



A study of selected igneous bodies of the Norris-Red Bluff area, Madison County, Montana  
by John Arthur Kavanagh Yllarramendi

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of  
MASTER OF SCIENCE IN APPLIED SCIENCE With a Major In Geology

Montana State University

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**Abstract:**

The igneous bodies studied crop out in the Norris Hills, between the upper and lower Madison Valley, southeast of the Tobacco Root Mountains and northwest of the Spanish Peaks, They appear to be intrusive plugs, with surface features obscured by Quaternary deposits. In average samples the silica content varies between 66 per cent and 78 per cent. Chemical and normative analyses indicate that the rocks with lower and intermediate silica content are dacites. Petrographic analysis indicates the richer silica rocks are rhyolites. One andesite body is also present. The sodium content of the dacites is unusually high.

The dacites at the northern end of the upper Madison Valley are aligned, generally northwest-southeast, and lie in a zone of intensive faulting. The igneous bodies east of Norris are flow-banded dacites and breccia pipes. Pyrite-gold mineralization is present in hydrothermal quartz veins peripheral to the dacites. This mineralization seems to have been controlled by the faulting in the area.

The dacites are microcrystalline with a few phenocrysts of plagioclase (andesine) and quartz. Microlites of feldspar and anhedral quartz grains mixed with volcanic glass form most of the groundmass. The microlites are oriented in the direction of flow. The phenocrysts in the rhyolites are orthoclase, sanidine, plagioclase, quartz, and biotite. The groundmass is also microcrystalline, with volcanic glass appearing either as partially crystallized microlites or as inclusions in the phenocrysts. Sericitization is abundant.

Although the Tobacco Root batholith seems to have been emplaced during early Tertiary time the igneous bodies studied appear to "be younger, probably of Eocene age. It is improbable that they were comagmatic with the batholith.

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ABSTRACT

The igneous bodies studied crop out in the Norris Hills, between the upper and lower Madison Valley, southeast of the Tobacco Root Mountains and northwest of the Spanish Peaks. They appear to be intrusive plugs, with surface features obscured by Quaternary deposits. In average samples the silica content varies between 66 per cent and 78 per cent. Chemical and normative analyses indicate that the rocks with lower and intermediate silica content are dacites. Petrographic analysis indicates the richer silica rocks are rhyolites. One andesite body is also present. The sodium content of the dacites is unusually high.

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INTRODUCTION

Purpose of the paper

The main purpose of this paper is to present results of a comprehensive field and laboratory study of selected igneous bodies situated between the upper and lower Madison Valley, southeast of the Tobacco Root Mountains and northwest of the Spanish Peaks. Included are their description and classification, the field relations between them and neighboring igneous bodies, plus special petrological considerations.

Previous work

A general reconnaissance of the Tobacco Root Mountains has been made by W. Tansley, P.A. Schafer and L.H. Hart (1933). Some of the igneous bodies treated here were described in the report, but no petrological nor detailed field work was involved. Rolland R. Reid (1957) wrote about the bedrock geology of the north end of the Tobacco Root Mountains. Although the igneous bodies studied in this paper were not treated in Reid's report, this work is valuable in the attempt to determine

petrological and structural relationships between the Tobacco Root batholith and the igneous bodies that surround it.

G.W. Berry (1943) studied the stratigraphy and structure in the vicinity of Three Forks, Montana; geomorphic studies of the area of the Madison Valley and Norris Hills have been done by Swanson (1950), and Montagne (1960).

## GEOLOGICAL SETTING

The igneous bodies studied occur over an area of about 280 square miles. They are exposed southwest, east, and northeast of the town of Norris (Fig. 1). The basement rocks are pre-Belt gneisses and schists of the Cherry Creek and Pony series. The igneous bodies cut these basement rocks and are either covered by Quaternary glacial sediments or are in close relation to them. East of the general area, Cambrian and Devonian sedimentary rocks are exposed in a southeast-northwest trend (Fig. 2), intruded at places by Tertiary coarse-grained igneous bodies, mainly quartz monzonites, diorites and other related rocks. Undifferentiated Tertiary sediments cover large areas south and north of the Tobacco Root batholith which lies close to the center of the area. The Tobacco Root batholith crops out in an elliptical shape with its longest axis having a length of about 18 miles, and its shortest axis having a length of 6 miles on the average. Glacial Quaternary sediments are predominant toward the northern end of the Madison Valley, and several distinct Quaternary surfaces can be distinguished, ranging in age from pre-Wisconsin

to Late Wisconsin. The present floodplain of the Madison River forms the most recent surface.

