Structural geometry of the Paradise Valley, Park County, southwest Montana
by Zhangming Wu

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Earth Sciences
Montana State University
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Abstract:
The Paradise Valley is located at the juncture of the Yellowstone hotspot, and Basin and Range and Laramide structural provinces. It is a fault controlled NE-oriented basin that is bordered by the Deep Creek fault to the southeast, Suce Creek fault to the northeast, Gardiner-Spanish Peak fault to the southwest and a discontinuous western boundary fault to the northwest. Generally, the valley is a NE-striking half-graben controlled heavily by the north-west-dipping Deep Creek fault. Its central-southwest part, however, is essentially an asymmetric graben characterized by one or more synthetic or antithetic secondary normal faults within the valley. The deepest trough of the valley, which is parallel to the southeast boundary fault, lies to the southeast of the long axis of the valley. Along its long axis, the bottom of the valley becomes shallower toward both its southwest and northeast ends. The deepest section is located in the central segment between the Yellowstone River and Chico in a NW-SE direction, and from the Mill Creek fault to Squaw Creek fault in a NE-SW direction. In three-dimensions, the Paradise Valley has the geometry of a southeastward inclined spoon.

Pre-existing structures appear to have had a strong effect on the structural geometry of Paradise Valley. The NE-striking Madison mylonite zone, a zone of crustal weakness, may have strongly influenced the orientation of the Deep Creek fault, which controls the general geometry of the valley. In addition, WNW-striking Laramide structures indirectly control the configuration of the pre-Neogene "basement" beneath the valley.

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Zhangming Wu

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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Date April 28, 1993

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ABSTRACT

The Paradise Valley is located at the juncture of the Yellowstone hotspot, and Basin and Range and Laramide structural provinces. It is a fault controlled NE-oriented basin that is bordered by the Deep Creek fault to the southeast, Suce Creek fault to the northeast, Gardiner-Spanish Peak fault to the southwest and a discontinuous western boundary fault to the northwest. Generally, the valley is a NE-striking half-graben controlled heavily by the north-west-dipping Deep Creek fault. Its central-southwest part, however, is essentially an asymmetric graben characterized by one or more synthetic or antithetic secondary normal faults within the valley. The deepest trough of the valley, which is parallel to the southeast boundary fault, lies to the southeast of the long axis of the valley. Along its long axis, the bottom of the valley becomes shallower toward both its southwest and northeast ends. The deepest section is located in the central segment between the Yellowstone River and Chico in a NW-SE direction, and from the Mill Creek fault to Squaw Creek fault in a NE-SW direction. In three-dimensions, the Paradise Valley has the geometry of a southeastward inclined spoon.

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INTRODUCTION

The Paradise Valley of southwest Montana is located at the juncture of the Yellowstone Plateau, eastern boundary of the Basin and Range province, and northern margin of the Laramide foreland province (Fig. 1). Therefore, not only will a study of the geology and geophysics of this valley increase our understanding of its structural geometry and evolution, but will also contribute to a greater understanding of the history of regional extension in Cenozoic time. For example, is the origin or development of the valley related to the proximity of the Yellowstone hotspot, or can its origin be solely attributed to Basin and Range extension?

The main purpose of this study is to determine the structural geometry of Paradise Valley (Fig. 2). In this study, the structural geometry of Paradise Valley refers to the spatial relations of structures that confine the valley, and the bottom of the valley is defined as the top of the pre-Neogene "basement". The reasons to consider the "basement" of the valley as all pre-Neogene rocks are: (1) the Paradise Valley extensional basin began to develop after mid-Miocene or late-Miocene to Pliocene time, as discussed subsequently (p. 51-56); (2) given the distribution of

