



Geology of the Southwestern Horseshoe Hills area, Gallatin County, Montana
by Ronald Arthur Spahn

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 oldest rocks of this 70 square mile area located at the northern edge of the Three Forks Basin are the arkosic slightly metamorphosed Precambrian sedimentary rocks which were derived from a nearby fault uplift to the south. Basement rocks beneath the 4700+ foot thick sequence are not exposed. Precambrian rocks are overlain unconformably by a primarily marine 8000 foot marginal geosynclinal sedimentary sequence. All systems except the Ordovician, Silurian, and Triassic systems are present. Scattered patches of a diversity of continental rock types represent the Cenozoic.

Deformation and erosion beginning in the latest Precambrian extended into the Early Cambrian. A major orogeny (the Laramide) began in the Late Cretaceous and continued into the early Tertiary. In the map area - this deformation began as folding and faulting and culminated in thrust faulting. Post-Laramide tensional faulting resulted from the relaxation of compressional forces. The northeast-trending structural features are the product of the juncture of two regional structural elements; the Montana Disturbed Belt and the northern edge of the Wyoming Shelf.

The three lithologically similar sill zones present indicate intrusion preceding deformation.

The mature landscape is the product of exhumation and dissection with continued fault movement.

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ABSTRACT

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INTRODUCTION

The Horseshoe Hills are a sparsely-populated, semi-arid area of moderate relief at the head of the Missouri River in southwestern Montana. The rugged mountains and broad basins of this part of the state are the site of much agricultural and mineral wealth. Geologically, the area contains an intricately folded and faulted Precambrian through Mesozoic sedimentary sequence with minor igneous intrusives and gently-dipping Cenozoic sediments.

Location and Physiography

The study area encompasses the southern two-thirds of the north half of the Manhattan Quadrangle, which is bounded by the $111^{\circ}30'$ meridians and the $45^{\circ}52'30''$ and 46° parallels. The mapped area is bounded on the south by the $45^{\circ}52'30''$ parallel, on the west by the Missouri River floodplain and quadrangle boundary, on the north by the northern edge of Township 2 North, and on the east by the quadrangle boundary (Figure 1 and Plate I). The nearest large town is Bozeman, located 25 miles to the southeast. The mapped portion of the quadrangle encompasses an area of approximately 60 square miles.

The Horseshoe Hills are a part of the Three Forks District of the Northern Rocky Mountain Province of Fenneman (1931, p. 183-224). Elevation in the map area ranges from 4,030 feet near the Missouri River to 6,044 feet near the northern boundary. Topographic features consist principally of un-forested, winding hogback ridges locally incised by streams. Peripheral gently rolling uplands lie within the western and

