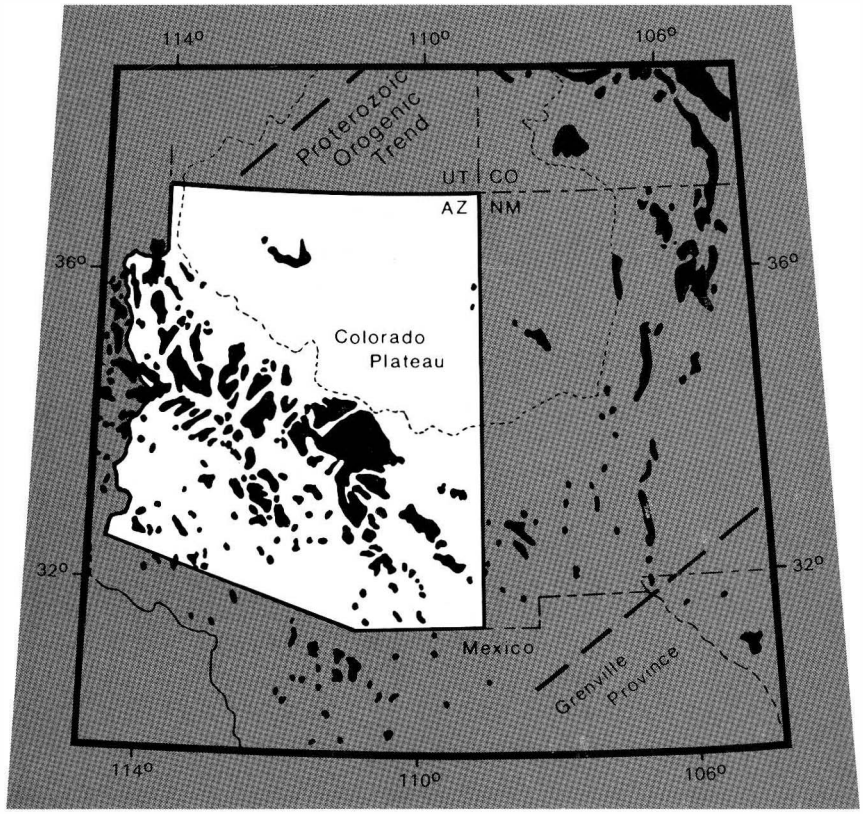
Proterozoic Geology and Ore Deposits of Arizona

Karl E. Karlstrom, *Editor*



Arizona Geological Society Digest 19

1991

Proterozoic Geology and Ore Deposits of Arizona

Karl E. Karlstrom, *Editor*

Arizona Geological Society Digest 19

1991

The cover illustration was adapted by Pete Corrao from Figure 1 in "Overview of Proterozoic Metamorphism in Arizona," which is included in this volume.

Produced in cooperation with the Arizona Geological Survey

Published by
Arizona Geological Society
P.O. Box 40952
Tucson, Arizona 85717

PREFACE AND ACKNOWLEDGEMENTS

Proterozoic rocks in Arizona have been the focus of interest for geologists since the late 1800's. Early investigations, led by the U.S Geological Survey, focused on the extensive ore deposits hosted by Proterozoic rocks. By the 1960's, these studies, combined with theses from academic institutions and the efforts of the Arizona Geological Survey, had produced a rich data base of geologic maps, primarily of the central part of the Transition Zone. The chronological significance of these maps became much better known with the application of U-Pb geochronology by L.T. Silver and his students starting in the 1960's. The 1970's and early 1980's were marked by numerous contributions from Masters and Ph.D students at a variety of academic institutions, and continued work by the U.S. Geological Survey. Interest in ore deposits persisted, and there was an increasing interest in interpretation of the tectonic history of Proterozoic rocks in terms of plate tectonic models, as summarized in papers by Phillip Anderson, Ed DeWitt, Clay Conway, Paul Lindberg, and J.L Anderson in the 1989 Arizona Geological Society Digest 17: "Geologic Evolution of Arizona".

The present volume: "Proterozoic Geology and Ore deposits of Arizona" builds upon A.G.S. Digest 17, and presents the results of geologic investigations from the latter part of the 1980's. A number of the papers are condensed versions of MS theses done by students at Northern Arizona University. These papers are based upon 1:10,000 mapping and structural analysis of several areas in Arizona. The geologic maps from each of these studies are available separately as part of the Arizona Geological Survey Contributed Map Series. These detailed maps, plus the continuing mapping efforts of the U.S.G.S. and students at other academic institutions, form an ever improving data base for continuing attempts to understand the Proterozoic geology and ore deposits of Arizona.

One theme of this volume involves descriptions of the complex segmented character of the Proterozoic orogen in Arizona. The tectonic significance of the segmented orogen, and of shear zones and high strain domains in Arizona, is certainly controversial. However, the bias expressed in a number of the papers is that the arc affinity of Proterozoic rocks, combined with actualistic models for continental accretion, necessitate more complex models involving large translations between tectonic fragments. The terrane analysis approach offers the most objective way to evaluate the significance of specific tectonic boundaries because there is no prior assumption of original autochthonous versus allochthonous relationships between adjacent blocks. Instead, there is an emphasis on applying detailed mapping and multidisciplinary research to understand the geologic history within and across potential boundaries.

It is hoped that this volume, and the related detailed mapping, will stimulate continued multidisciplinary efforts in the 1990's that will provide better insights into the significance of different types of tectonic boundaries. At present we can not point confidently to any suture zones that mark the assembly of exotic fragments. As in many orogenic belts, sutures appear to be elusive and perhaps cryptic parts of the orogen. However, neither do fixist models involving in situ development of arc terranes adequately explain the observed juxtapositions of rocks with different lithologic, isotopic, structural, and metamorphic signatures.

In addition to encouraging continuing scientific debate of the tectonic history of the orogen, this volume highlights the rich variety of Proterozoic geology exposed in Arizona. Few areas offer such variety in a small area: a Proterozoic ophiolite, arc batholiths and related arc volcanics, structural styles ranging from foreland thrust belt to polyphase ductile deformation; metamorphic grade ranging from low greenschist to granulite, world class ore deposits, major isotopic provinces, and a complex history of granitoid plutonism. The variety and excellent exposure of Proterozoic tectonic features make this an important orogenic belt for general studies of orogenic processes and a natural laboratory for earth science education.

This volume was conceived by Steve Reynolds, who proposed that a theme volume might accompany the annual Arizona Geological Society field trip. He asked Ed DeWitt and me to organize the field trip and this volume. After an announced "call for papers", the field trip was run in Spring of 1991. We had hoped to have the volume completed by that time but only a few of the authors (not including Ed or me) were able to make our early deadlines. Each paper was reviewed by two reviewers (usually including me or Ed DeWitt) as it was submitted. Authors then prepared camera-ready copies on their individual word processors. Final compilation of the volume at Northern Arizona University was greatly facilitated by the efforts of Kevin Wilson, who checked for uniformity and pasted in final illustrations, and Louella Holter, who did the word processing for several of the contributions from Northern Arizona University. Pagination was done by Rick Trapp, A.G.S president.

Karl E. Karlstrom
Editor

ARIZONA GEOLOGICAL SOCIETY
DIGEST 19
1991

TABLE OF CONTENTS

MAZATZAL PROVINCE: CENTRAL AND SOUTHEASTERN ARIZONA

ORE DEPOSITS

FIELD TRIP GUIDE