

ARIZONA GEOLOGICAL SOCIETY

DIGEST

VOLUME V



TUCSON, ARIZONA

NOVEMBER, 1962

**THIS PAGE
INTENTIONALLY BLANK**

ARIZONA GEOLOGICAL SOCIETY

DIGEST

VOLUME V

TUCSON, ARIZONA

NOVEMBER, 1962

CENOZOIC GEOLOGY OF ARIZONA
A SYMPOSIUM

Sponsored by
Arizona Academy of Science

Edited by
L. A. Heindl

Contribution No. 7, Program in Geochronology
University of Arizona

Published by
Arizona Geological Society

November 1962

ARIZONA GEOLOGICAL SOCIETY

OFFICERS for 1962-63

Frank D. MacKenzie, Banner Mining Company	President
Thomas W. Mitcham, University of Arizona	Vice President
Charles L. Fair, Bear Creek Mining Company	Secretary
Samuel I. Bowditch, American Smelting & Refining Company .	Treasurer

COUNCILORS

Samuel F. Turner	Turner and Associates
Glenton Sykes	City of Tucson, Retired
John L. Splane	Consultant
H. Wesley Peirce	Arizona Bureau of Mines
Phillip W. Johnson	U. S. Geological Survey
John W. Anthony	University of Arizona

The Digest is issued periodically by the Society as an informal bulletin intended to present technical papers and progress reports of research bearing on geological problems of Arizona in particular and the southwest generally. The editor welcomes such papers as well as notes and news of geological and related activities within this broad framework.

We feel that the publication of the papers in this volume will serve a useful purpose even though they were originally presented about 6 years ago, and only limited updating has been attempted. The Selected Bibliography, which has been considerably expanded and updated by Mr. M. E. Cooley, is of special value.

PREFACE

The Cenozoic geology of Arizona has been the subject of increasing academic and economic interest during the past 20 years. The geologic work during these years has led to an improved understanding of the complex history of this era, but much of this work has been unpublished—some was available as theses; some was incidental to other studies; and a great deal is still part of "works in progress." The Symposium on Cenozoic Geology of Arizona was sponsored by the Geology Section of the Arizona Academy of Science to make some of this work available in print. The Symposium was held during the joint meeting of the 33rd annual session of the Southwestern and Rocky Mountain Division of the American Association for the Advancement of Science and the 1st annual session of the Arizona Academy of Science at Tucson, Arizona, on April 30, 1957. Dr. John W. Harshbarger, then with the U.S. Geological Survey and now with the University of Arizona, presided.

The Symposium program included nine papers:

1. Cenozoic deposits of the Agua Fria area, Charles St. Clair.
2. Tertiary rocks and structure in the Cienega Wash area, Daniel J. Brennan.
3. Cenozoic stratigraphy in the upper Gila River basin, L. A. Heindl.
4. Late Cenozoic deposits of the Safford area, William Van Horn.
5. Geomorphology and volcanic rocks of the Little Colorado River valley, Maurice E. Cooley.
6. Alluvial deposits in the Mammoth area, L. A. Heindl.
7. Cenozoic fossil record of Arizona, J. F. Lance.
8. Cenozoic climates and secondary enrichment of copper deposits, Lewis Smith.
9. Cenozoic plant record and climates of Arizona, Roger Y. Anderson.

The preparation of these papers and the publication of this volume is representative of the high degree of interest in Cenozoic geology by many public and private agencies—papers were written by geologists associated with the Universities of Arizona and New Mexico, private companies, the Museum of Northern Arizona, and the U.S. Geological Survey. The Geochronology Laboratories of the University of Arizona, under the direction of Mr. Terah L. Smiley, assisted generously in the preparation of the manuscripts for publication and the actual publication was sponsored by the Arizona Geological Society.

Six of the papers presented at the symposium are included in this volume. Dr. John F. Lance's report on the Cenozoic fossil record has been published in an abbreviated form in the 1960 Arizona Geological Society Digest, volume III, and the report on the Mammoth area has been revised for publication as U.S. Geological Survey Bulletin 1141-E. Two papers not presented have been added. Mr. R. T. Chew III prepared a resume of his thesis on the Mineta Ridge area because of the pertinence of his material to the general subject. The introductory paper was added to summarize the general outlines of Cenozoic geology within which these individual papers fit and which they have helped to clarify.

