Geothermal systems of the Corwin Springs-Gardiner area, Montana : possible structural and lithologic controls
by Eric Mitchell Struhsacker

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Earth Sciences
Montana State University

Abstract:
This study is an attempt to determine by means of geologic observations the structural and lithologic controls on the circulation of geothermal waters in the La Duke and Bear Creek thermal spring systems. Hot spring activity has persisted in the Corwin Springs-Gardiner, Montana area since the Pleistocene. Presently the only active hot springs, La Duke and Bear Creek, emerge at opposite ends of a two square mile Pleistocene travertine deposit.

The hot springs and travertine lie along the northwest trending Gardiner fault, a Laramide high-angle reverse imbricate fault zone, which bounds the Beartooth crystalline rock uplift on the southwest.

The post-Laramade Reese Creek and Mammoth faults are graben-forming normal faults that extend from the Yellowstone Park upland, northward into the hanging wall of the Gardiner fault. The local thermal features lie on or between the intersections of these faults with the Gardiner fault zone.

More than 10,000 feet of Paleozoic and Mesozoic sedimentary rock are preserved within the graben in the footwall of the Gardiner fault. From a structural high within Yellowstone Park, the sedimentary units dip gently into the Gardiner fault zone, where they are dragged up and locally overturned to form an asymmetrical syncline striking northwest. These structural relationships suggest that meteoric waters flow down permeable sedimentary units within the graben from the Yellowstone upland to great depth under the Gardiner fault zone, thereby forming a common reservoir for the hot spring systems. The cavernous Mississippian Madison Limestone, lying near a depth of 10,000 feet under the Gardiner fault zone, may be the principal aquifer and produces the high Ca content of the active hot springs.

Waters are heated at depth by conduction from rocks whose temperatures depend on the geothermal gradient. They then ascend through fractures to the surfaced A normal thermal gradient for western Montana causes base temperatures near 100° C at this depth. However, the proximity of a shallow magma body beneath the Yellowstone Plateau to the south may accentuate the normal regional thermal gradient and produce higher base temperatures in the reservoirs.

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Date August 11, 1976

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Chapter 1

INTRODUCTION

Geothermal phenomena have been intermittently active in the Corwin Springs-Gardiner area of southwestern Montana from the early Pleistocene to the present. Thermal springs have produced extensive travertine deposits up to 60 feet in thickness that extend for four miles from the vicinity of Little Trail Creek, northwest of Gardiner, to Bear Creek, east of Gardiner (Figure 1). Whereas most of the travertine was deposited before the last Pinedale glaciation, minor thermal spring activity continues on this trend at the Bear Creek warm spring (Plate 1) and at La Duke Hot Spring (Plate 2) (Fraser et al, 1969). Both springs are presently depositing moderate amounts of travertine. Base reservoir temperatures for La Duke Hot Spring are thought to range from 81° C in the summer to 130° C in the winter (Chadwick, personal communication, 1976).

These thermal features lie within the northwest trending Gardiner fault zone on the north side of the Yellowstone River valley. They also lie on the northern edge of the Yellowstone geothermal field. Most hot springs within the Yellowstone field actively deposit siliceous sinter, and have base temperatures in excess of 250° C (Fournier, White and Truesdell, 1975). These hot spring systems are thought to derive their heat from a molten or partially crystallized rhyolitic

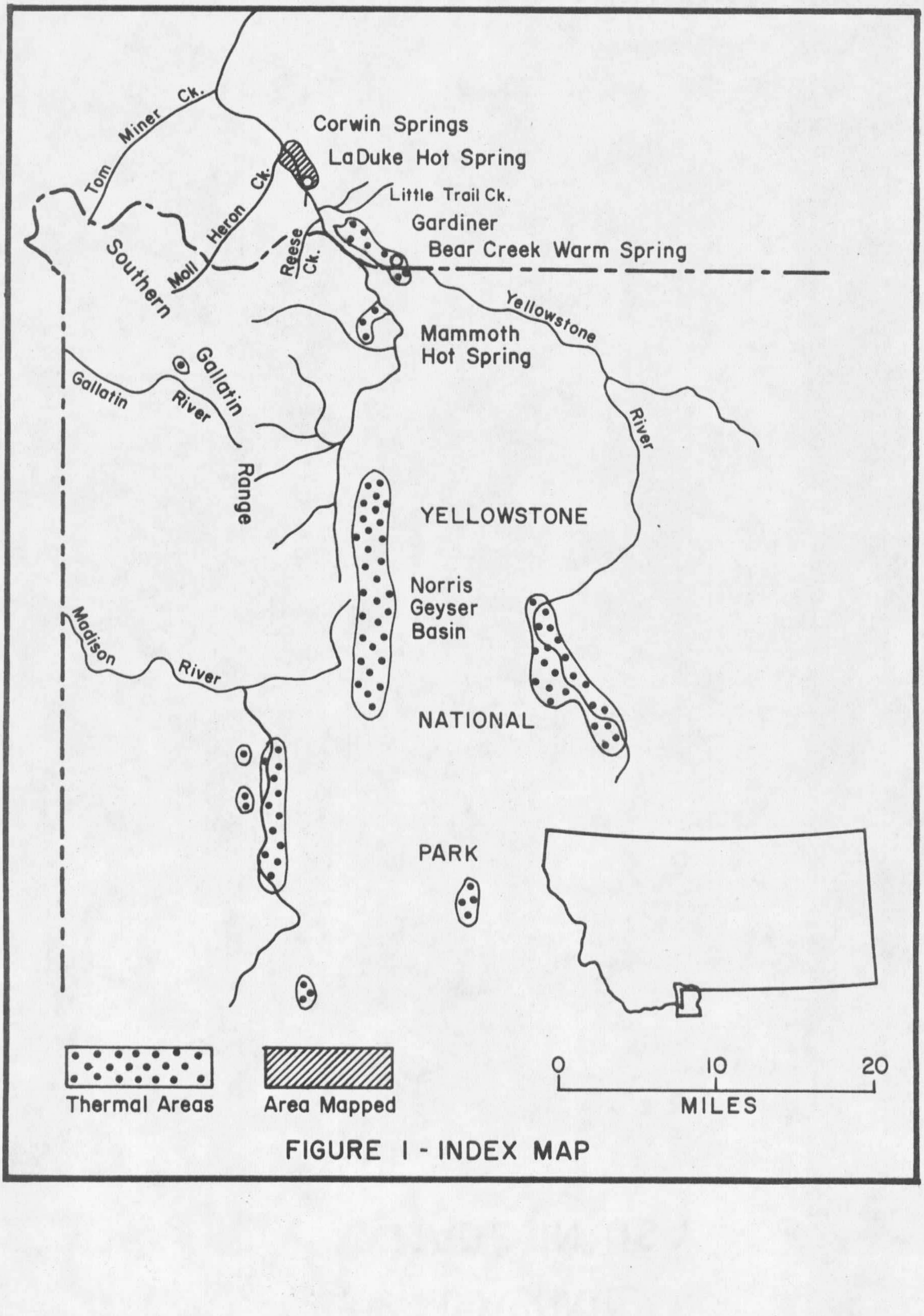

FIGURE 1 - INDEX MAP