Sedimentology, provenance, and tectonic setting of the Miocene Horse Camp Formation (Member 2), east-central Nevada
by Brian Keith Horton

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:
A study of the sedimentology, compositional trends, and modem tectonic setting of a 1600 m-thick sedimentary succession provides information on the late Cenozoic paleogeography and tectonics of an extensional basin and adjacent orogen in the Basin and Range province of east-central Nevada. Interpretations of depositional environments and reconstructions of paleogeography utilize detailed sedimentologic analyses of fourteen distinct facies and four facies associations from nine measured stratigraphic sections. Conglomerate compositional data and considerations of modern tectonic setting and local geologic structures provide constraints on the tectonic development of the extensional basin and orogen.

Within the Miocene Horse Camp Formation (Member 2), four facies associations are defined by specific combinations of fourteen potential facies and attributed to processes characteristic of particular depositional environments. Subaerial and subaqueous fan-delta environments were characterized by deposition of sediment gravity flows and an absence of fluvial processes. A nearshore lacustrine facies association recorded wave-influenced sedimentation near a lake shoreline. Quiet-water deposition and limited sediment gravity flows characterized an offshore lacustrine environment.

Lateral facies variations and stratal thinning and fining trends suggest a sediment source terrane to the south/southeast in the northern Grant Range. Simulated unroofing of this source terrane generated a hypothetical clast composition suite that is similar to actual conglomerate compositional data from Member 2. Therefore, Member 2 strata recorded early to late Miocene unroofing of the northern Grant Range portion of an extensional orogen. A lack of lower Paleozoic clasts in Member 2 conglomerates requires at least 1 km of post-Miocene (post-Member 2)uplift in order to account for unroofing of the modern northern Grant Range down to lower Paleozoic rocks.

The 3000 m-thick Horse Camp Formation is exposed in an uplifted footwall adjacent to a modern extensional basin, Railroad Valley, to the west. The Horse Camp Formation was deposited in a Miocene extensional basin prior to the development of Railroad Valley. Post-Miocene development of Railroad Valley coeval with uplift and eastward tilting of Horse Camp strata is explained by a model that requires a westward migration of the zone of active normal faulting and footwall uplift.

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of the requirements for the degree

of

Master of Science

in

Earth Sciences

MONTANA STATE UNIVERSITY
Bozeman, Montana

May 1994

T1378
H7895

APPROVAL

of a thesis submitted by

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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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ACKNOWLEDGMENTS

I would like to thank Dr. Jim Schmitt for support, encouragement, and advice above and beyond the call of a graduate advisor. His expertise and enthusiasm were vital to the completion of this project. I thank Drs. Dave Lageson and Joan Fryxell for discussions of the structural complexities of the study area. Discussions with Dr. Stephan Custer, Scott Singdahlsen, and Ted Campbell are greatly appreciated. Jessie Smith provided invaluable encouragement, field assistance, financial assistance, and culinary expertise. Her personal decision to pause her academic studies so that I could finish my degree in a timely fashion is appreciated and will not be forgotten. I also thank my parents, Steve and Cindy Horton, for their interest and encouragement throughout my academic pursuits.

Field work was supported by research grants from the American Association of Petroleum Geologists, Geological Society of America, and Sigma Xi. Other financial support included funds from a MSU Graduate Presidential Scholarship and the 1993 D.L. Smith Memorial Scholarship. A National Science Foundation Graduate Research Fellowship supported academic studies during the 1993-94 school year. This material is based upon work supported under a National Science Foundation Graduate Research Fellowship. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation.

TABLE OF CONTENTS

TABLE OF CONTENTS—Continued

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES—Continued

LIST OF FIGURES—Continued

LIST OF PLATES

ABSTRACT

A study of the sedimentology, compositional trends, and modern tectonic setting of a 1600 m-thick sedimentary succession provides information on the late Cenozoic paleogeography and tectonics of an extensional basin and adjacent orogen in the Basin and Range province of east-central Nevada. Interpretations of depositional environments and reconstructions of paleogeography utilize detailed sedimentologic analyses of fourteen distinct facies and four facies associations from nine measured stratigraphic sections. Conglomerate compositional data and considerations of modern tectonic setting and local geologic structures provide constraints on the tectonic development of the extensional basin and orogen.