This volume could not have been compiled without assistance from many sources and I wish to thank everyone who helped with cooperation, criticism, patience, and encouragement. The assistance of Mrs. St. Ives Gray in supervising and expediting the final stages of preparation through publication is acknowledged gratefully.

L. A. Heindl

Washington, D. C.
November 26, 1962

CONTENTS

	Page
Abstracts	1
Chapter I. Cenozoic geology of Arizona—A 1960 resume, by L. A. Heindl	9
Chapter II. Cenozoic climate in the arid Southwest, by Roger Y. Anderson	25
Chapter III. The Mineta Formation, a middle Tertiary unit in southeastern Arizona, by Randall T. Chew III	35
Chapter IV. Tertiary sedimentary rocks and structures of the Cienega Gap area, Pima County, Arizona, by Daniel J. Brennan	45
Chapter V. Tertiary sedimentary and volcanic rocks of south- central Yavapai County, Arizona, by Charles St. Clair	59
Chapter VI. Should the term "Gila Conglomerate" be abandoned?, by L. A. Heindl.....	73
Chapter VII. Late Cenozoic alluvial deposits of the upper Safford Valley, Graham County, Arizona, by W. L. Van Horn	89
Chapter VIII. Geomorphology and the age of volcanic rocks in northeastern Arizona, by Maurice E. Cooley	97
Selected bibliography	117

ILLUSTRATIONS

Figure 1.1. Map showing areas discussed in the papers included in this volume, physiographic provinces, and Mogollon Highlands in Arizona	viii
---	------

Figure 1.2. Arizona and adjacent states, showing structural provinces in Arizona and areas affected by different intensities of Late Cretaceous and early Tertiary deformation and by late Cenozoic basin-and-range type of normal faulting and warping	11
1.3. Synoptic diagram showing the general sequence of geologic events of the Cenozoic Era in Arizona	13
1.4. Synoptic diagram showing inferred relationship of Mesozoic and early(?) Tertiary rocks in southern Arizona	24
2.1. Map showing location of fossil floras	26
2.2. Graph relating percentage of genera in North American fossil flora to the same genera now native to the geologic region of the deposit	28
2.3. Diagram showing influence of moist air currents and mountains on forest distribution across the United States ..	28
3.1. Generalized geologic map and section of the Mineta Ridge area, Pima County, Arizona	36
4.1. Generalized geologic map of the Cienega Gap area, Pima County, Arizona	47
4.2. Geologic sketch along section A-A', Cienega Gap area, Pima County, Arizona. (For location of section, see figure 4.1.)	48
5.1. Part of southern Yavapai County, Arizona, showing selected topographic features and general locations of measured sections	60
5.2. Diagrammatic sketch showing relationships of measured sections of the Rock Springs beds, Yavapai County, Arizona	62
6.1. Map of Arizona and New Mexico showing areas included in Gilbert's (1875) definition of the Gila Conglomerate and other areas to which the term has been extended	74
6.2. Map showing areas where Gilbert (1875) defined the Gila Conglomerate, generalized outlines of Cenozoic alluvial deposits, and sections examined	75
6.3. Charts showing Cenozoic alluvial deposits in areas of Gilbert's (1875) original definition of the Gila Conglomerate, upper Gila River basin, Arizona and New Mexico. (Pleistocene and Recent alluvial deposits not included.) ...	78
7.1. Generalized topography of Graham County, Arizona	90

	Page
Figure 7.2. Hypothetical sections of the Safford Valley, Arizona, showing three interpretations of sedimentary relationships of the alluvial fill: (A), after Schwennesen, 1919; (B), after Knechtel, 1936; and (C), this report	94
8.1. Map of northeastern Arizona and adjacent part of New Mexico showing major physiographic features and locations of figure 8.5 and generalized geologic sections shown in figure 8.6	98
8.2. Chart showing age and correlation of the erosion surfaces and geomorphic cycles in the Little Colorado River area ..	101
8.3. Diagram showing relationships between the several erosion surfaces preserved in the valley of the Little Colorado River, Arizona	101
8.4. Chart showing correlation and relationships of the volcanic flows in the San Francisco volcanic field, Arizona.....	104
8.5. Sketch map of San Francisco Mountain area, Arizona, showing major structural features and structure contours on top of the Permian Kaibab Limestone	105
8.6. Generalized geologic sections showing relationships of the lava flows on Anderson Mesa to the erosion surfaces along the Little Colorado River	107
8.7. Generalized geologic sections showing relationships of stage I-IV basalt flow, igneous rocks of intermediate composition, and associated alluvial deposits in the San Francisco Mountain area	109

