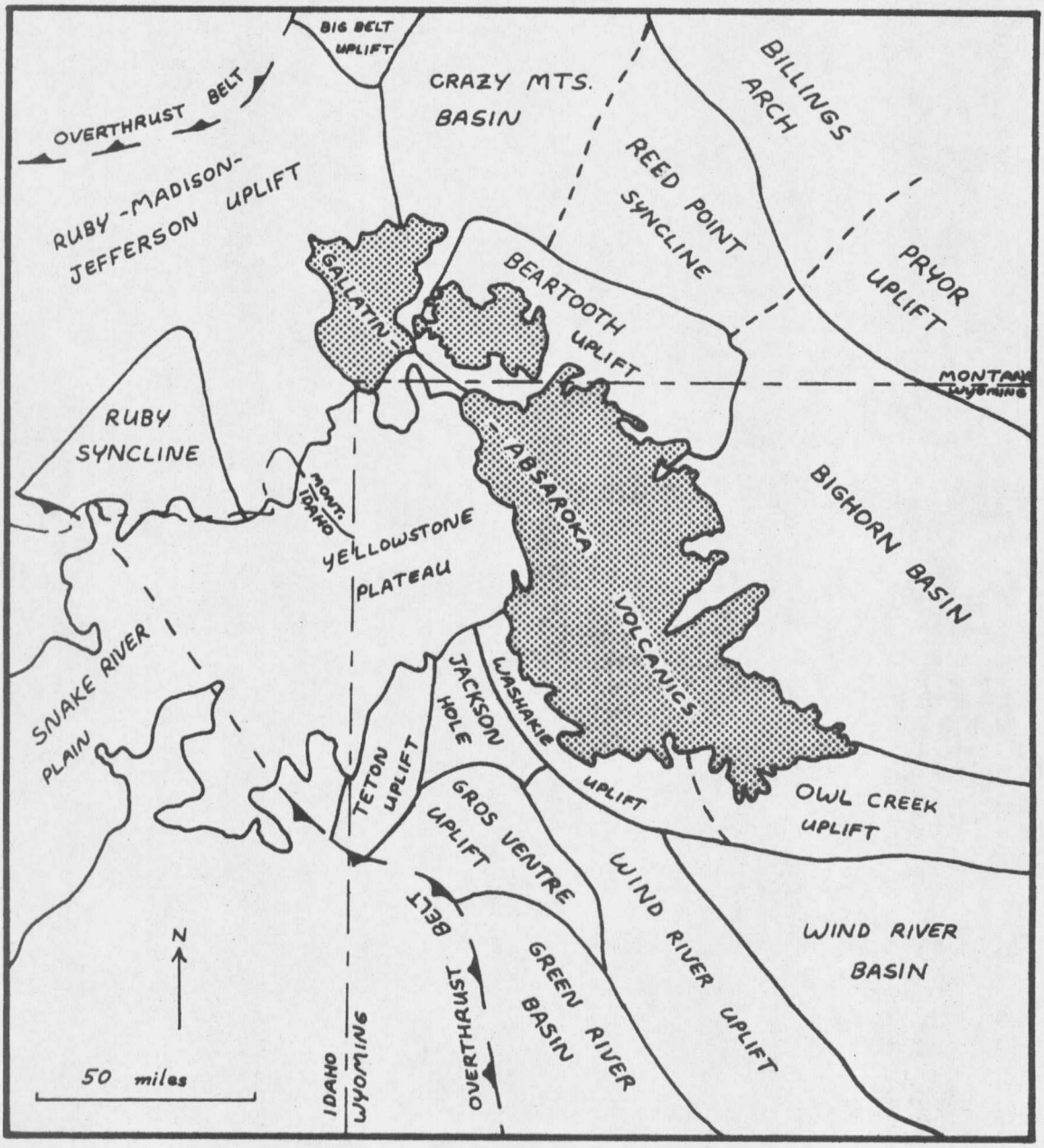

Figure 1. The Absaroka-Gallatin volcanic province and surrounding tectonic features. (after Grose, 1972; and A.A.P.G., 1944)

done because most bodies inside the Park boundaries have been previously described (Iddings, 1891; Hague and others, 1899; Witkind, 1969; and Ruppel, 1972). During the course of this investigation it was learned that L.L. Love (1972) recently made a similar study of three intrusives in the southern and north central portions of the province.