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INTRODUCTION

Deposits of ancient extensional basins possess a wealth of information about depositional processes and paleoenvironments during extension (e.g., Golia and Stewart, 1984; Hendrix and Ingersoll, 1987; Cavazza, 1989; Fedo and Miller, 1992). These deposits also contain a record of the tectonic evolution of adjacent sediment source terranes. In fact, if an extensional orogen has been uplifted and completely eroded, the only record of its temporal evolution may be the sediment derived from that orogen. In order to gain as much information as possible from an extensional basin sequence, an integrated study incorporating sedimentologic and stratigraphic data with sediment compositional trends is required. This study utilizes these various data sources to decipher the sedimentary processes, depositional environments, paleogeography, and tectonic development of an extensional basin and adjacent orogen in the Basin and Range province of western North America.

The Miocene Horse Camp Formation (Member 2) is an extensional-basin sequence in east-central Nevada which contains a continuous 1500–2000 m-thick succession of conglomerate and sandstone with minor amounts of mudstone, carbonate, megabreccia and volcanic tuff breccia (Moores, 1968). This sequence is amenable to a study that evaluates the area's sedimentary and tectonic history. First, the well-exposed deposits are in an area with a fairly well-defined structural geology. A previous study by Moores and others (1968) has defined probable basin-margin faults and the stratigraphy of potential sediment source terranes. In addition, the Miocene tectonic and sedimentary conditions recorded by the Horse Camp Formation can be coupled with the

area's modern tectonic setting to produce a more complete account of its late Cenozoic history.

This study is divided into three primary sections. First, sedimentologic and stratigraphic descriptions of the Horse Camp Formation (Member 2) provide a basis for interpretations of the depositional environments and paleogeography of a Miocene extensional basin. Second, compositional analysis of Member 2 conglomerates is incorporated into a provenance model that defines the late Cenozoic tectonic evolution of a particular source terrane within the adjacent extensional orogen. Third, a model depicting late Cenozoic tectono-geomorphic evolution of the area is developed based upon constraints imposed by sedimentary and tectonic data preserved in the Miocene extensional-basin sequence and present in the modern geologic environment.

GEOLOGIC SETTING

Outcrops of the Miocene Horse Camp Formation and the surrounding northern Grant Range, Horse Range, and southern White Pine Range (Fig. 1) comprise the footwall of the Railroad Valley fault, a modern, west-dipping normal fault (Fig. 2). A modern extensional basin within the hanging wall of this fault, Railroad Valley (Fig. 1), contains an eastward thickening, 3000 m-thick sequence of late Miocene to Holocene sedimentary rocks (Bortz and Murray, 1979; Effimoff and Pinezich, 1981). Exposures of the Horse Camp Formation are separated from Railroad Valley by the Railroad Valley fault and from the surrounding ranges by a north-striking, west-dipping normal fault (north segment of Ragged Ridge fault) and two east-striking transverse fault zones (Currant Summit and Ragged Ridge-Stone Cabin fault zones; Fig. 2).

Jurassic-Cretaceous contractional deformation in the northern Grant Range and southern White Pine Range consisted of minor east-vergent folding (Fig. 2) and associated axial-planar cleavage development in the lower Paleozoic section (Camilleri, 1992; Walker and others, 1992; Lund and others, 1993). In the Horse Range, east-vergent overturned folds in Devonian rocks (Fig. 2) and isoclinal folding and cleavage development in the Cambro-Ordovician section originally attributed to Tertiary extension (Moores and others, 1968) probably record a regional Jurassic-Cretaceous, east-west shortening episode (Taylor and others, 1993). The overturned Paleozoic section comprising most of the Horse Range (Fig. 2) is herein interpreted as the east limb of a large, east-vergent anticline. Greater contraction within the Horse Range (relative to the northern Grant Range and southern White Pine Range) may have been accommodated by the east-striking Currant Summit and Ragged Ridge-Stone Cabin fault

zones (Fig. 2). These transverse structures may have acted as lateral ramps or tear faults bounding a fold within the Horse Range. This scenario would account for the overturned Paleozoic section defining the Horse Range and lack of such extensive overturned sections in the northern Grant Range and southern White Pine Range (Fig. 2).

