

New Mexico Geological Society

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Front Matter

(Usually includes Dedication, President's Message, & Conference Organizer's Message.)

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Annual NMGS Fall Field Conference Guidebooks

Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual [Fall Field Conference](#) that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

Free Downloads

NMGS has decided to make peer-reviewed papers from our Fall Field Conference guidebooks available for free download. This is in keeping with our mission of promoting interest, research, and cooperation regarding geology in New Mexico. However, guidebook sales represent a significant proportion of our operating budget. Therefore, only *research papers* are available for download. *Road logs*, *mini-papers*, and other selected content are available only in print for recent guidebooks.

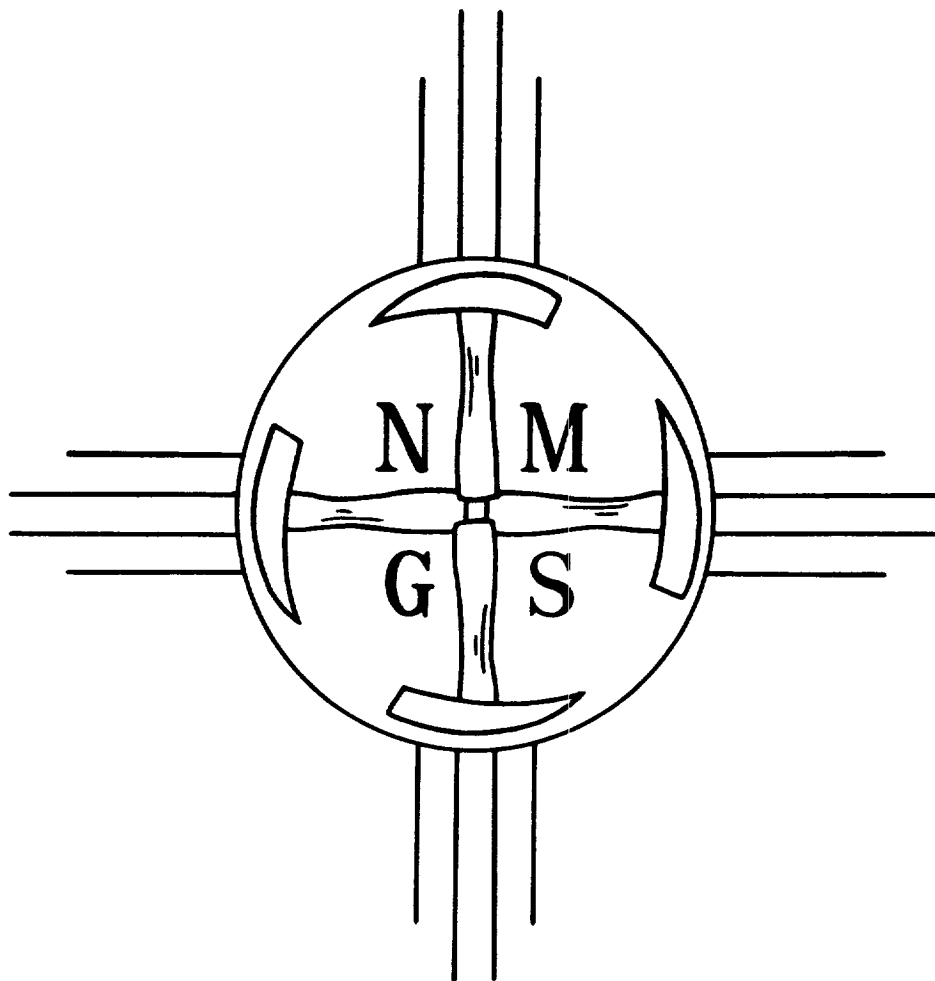
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NEW MEXICO GEOLOGICAL SOCIETY



Guidebook

OF THE

SAN JUAN BASIN

New Mexico and Colorado

FIRST FIELD CONFERENCE

November 3-4-5, 1950

NEW MEXICO GEOLOGICAL SOCIETY * FIRST FIELD CONFERENCE * SAN JUAN BASIN

EDUCATIONAL INSTITUTIONS

University of New Mexico
Albuquerque

Welcome to the University:

The University of New Mexico hopes that you will make yourselves at home on the campus during registration for the Field Conference of the New Mexico Geological Society.

The campus is situated on an eminence in the eastern part of Albuquerque, almost within the shadow of the towering Sandia Mountains to the east, and overlooks the historic Rio Grande to the west. The campus is a mile above sea level.