The igneous bodies studied have been identified with letters of the alphabet (Fig. 1). South of Norris, five igneous bodies are labelled as A, B, C, D, and E. East of Norris and south of Red Bluff, two more igneous bodies, F and G, are exposed, and igneous body H is located northeast of Red Bluff.

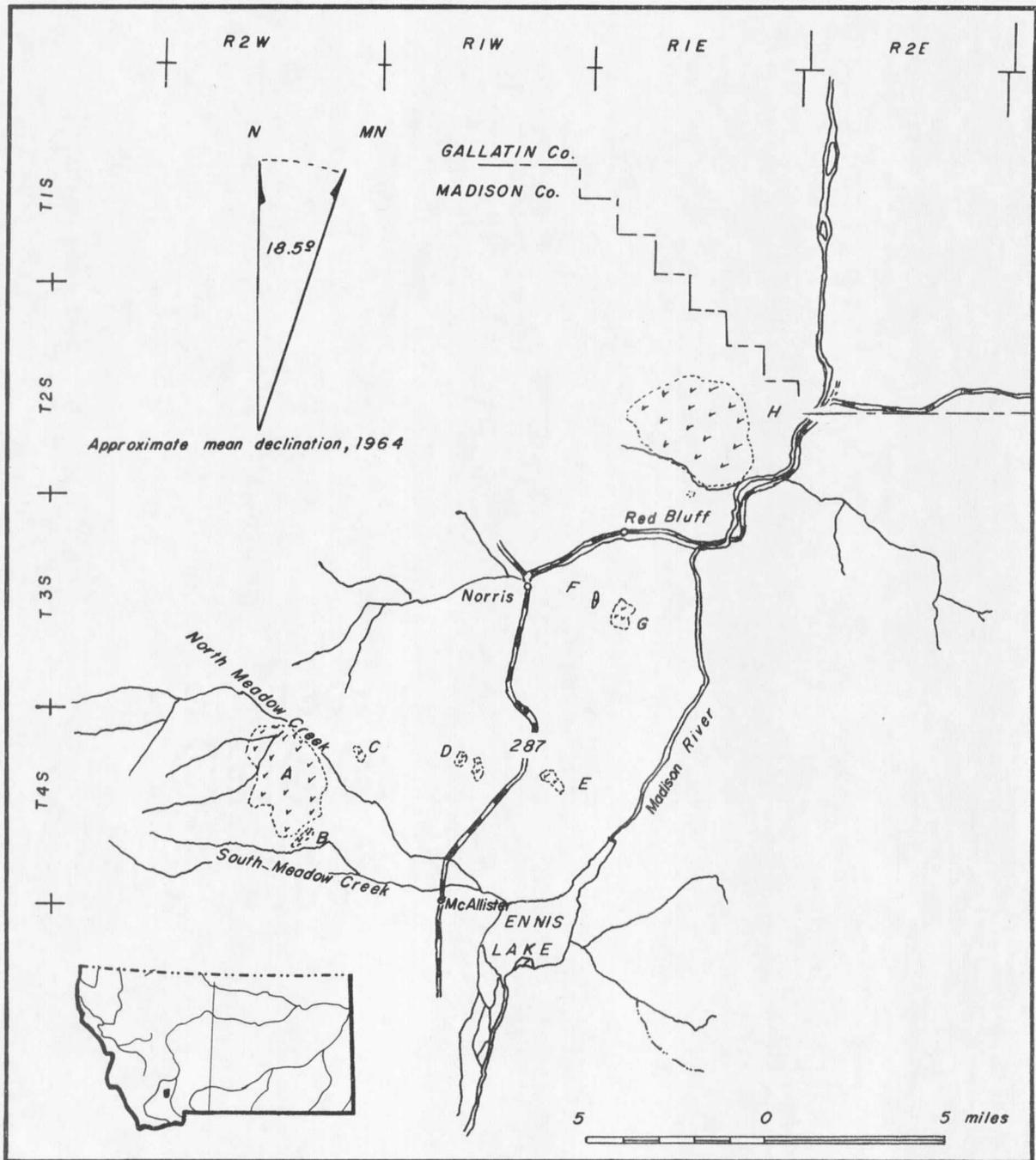
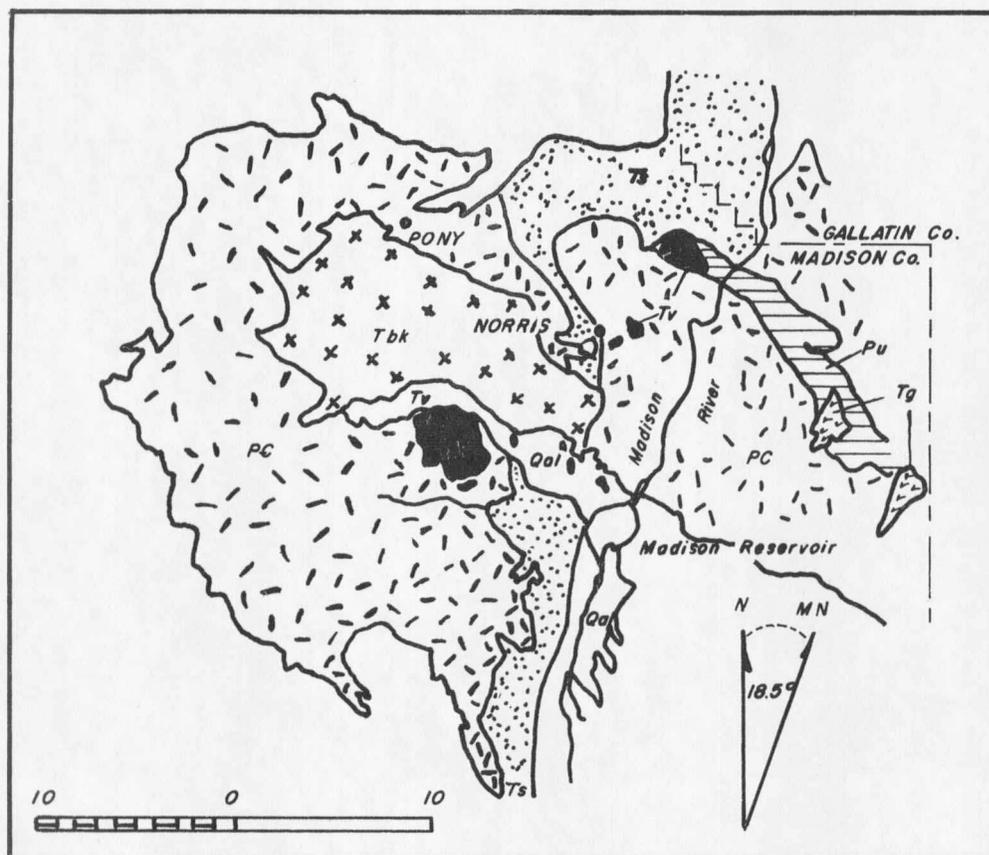