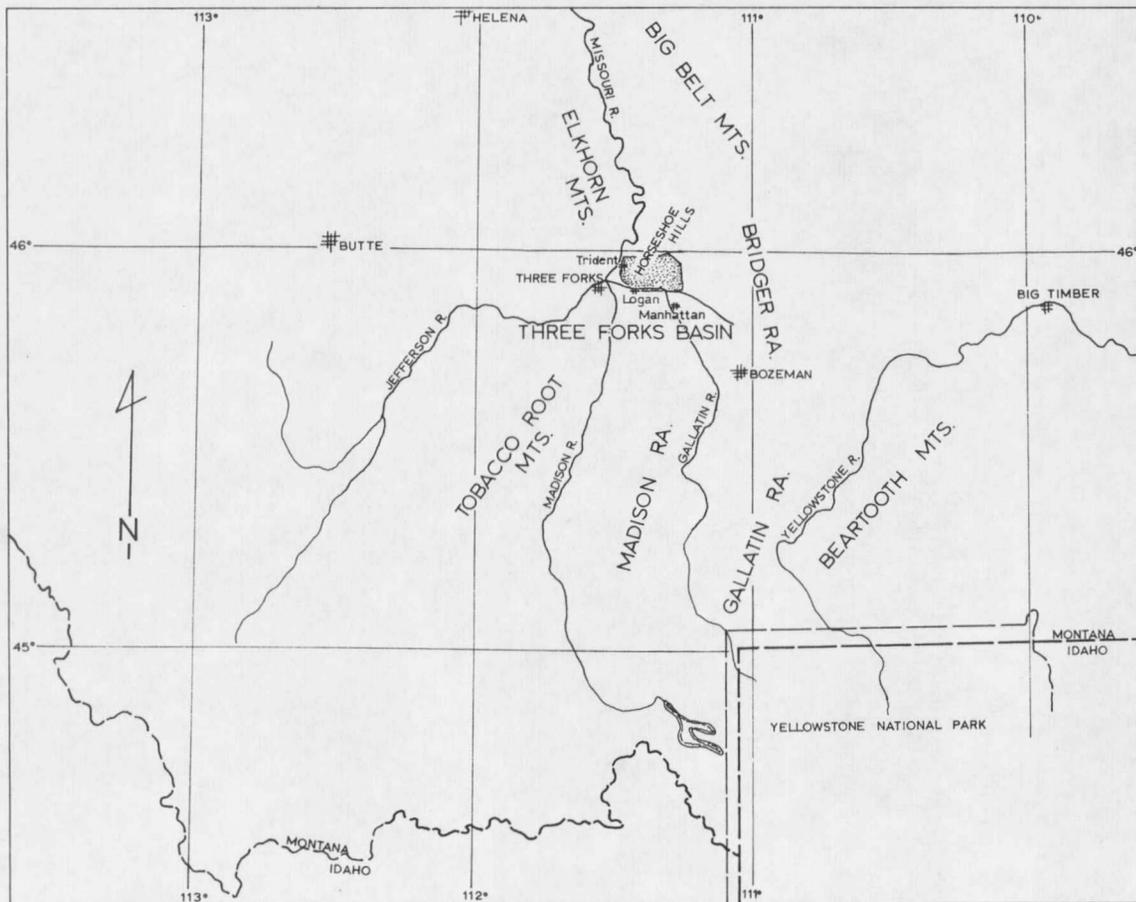
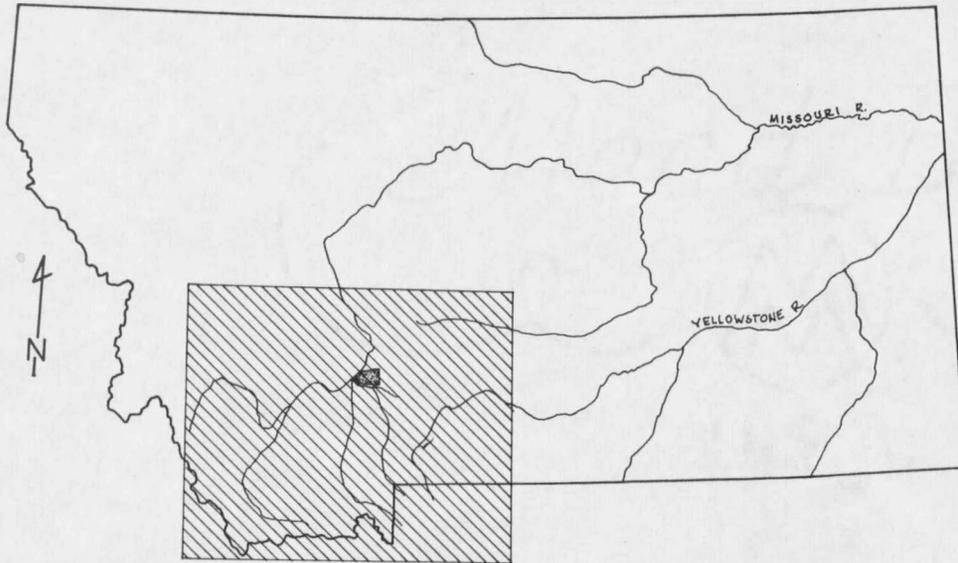


Figure 1 - Index Map

southern limits of the area studied. Maximum local relief is 1000 feet. Resistant rocks are generally moderately well-exposed, although in areas of low relief outcrops are rare. Good exposures of non-resistant formations are uncommon; these outcrops are produced only by the deepest stream incision and excavations of man. Topography corresponds closely to lithology, with trellis drainage patterns predominant. Figure 2 is an aerial view of the area showing the general nature of topography, vegetation, outcrops and structure.

Natural Setting

The north temperate semiarid climate is characterized by long windy cold winters, warm wet springs, hot dry summers, and long clear autumns. Maximum winter temperatures are generally near freezing with minimum temperatures often well below zero. During the summer, daytime temperatures are commonly in the 90's, but the nights are cool. The area receives 10 to 14 inches of precipitation per year, mostly as winter and early spring snow. Geologic field work is possible at times during any month of the year. From mid-December through February occasional warm spells may be utilized. During November to mid-December and March, field work is somewhat uncomfortable but feasible. The remainder of the year is quite pleasant.

Most of the Horseshoe Hills is rangeland. Trees are locally present along stream courses and at the uppermost elevations. Sagebrush grows on shales and igneous rocks. Carbonates, sandstones, sandy shales, and gravels support grasses and scrubby trees. Deer, antelope, rattlesnakes,

