Temporal and spatial relations of late Quaternary valley and piedmont glaciers in Tom Miner Basin, Montana

by Gregory Scott Vandeberg

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Earth Sciences

Montana State University

Abstract:

The temporal and spatial relations of late Quaternary valley glaciers and the northern Yellowstone outlet glacier in Tom Miner Basin, Montana were studied through the mapping of the surficial geology of the basin. The purpose of the study was to test the hypothesis that late Quaternary (Pinedale) valley glaciers in Tom Miner Basin were tributary to the northern Yellowstone outlet glacier during maximum glacial conditions; and that following maximum glacial conditions, valley glaciers receded prior to the recession of the northern Yellowstone outlet glacier in the basin.

Mapping of the surficial geology of Tom Miner Basin shows no direct contact between moraines of the northern Yellowstone outlet glacier and local valley glacier deposits in the basin. The local, valley glaciers did not extend past the mouths of their respective tributaries based upon the locations of mapped glacial deposits, and the reconstruction of equilibrium line altitudes for the glaciers. The presence of strandlines, ice-rafted erratics and lacustrine type sediments suggests that the northern Yellowstone outlet glacier and local valley glaciers were separated by ice-dammed lakes in Tom Miner Basin. Glaciofluvial deposits leading from the near maximum terminus of former valley ice in Horse Creek, a basin tributary, cut across deposits of the northern Yellowstone outlet glacier. Therefore, the northern Yellowstone outlet glacier receded from the basin, while local glaciers were at or near their maximum extents.

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APPROVAL

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Gregory Scott Vandeberg

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Signature Gregory S. Vinkey

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ABSTRACT

The temporal and spatial relations of late Quaternary valley glaciers and the northern Yellowstone outlet glacier in Tom Miner Basin, Montana were studied through the mapping of the surficial geology of the basin. The purpose of the study was to test the hypothesis that late Quaternary (Pinedale) valley glaciers in Tom Miner Basin were tributary to the northern Yellowstone outlet glacier during maximum glacial conditions; and that following maximum glacial conditions, valley glaciers receded prior to the recession of the northern Yellowstone outlet glacier in the basin.

Mapping of the surficial geology of Tom Miner Basin shows no direct contact between moraines of the northern Yellowstone outlet glacier and local valley glacier deposits in the basin. The local valley glaciers did not extend past the mouths of their respective tributaries based upon the locations of mapped glacial deposits, and the reconstruction of equilibrium line altitudes for the glaciers. The presence of strandlines, ice-rafted erratics and lacustrine type sediments suggests that the northern Yellowstone outlet glacier and local valley glaciers were separated by ice-dammed lakes in Tom Miner Basin. Glaciofluvial deposits leading from the near maximum terminus of former valley ice in Horse Creek, a basin tributary, cut across deposits of the northern Yellowstone outlet glacier. Therefore, the northern Yellowstone outlet glacier receded from the basin, while local glaciers were at or near their maximum extents.

INTRODUCTION

Problem

The late Quaternary was a time of extensive glaciation in the Yellowstone National Park region of Montana and Wyoming. Many of the mountain ranges were occupied by ice caps, piedmont glaciers, valley glaciers or cirque glaciers. During late Wisconsin (Pinedale) time, an icecap on the Beartooth uplift, three icecap sources on the Yellowstone plateau, and an icecap on the Gallatin Range coalesced to form the northern Yellowstone outlet glacier (Fig. 1). A portion of the northern Yellowstone outlet glacier flowed northward down the Yellowstone valley approximately 60 km beyond the present Yellowstone National Park boundary. In addition to the outlet glacier, glaciers of local origin occupied some of the tributary valleys of the upper Yellowstone River.

Pierce (1979) concluded that, following the Pinedale glacial maximum, local mountain valley glaciers receded prior to the recession of the northern Yellowstone outlet glacier. This conclusion was based on the existence of: 1) morainal backfills of the northern Yellowstone outlet glacier in Tom Miner Basin (Fig. 2); 2) ice-dammed lake sediments in tributary valleys to the upper Yellowstone River such as Sixmile and Emigrant Creeks; and 3) northern Yellowstone outlet glacier erratics across the mouths of tributary valleys such as

Mol Heron and Bear Creeks. The morainal backfills, ice-dammed lake sediments, and erratics of the northern Yellowstone outlet glacier are in areas presumed to have been previously occupied by local valley glaciers. Thus, local glaciers must have receded before these features could have been deposited by the northern Yellowstone outlet glacier. Pierce (1979) integrated this information into a model