FIGURE 1. Index map of igneous bodies



Qal	Quaternary alluvium, glacial and fluvial sediments
Ts	Tertiary sediments, undifferentiated.
Tv	Tertiary volcanics, andesites, dacites and rhyolites
Tbk	Tertiary, Tobacco Root Batholith
Tg	Tertiary, intrusive coarse-grained rocks diorites, quartz monzonites and similar rocks
Pu	Paleozoic, undifferentiated
PC	Precambrian, gneisses and schists

Modified from Geologic Map of Montana (1955), compiled by  
 C. P. Ross,  
 D. A. Andrews, and  
 I. J. Witkind.

FIGURE 2. General geology of the area

## GENERAL GEOLOGY OF IGNEOUS BODIES

### Igneous bodies A and B

Igneous bodies A and B are acid igneous rock; megascopic, plus chemical and petrographic analysis (see Petrography) permit classification of these rocks as dacites. These intrusive dacites are exposed in the general region of Meadow Creek. Quaternary sediments and alluvium obscure border relationships with the host rock. The boundaries of the igneous bodies were determined by float, because contacts do not crop out. Cooling cracks are found throughout the dacites of this body, forming plates which range in thickness between 3 and 8 mm., according to the amount of exfoliation. The cooling cracks give the dacites a peculiar form in outcrops (Plate 1, Fig. 2), and there is microscopic evidence that these cracks are oriented parallel to the direction of flow. The tendency of the igneous bodies to form parallel plates aligned with the direction of flow will be referred to from now on as fissility. The structure of the bodies was determined by measuring attitudes of the flow, as indicated by this fissility. The general structure of igneous body A shows











































































