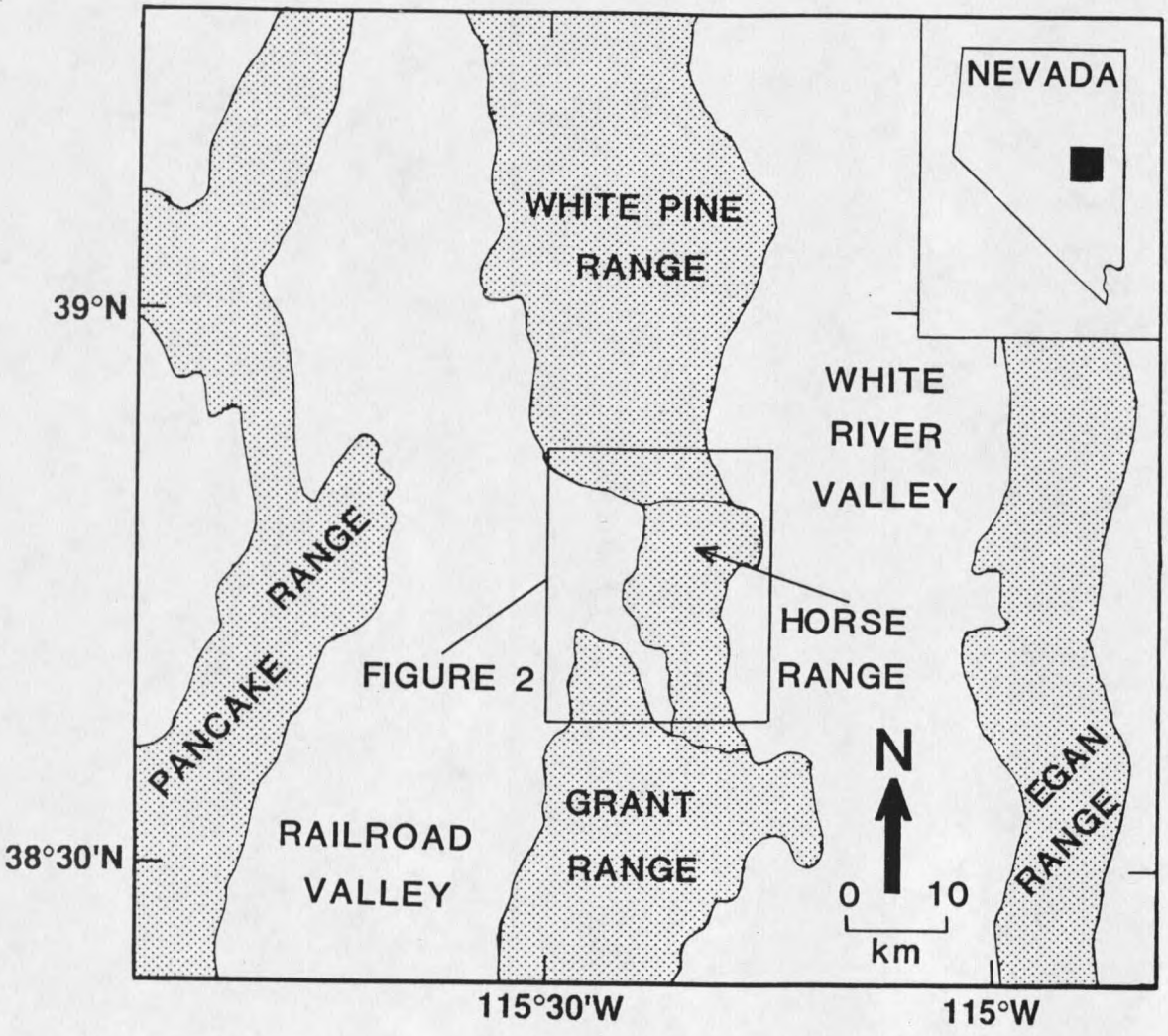

Figure 1. Index map of basin and range physiography of east-central Nevada.