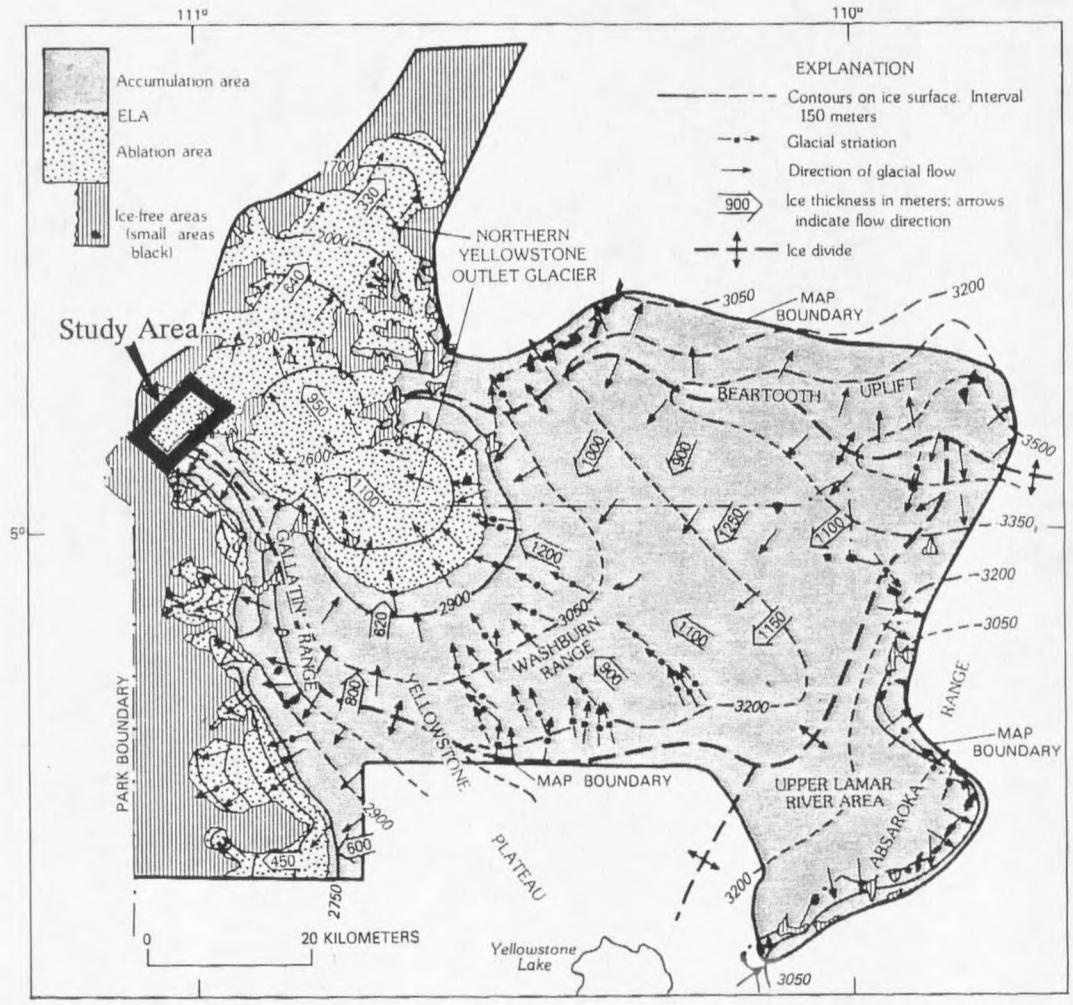

Figure 1. Extent of the northern Yellowstone outlet glacier (From Porter and others, 1983, Figure 4-25).

