



Surficial geology of the Porcupine Drainage Basin, Gallatin County, southwest Montana
by Sherman Allan Sollid

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

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Abstract:

The Porcupine Drainage Basin lies east of the West Gallatin River in the Gallatin Range between Bozeman and West Yellowstone, Montana. It is a structural and topographic basin in the Northern Rocky Mountain Physiographic Province. It is bounded on the north by the crystalline upthrown block of the Spanish Peaks Fault. Cretaceous bedrock is exposed in the lower part of the basin and Tertiary volcanics dominate the upper reaches.

The Porcupine Drainage Basin is a semi-primitive area, rich in natural beauty and containing an abundance of wildlife. It is the winter range for the migratory Northern Yellowstone elk herd. It is also unique in that it contains part of the Gallatin Petrified Forest, a sequence of up to 27 buried forests of early Cenozoic age, in which many of the trees are standing upright in the position in which they grew.

Due to the characteristics of the underlying rock material, the abundance of steep slopes (over 30°), and the amount of available water, the basin is extremely prone to landsliding. Landslides and landslide debris cover more than one-third of the basin and have apparently obliterated most of the glacial deposits.

The surficial geology was studied and mapped in an attempt to relate geology to land management decisions for the Porcupine Drainage Basin and adjacent areas. The data obtained was ultimately used by planning personnel of the Gallatin National Forest to determine management alternatives for this area.

Development plans must focus on the high incidence of unstable slopes in the basin. Water is considered to be one of the major mechanisms for landslide release. Lubricated glide planes, increases in pore water pressure, and overloading through saturation are brought about by increased amounts of available water. Activities which increase the amount of available water, such as clearcutting, must be avoided in many areas. Ironically, many of the more desirable stands of commercial timber occur on old landslides, due to high water content and loose soil.

Due in part to the large number of geological hazards, the U.S. Forest Service has classified Porcupine Drainage Basin as an area to remain undeveloped. There will be no roads, and logging to control fire or disease threats will be by balloon or helicopter only.

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by

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Date May 23, 1973

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ABSTRACT

The Porcupine Drainage Basin lies east of the West Gallatin River in the Gallatin Range between Bozeman and West Yellowstone, Montana. It is a structural and topographic basin in the Northern Rocky Mountain Physiographic Province. It is bounded on the north by the crystalline upthrown block of the Spanish Peaks Fault. Cretaceous bedrock is exposed in the lower part of the basin and Tertiary volcanics dominate the upper reaches.

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INTRODUCTION



Figure 1-Panoramic view looking east into the Porcupine Drainage Basin. Snow capped peaks in the distance are part of the Gallatin Range, the eastern boundary of the study area.

PURPOSE AND METHOD OF STUDY

The field work for this project was undertaken as part of an interdisciplinary study by the Montana State University RANN (Research Applied to National Need) project funded by the National Science Foundation. Geology represents only one of many disciplines which were involved in studying the physical and environmental aspects of a semi-primitive area. A large amount of the writer's research time was spent with planning personnel of the Gallatin National Forest because Porcupine Drainage Basin is part of a U.S. Forest Service Multiple-Use Planning Unit. Data obtained by members of the interdisciplinary team played a major role in the management alternatives developed for this area by the United States Forest Service. Information on Porcupine Creek high water sediment sources, locations of unstable slopes, percent of clay in soil types, and other physical factors aided the Forest Service personnel in making the necessary decisions.

This report represents the results of the study of surficial and environmental geology of the entire Porcupine Drainage Basin. As background, the general geological relationships such as stratigraphy, structure and geomorphology were also examined. I have included this information in the report to give the reader a brief overall geologic background of the area. Also an effort has been made to determine the

role that geology will play in man's projected use of the area.

Approximately ten weeks were spent in the field during the summer of 1972, plus several weekends during the fall of the same year. The geology was mapped on 1:20,000 scale airphotos obtained from the United States Forest Service and transferred by inspection to a 1:62,500 scale United States Geological Survey topographical map of the same area. An attempt was made to use a Saltzman vertical reflecting projector to transfer the data from the airphotos to the topographical sheet but minor errors in the base map made transferring by inspection the only alternative.

THE PORCUPINE PROBLEM

Early in 1970, it was announced that plans for a year-around large-scale resort were finalized for the West Fork drainage. It was to be named Big Sky of Montana and was to be funded by Chrysler Realty and other large corporations. The winter resort was to be located at the base of Lone Mountain to gain access to the skiable areas and the summer resort would be located in the broad valley between the West Gallatin River and the mountains.

The announcement of the resort plans in 1970 produced a flurry of concern and speculation among local citizens and others throughout the state and nation. The main concern was that the economic gains from such an enterprise would not offset the loss in environmental

quality.

For some time there has been a need to determine the impact that such a large-scale resort would have on the environment in a semi-pristine area. The announcement of the Big Sky plans in the West Fork basin provided an ideal opportunity to study the Gallatin Canyon as it was then, as it is now, and as it will be in the future. The objective is to construct guidelines for land use for future developments in similar areas.

To the above end a multi-disciplinary team of Montana State University scientists initiated a major study of the canyon in the summer of 1970, supported by funds from the National Science Foundation.

The data obtained in 1970 and 1971 were apparently significant and the National Science Foundation funded an additional year of study in 1972. At this time, Montana State University researchers proposed to determine what effects the Big Sky complex would have on the rest of the Gallatin Canyon.

One of the most obvious areas of impact and shifted open space interest was the Porcupine Drainage Basin east and slightly south of the West Fork basin. There were several reasons why it was thought that Porcupine Drainage Basin should be studied. First, its proximity to Big Sky makes it a natural overflow area for activities from Big Sky such as hunting and cross-country skiing. Secondly, it is the winter range for one of the world's largest elk herds. This is the

northern Yellowstone herd which forages high in the Gallatin Range near the park border in the summer and migrates into the Porcupine area in the winter. Thirdly, Porcupine Drainage Basin contains several sections of land that belong to Burlington Northern, Inc., and these are very rich in timber. Burlington Northern has a road application to gain access to their timber and must cross public domain to do so. It is possible that Burlington Northern could allow development on their lands in Porcupine in conjunction with the rapid development taking place in the canyon.

Several of the research team members, including the writer, commenced studies in Porcupine Drainage Basin during the 1972 field season and took an active part in the planning process that the U.S. Forest Service undertook to develop management decisions for this and adjacent areas.

LOCATION AND DESCRIPTION OF AREA

The Porcupine Drainage Basin study area covers approximately twenty-six square miles west of the West Gallatin River, on the west flank of the Gallatin Range, Gallatin County, Montana (Figure 2). It lies almost midway between Bozeman and West Yellowstone along Route 191 which follows the canyon formed by the West Gallatin River. Although the drainage is essentially a roadless area, very limited access by 4-wheel drive vehicle is provided by several unmaintained