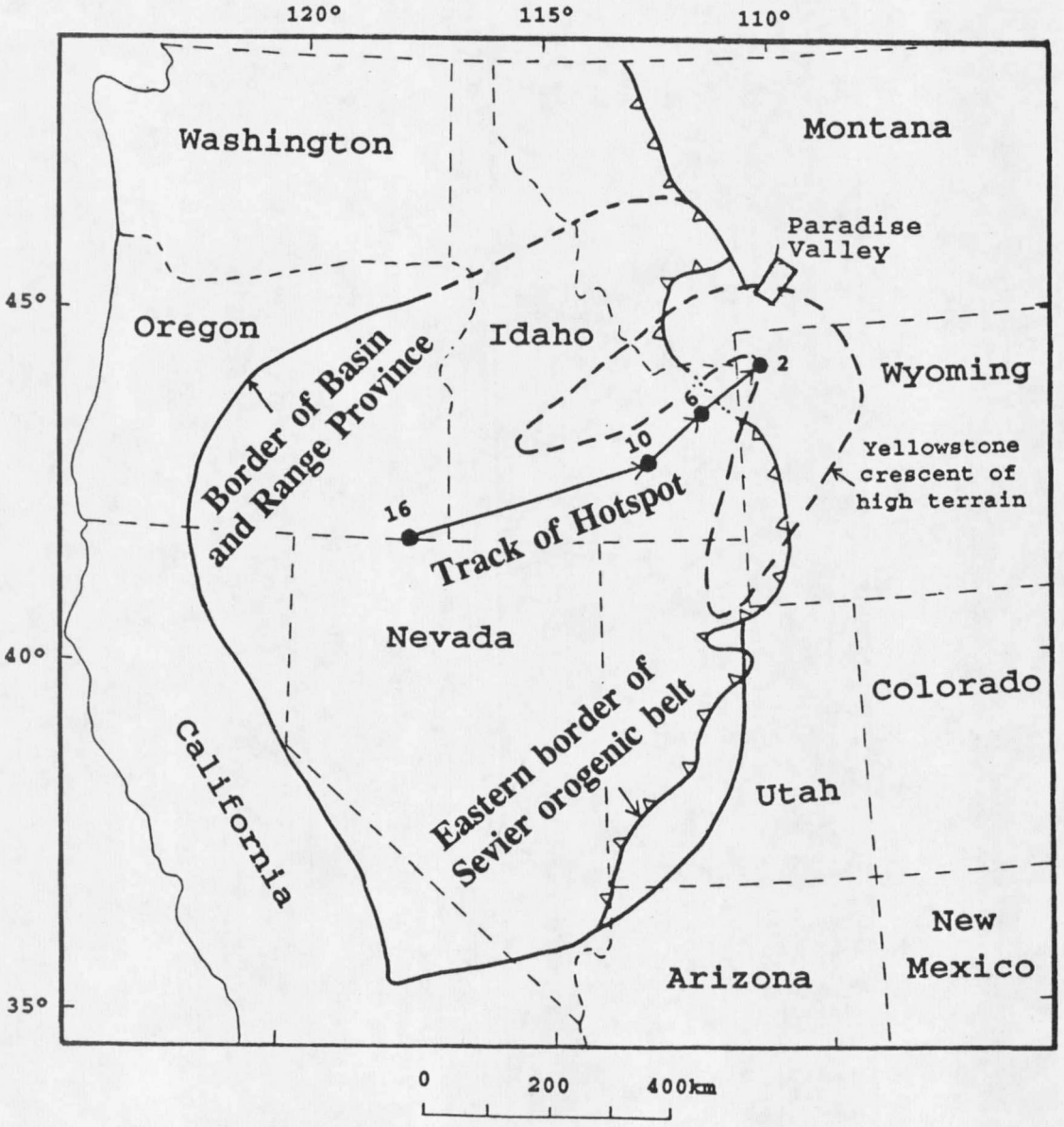

Fig. 1 Tectonic setting of Paradise Valley. Modified from Pierce and Morgan(1992; Fig. 23). Solid circles show the position of Yellowstone hotspot relative to western North America in Neogene time. Numbers refer to age (in Ma) of volcanism at different locations.