The present study was conducted during the 1973 field season and through the following academic year. The work involved observing the field characteristics of the bodies and sampling for subsequent petrographic and paleomagnetic work. It was hoped that new chemical analyses of the specimens could be obtained for this report, but numerous complications with the analytical proceedures has delayed those results.

Until fairly recently the Cenozoic volcanics of the Gallatin and western Beartooth Ranges had been the subject of very few geologic studies, and even now most of this area is not as well studied as much of the rest of the Absaroka-Gallatin volcanic province. Yellowstone National Park has been more thoroughly studied than the rest of the area as the result of work by Iddings (1891), Hague and others (1899), Brown (1961), the U.S.G.S. (1972), Ruppel (1972), Smedes and Prostka (1972), and L.L. Love (1972).

The general geology north of the Park was summarized by Iddings and Weed (1894). The Gardiner area was described in more detail by C.W. Wilson (1934) and by Fraser and others (1969), Emigrant Peak was studied by Basler (1965), J.T. Wilson (1936) mapped the Mill Creek area, and McMannis (unpublished preliminary data, 1969) mapped the Emigrant Quadrangle. Todd (1969, 1972) examined the southern part of Tom Miner Basin, Chadwick mapped the Fridley Peak Quadrangle (1969) and described the Point of Rocks vent complex (1965), and the Garnet Mountain Quadrangle was studied by McMannis and Chadwick (1964). The geomorphology of the area has been the subject of several investigations by faculty and students at Montana State University and by others including Horberg (1940).

GEOLOGIC SETTING

The volcanic field is characterized by Eocene calc-alkaline rocks which are the products of numerous eruptive centers that are apparently aligned along two subparallel belts (Chadwick, 1968, 1970). The volcanic rocks rest unconformably on Precambrian, Paleozoic, and Mesozoic rocks. The Precambrian rocks are highly deformed and evidently have been affected by three or possibly four major Precambrian orogenic events (McMannis and others, 1971). The Paleozoic and Mesozoic sediments unconformably overlie the Precambrian rocks, and evidently were not folded significantly until the Laramide orogeny. The Absaroka-Gallatin volcanics are only slightly tilted.

The rocks are mostly andesitic to dacitic in composition, but some belong to the absarokite-shoshonite-banakite series (Hague and others, 1899). Since the excellent early work of Hague and others (1899), the Absaroka volcanics have traditionally been divided, stratigraphically upward, as: early acid breccia, early basic breccia, early basalt flows, late acid breccia, late basic breccia, and late basalt flows. Until recent detailed work by many members of the U.S. Geological Survey, specific formation names were in use only in a few well-explored areas. However, Smedes

and Prostka (1972) recently published the results of the new U.S.G.S. work in Yellowstone National Park, and it now seems desirable to replace the terminology of Hague and others with that of Smedes and Prostka (fig. 2). They have divided the Absaroka-Gallatin volcanics into three main groups: the Washburn, Sunlight, and Thoroughfare Creek groups. The Washburn group is early to middle Eocene in age and is found throughout the northern two thirds of the Gallatin Range and in the extreme western portion of the Beartooth Range. The Sunlight group is middle Eocene in age and occurs in the central portion of the province. The Thoroughfare Creek group has tentatively been assigned middle to late Eocene age; it covers the southern portion of the field (Plate I, and fig. 3,8 in Smedes and Prostka, 1972). These ages were assigned on the basis of both paleontologic and radiometric data from the extrusive rocks and eruptive centers; L.L. Love (1972, 1974) has obtained an early Oligocene radiometric date for the Washakie Needles intrusive in the southern portion of the province.