It is our hope that you may find time to visit around the campus and see the modified Indian pueblo style of architecture which has been incorporated uniformly into its buildings.

The scope of the institution's educational program is wide and therefore many departments serve the petroleum industry in one way or another. The departments of chemical engineering, mechanical engineering, electrical engineering, and civil engineering, all within the College of Engineering, train men who take active parts in the various phases of the petroleum industry. The large Fuels Section of the U. S. Geological Survey is located at the University of New Mexico.

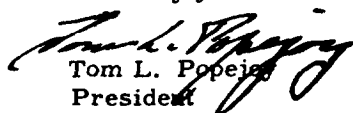
The University has a very fine library and its facilities are made available to industry and the public. The geology library has proved especially useful to the petroleum geologists in this part of the State.

The Department of Geology is located on the second floor, west wing of the building in which registration is held. They have a fine museum in which are exhibits of minerals, fossils, and rocks. In addition to their regular exhibits, there are special displays for this occasion, including maps, charts, and cross sections of the San Juan Basin region.

The faculty of the Department of Geology has had a long and wide interest in the geology of New Mexico, and its members are very active in geological research in and near the San Juan Basin. The department graduates students with bachelor's and master's degrees specialized in stratigraphy, paleontology, sedimentation, mineralogy, petrography, or mining geology.

It is my hope that you will have a most enjoyable and successful Field Conference.

Sincerely yours,


Tom L. Pope
President

New Mexico School of Mines
Socorro

New Mexico School of Mines extends its heartiest welcome to the participants in the first Field Conference of the New Mexico Geological Society.

This institution in all of its three divisions; namely, the College Division, the State Bureau of Mines and Mineral Resources, and the Research and Development Division has a very strong interest in the geology of the state as well as the various industries which are concerned with the development of the mineral resources of the state. The faculty and the professional staff of the three divisions of the institution are actively engaged in research on various problems of interest to the petroleum industry and other mineral industries. Staff members of the Department of Geology especially have been active in geologic research in the San Juan Basin and elsewhere in the state.


Students are graduated with a bachelor's degree in geology, geophysics, petroleum engineering, mining engineering, metallurgical engineering, and in the related basic fields of chemistry, mathematics, and physics. In addition, graduate work leading to the master's degree is performed in geology and geophysics.

The Petroleum Section of New Mexico Bureau of Mines and Mineral Resources is very active in its services to the petroleum industry. Oil-well sample cuttings, sample descriptions and plotted log strips on many of the wells drilled in New Mexico are available for reference use at the Bureau. Copies of 6,000 drillers' logs for most of the wells drilled in New Mexico may be obtained from the Bureau of Mines. The Bureau publishes bulletins, many of which are on subjects of interest to petroleum geologists. Maps and bulletins of the United States Geological Survey that pertain to New Mexico may be obtained from the Bureau at the regular sale price.

The Bureau of Mines and Mineral Resources is also actively sponsoring and cooperating in several geological mapping projects in New Mexico. Members of the staff of the Bureau of Mines are available for regular consultation service to representatives of the industry.

I extend my best wishes to you for an enjoyable and successful Conference.

Sincerely yours,


E. J. Workman
President

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GREETINGS

The New Mexico Geological Society welcomes you to its First Field Conference. It is our sincere hope that the conference will succeed in spreading knowledge, stimulating thought, and developing ideas which will contribute significantly to the science and especially to the geology of the San Juan Basin.

We hope that you will enjoy the trip and the scenery as well as the geology, and that the spirit of good fellowship may prevail throughout the conference.

OFFICERS OF THE SOCIETY

President

Harrison Schmitt

Consulting Geologist

First Vice-President

T. P. Stipp

U. S. Geological Survey

Second Vice-President

J. P. Smith

U. S. Potash Company

Secretary-Treasurer

Clay T. Smith

New Mexico School of Mines

ACKNOWLEDGEMENTS

The Conference Committee expresses its appreciation and gratitude to each person and organization contributing to the field conference and the guidebook.

Circumstances have been such that three organizations, the U. S. Geological Survey, the New Mexico School of Mines, and the University of New Mexico contributed most heavily to the success of the conference and the guidebook. Authors of the many papers in the guidebook deserve special credit for their contributions which were made under the pressure of shortness of time. The Committee especially expresses its gratitude to the advertising sponsors who have contributed to the financial success of the conference. Two companies, Sinclair Oil and Gas Company and Skelly Oil Company through their Albuquerque offices were especially helpful in the preparation of the guidebook. The State Geologists at Santa Fe also made certain contributions, and the U. S. Soil Conservation Service through its Cartographic Office in Albuquerque contributed certain reproductions of maps and photographs.