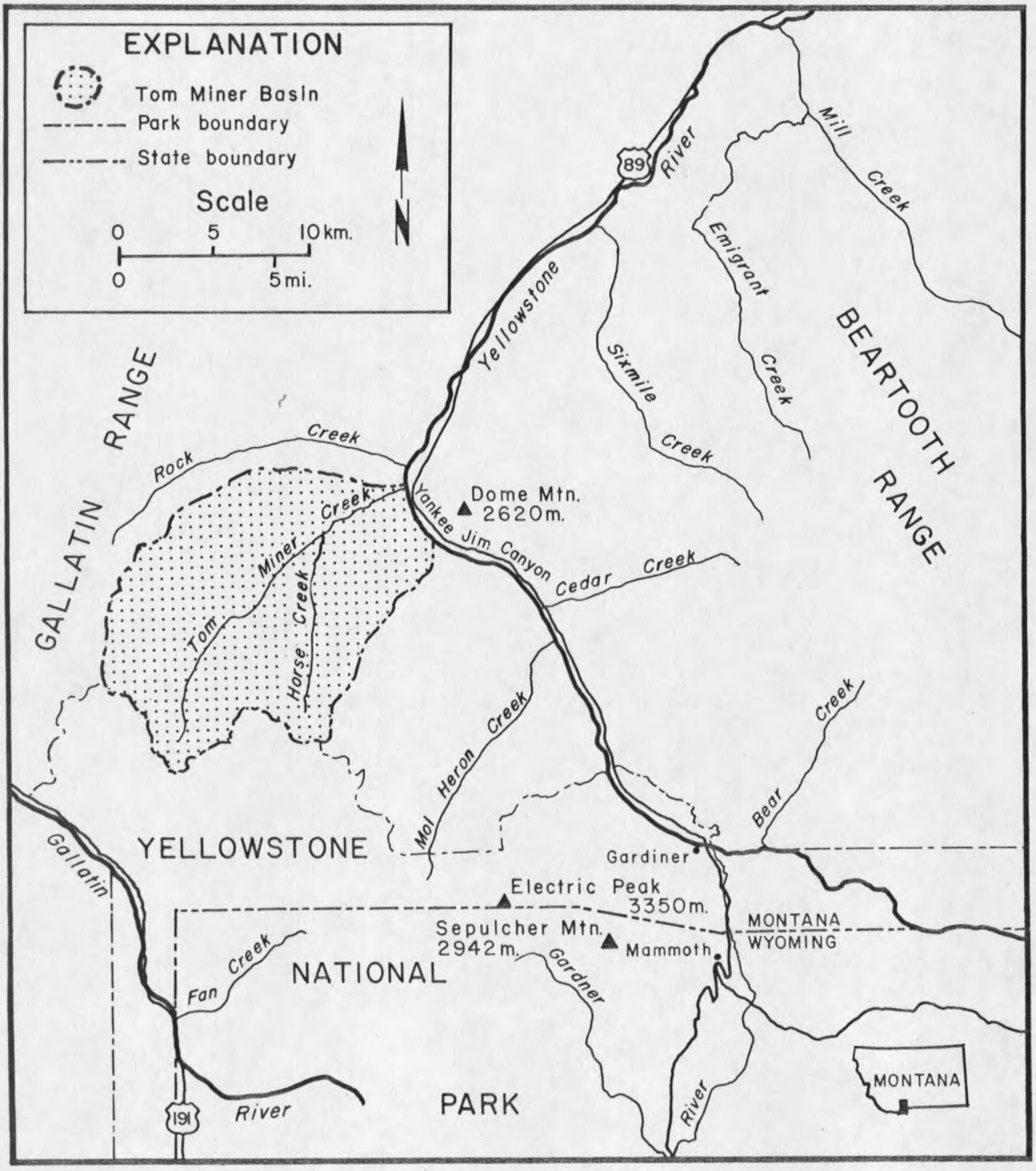

Figure 2. Location of Tom Miner Basin and principal drainages discussed in the text.

of the spatial and temporal relations between source areas of the northern Yellowstone outlet glacier and adjacent mountain valley glaciers (Fig. 3). According to the model, mountain and plateau icecaps such as those which supplied the northern Yellowstone outlet glacier reached full-glacial volume after the mountain valley glaciers had reached full-glacial volume. Furthermore, the plateau icecaps and the northern Yellowstone outlet glacier maintained their maximum or near maximum volumes while the mountain valley glaciers receded. The mountain and plateau icecaps thus advanced into the former domains of the mountain valley glaciers. The importance of this model lies in the description of the late Wisconsin glacial dynamics of the northern Yellowstone region, and its relevance to regional differences in late Pleistocene glacial climates as interpreted from glacial activity.

Pierce's model is based in part on his interpretation of the extent of local mountain valley glaciers and the northern Yellowstone outlet glacier in Tom Miner Basin. His interpretation differs in some respects from those of Weed (1893), Horberg (1940), Alden (1932, 1953), Hall (1960a), and Montagne and Locke (1989). Therefore, the relations of glacier and nonglacial deposits in Tom Miner Basin are a test of Pierce's model of ice dynamics.