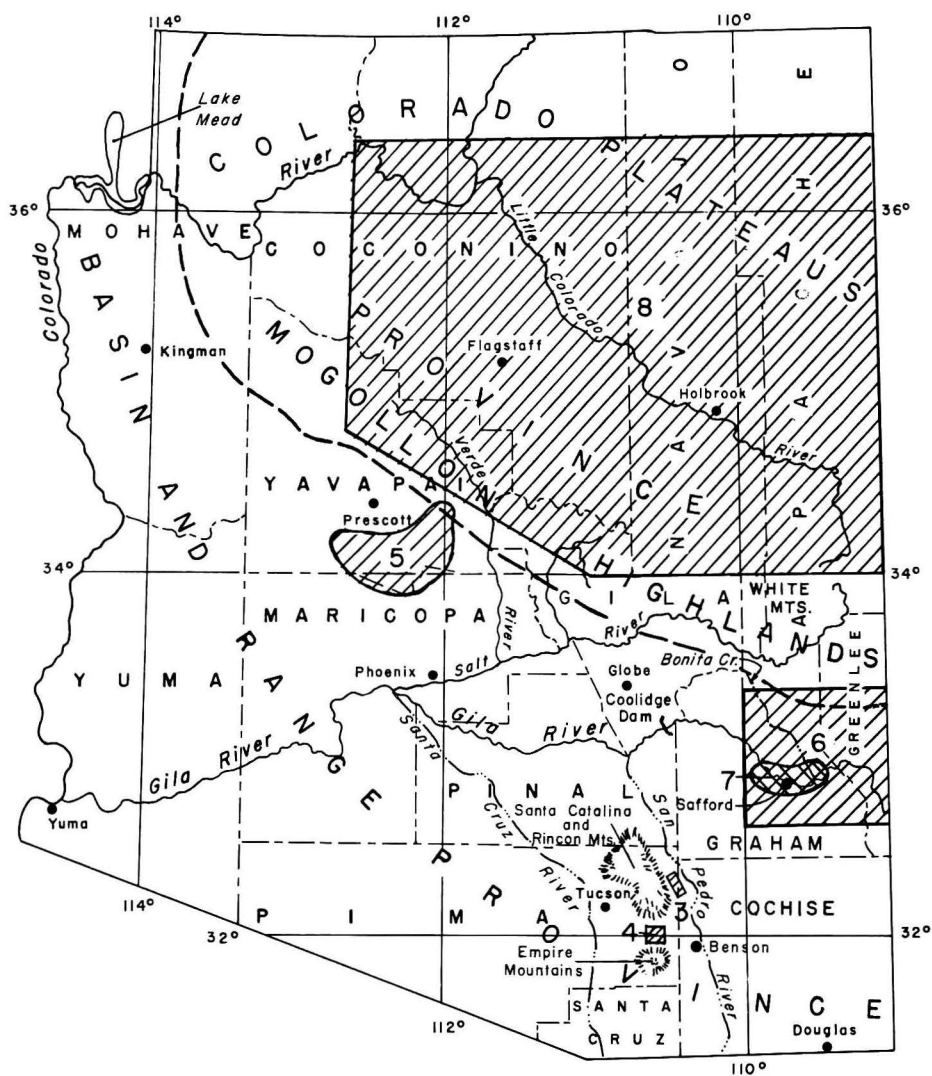


Figure 1.1. --Map showing areas discussed in the papers included in this volume, physiographic provinces, and Mogollon Highlands in Arizona. (Numbers refer to papers as shown in table of contents; R. Y. Anderson's discussion includes all of Arizona)