

Precambrian Geology of the Tobacco Root Mountains, Montana

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Cover: Metamorphosed mafic dikes and sills (MMDS) that have intruded quartzofeldspathic gneisses of the Pony–Middle Mountain Metamorphic Suite are visible as nearly horizontal bands in a cliff face in the central Tobacco Root Mountains. The middle of the three prominent MMDS in the photo thins dramatically, as if caught in the act of intrusion. The photograph is taken from the northeast ridge of Spuhler Peak looking northwest toward previously unnamed, flat-topped, 10,080 foot Keck Mountain. In the foreground on the left are rocks of the Spuhler Peak Metamorphic Suite, which are typically more brown in color than the gray-weathering gneisses of the Pony–Middle Mountain Metamorphic Suite. The absence of the MMDS in the Spuhler Peak Metamorphic Suite suggest that the rocks of this suite were not in their present position at the time of intrusion of the MMDS.

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Preface

OVERVIEW

The Tobacco Root Mountains occupy a unique niche in the Wyoming province of North America. Located near the northwestern margin of the province, the Precambrian rocks of the Tobacco Roots were subjected to an intense tectonothermal event during the collision of the Wyoming province with the Hearne province in the Early Proterozoic. This event overprinted earlier periods of deformation and metamorphism, but the unique lithologic packages present in the Tobacco Root Mountains aid in unraveling early from later events and in detailing many results stemming from this Early Proterozoic collision.

This Geological Society of America Special Paper is organized into three separate parts. In Chapters 2–6, an effort is made to review the geochemistry and petrology of the four major Precambrian rock sequences present in the Tobacco Root Mountains: the Indian Creek Metamorphic Suite, the Pony–Middle Mountain Metamorphic Suite, the Spuhler Peak Metamorphic Suite, and metamorphosed mafic dikes and sills. Each of these suites, or sequences, plays an important role in understanding the Precambrian geology of this region. This section focuses on what each rock suite represents in terms of original protolith and provides the foundation for understanding the extensive petrological and geochronological information that follows. In addition, Chapter 4 considers the meta-ultramafic rocks that are dispersed throughout all Precambrian exposures in the Tobacco Root Mountains. Chapter 6 presents petrologic observations and interprets them in terms of a metamorphic history and a pressure-temperature path for the four rock suites.

The second section (Chapters 7–9) presents the results of numerous and extensive radiometric age determinations from all four major rock suites. Each chapter details the results of a different approach; taken together, they provide a solid base for understanding the timing of the tectonothermal events that affected these rock suites and for separating the effects of the last major event in the Early Proterozoic. The final chapters (Chapters 10 and 11), comprising the third section, examine the structures and fabrics present in these Precambrian rocks and propose a sequence of events that correlates observed field relations and structures with age determinations and metamorphic history.

Included with this volume is a reprinted version of the Geologic Map of Southern Tobacco Root Mountains, Madison County, Montana, that was compiled by Charles J. Vitaliano and William S. Cordua and published by the Geological Society of America in 1979 as MC-31. The map is included as a pocket insert, and the text that accompanied the map is appended at the end of this volume. As this map was the foundation upon which our research was based and as it currently is out of print, we are pleased that it can be included here. This reprinting of MC-31 is made possible by a generous donation from a former student of Dr. Charles J. Vitaliano.

DEDICATION

The editors dedicate this volume to Sandra Glass, former program vice-president of the W.M. Keck Foundation. It was largely through the wisdom and foresight of Sandra Glass that the Keck Geology Consortium was born. Her insights into science education and research, especially (in our case) at undergraduate liberal arts colleges, provided the support that ultimately made possible our field seasons in Montana and, by extension, this volume.

ACKNOWLEDGMENTS

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