CONFERENCE COMMITTEE

General Chairman

Vincent C. Kelley University of New Mexico

Advisory

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William B. Hoover	Humble Oil and Refining Company
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Caswell Silver	Consulting Geologist
Clay T. Smith	New Mexico School of Mines
Paul H. Umbach	Stanolind Oil and Gas Company
Sherman A. Wengerd	University of New Mexico

Guidebook

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Caswell Silver (Sub-editor)	Consulting Geologist
Jean LaPaz (Assembling)	Sinclair Oil and Gas Company
Diana Baltz (Assembling)	U. S. Geological Survey
Marian Jo Cowan (Drafting)	U. S. Geological Survey

Road Log

Charles B. Read (Chairman)	U. S. Geological Survey
Harley Barnes	U. S. Geological Survey
N. Wood Bass	U. S. Geological Survey
Edward C. Beaumont	U. S. Geological Survey
Joe L. Borden	Pure Oil Company
Philip T. Hayes	U. S. Geological Survey
A. D. Zapp	U. S. Geological Survey

Trip Arrangements

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Joe L. Borden (Durango Representative)	Pure Oil Company
B. B. Bradish (Albuquerque Representative)	Skelly Oil Company
Caswell Silver (Pagosa Springs Representative)	Consulting Geologist

Registration

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Carl W. Beck	University of New Mexico
J. Paul Fitzsimmons	University of New Mexico

Caravan

John E. Allen (Chairman)	New Mexico School of Mines
Stewart M. Jones (Assistant)	New Mexico School of Mines
Robert A. Bieberman (Flagman)	New Mexico Bureau of Mines
James E. Doyle (Flagman)	New Mexico School of Mines
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Advertising

George A. Hemenway	Sinclair Oil and Gas Company
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SCHEDULE

Thursday, November 2.

2:00 p. m. Registration, Administration Building,
University of New Mexico.

Friday, November 3. Albuquerque, New Mexico to Pagosa Springs,
Colorado.

7:00 a. m. Caravan assembles on Cibola Avenue just
north of Central Avenue.

7:30 a. m. Caravan leaves Albuquerque, New Mexico.

5:30 p. m. Caravan arrives Pagosa Springs, Colorado.

8:30 p. m. Talk and colored slides by Robert Murphy,
Magnolia Petroleum Company, and Jack
Frost, U. S. Geological Survey on "Geology
along the San Juan River". Pagosa Springs
High School Gymnasium.

Saturday, November 4. Pagosa Springs to Durango, Colorado.

6:00 a. m. Breakfast in Pagosa Springs.

8:15 a. m. Caravan assembles at bridge over San Juan
River.

5:00 p. m. Caravan arrives Durango, Colorado.

6:30 p. m. Informal dinner and smoker.

Sunday, November 5. Durango to Molas Lake and Return.

6:00 a. m. Breakfast in Durango.

8:00 a. m. Caravan leaves from bridge north of town.

4:00 p. m. Caravan disbands at Molas Lake.

Conference ends.

NEW MEXICO GEOLOGICAL SOCIETY * FIRST FIELD CONFERENCE * SAN JUAN BASIN

GENERAL INSTRUCTIONS

1. It is essential that the caravan start each morning at the announced time. Your cooperation will be appreciated.
2. You will be seated in a different car each day (except drivers). Each morning your name will be posted on a bulletin board in the cafe where you have breakfast, and opposite it the number of the car in which you are to ride for that day. If you wish to ride in some special car please notify some member of the Arrangements Committee the night before.
3. You will be assigned your lodging reservations at the time of registration. Please do not make any subsequent change of room without notifying a member of the Arrangements Committee. (Note: If you do not stay in your assigned car, you will have difficulty in locating your lodging reservations.)
4. Please pay your lodging bill in advance or before your assigned breakfast hour so as not to delay the departure time of the caravan.
5. Anyone leaving the party before completion of the Conference please notify the Arrangements Committee.
6. You will be assigned a time for both breakfast and dinner at a specific eating place on each day of the conference. Please be prompt at breakfast because our facilities are limited and must be utilized to the maximum in order to facilitate a prompt start each day.
7. A truck will be provided to transport luggage from Albuquerque to Pagosa Springs and from Pagosa Springs to Durango, and on Nov. 5 from Durango back to Albuquerque. Luggage will be delivered to the hotel or motor court where you have room reservations each night, or if you do not have reservations for any of the nights, you may pick up your luggage from the truck at the Los Banos Hotel in Pagosa Springs and at the Strater Hotel in Durango. Luggage tags will be provided by the Arrangements Committee, but it will be your responsibility to write your name on the tags and deposit your luggage in the truck each day.
8. The person sitting in the front seat with the driver should keep him informed of stops, points of danger, points of interest, etc., noted in the road log, and he should read the geologic road log to the driver.

SPECIAL INSTRUCTIONS TO CAR DRIVERS

1. You will be given a numbered placard for attachment to your rear window. This number designates your position in the caravan.
2. If for any reason you have dropped out of line, you may resume your position at any subsequent stop. A space will be left for you by the driver in your rear at all stops until you return.
3. Never pass another Conference car while the caravan is in motion unless that car has dropped out of line.
4. If you have car trouble, please stop at the side of the road and allow the caravan to pass. If you need help, flag down the tow car which will be at the rear of the caravan.
5. Please service your car at night to insure prompt departure the following morning. Freezing weather is practically a certainty so each car should be provided with anti-freeze or the radiator should be drained each night.
6. DO NOT OMIT THE GAS STOP AT CUBA, NEW MEXICO. The run from Albuquerque to Pagosa Springs is long and the average car will not make the trip on one filling of the tank. There are about 8 gasoline stations in Cuba. If you have more than one credit card please pick the station which is least crowded.
7. When double parking in more than one line, drive as close as possible to the adjacent line and leave as little space as possible (1 foot or less) between bumpers.

INTRODUCTION

By V. C. Kelley
University of New Mexico

The San Juan Basin is located mostly in northwestern New Mexico where it embraces all of San Juan County and parts of McKinley, Rio Arriba, Sandoval, Valencia, and Bernalillo Counties. Most of the north rim of the basin is in Colorado where it occupies parts of Archuleta, La Plata, Montezuma, Hinsdale, and Mineral Counties. A narrow part of the west rim of the basin extends into Apache County, Arizona. The area of the San Juan Basin is irregularly circular and includes 15-20 thousand square miles.

Drainage from the central part of the basin is mostly toward the northwest through the San Juan River. To a very considerable extent the basin is coincident with the watershed of the San Juan River and its tributaries. The Chama River, however, drains a small sector in the northeastern part of the basin eastward into the Rio Grande, and two rivers, Rio Puerco of the west and Rio Puerco of the east, drain watersheds in the southwestern and southeastern parts of the basin.

Most of the interior of the basin is open country broken by occasional low mesas, buttes, or wide cuestas. Probably twenty per cent of the area is badland topography. Along the outer part hogbacks and pediments capped with gravel or lava flows are rather common features of the landscape. Valleys in the central part are wide and seldom of great depth. They are commonly flanked by stream terraces. Local relief in the open part of the basin is rarely more than a few hundred feet. Approaching the rim, however, the relief increases to one or two thousand feet, and along the mountain uplifts the relief reaches several thousand feet. Altitudes in the central part of the basin range from 5,000 to 7,500 feet. Altitudes of some of the prominent peaks or ranges are as follows:

North side:	Feet
Babcock Peak, La Plata Mountains	13,150
Mount Eolus, Needle Mountains	14,079
Chama Peak	12,027
Navajo Peak, Chalk Mountains	11,330
East side:	
Brazos Uplift	11,300
San Pedro Mountains	10,000
Pajarito Peak, Nacimiento Mountains	9,042
Cabazon Peak	8,000

South side:	Feet
Mount Taylor	11,326
Mount Sedgwick, Zuni Mountains	9,300

West side:	
Defiance Uplift	8,500
Lukachukai Mountain	9,430
Chuska Mountains	8,900
Pastora Peak, Carrizo Mountains	9,420
Ship Rock	7,178

Relief of the San Juan Basin from the highest bordering peak to a point on the San Juan River where it leaves the basin is about 9,300 feet.

The principal towns on the north side of the basin are Durango, Pagosa Springs, and Cortez, all in Colorado. The villages of Chama, Park View, Tierra Amarilla, and Cuba are along the east edge of the basin. Gallup and Grants are located along U. S. Highway 66 on the south side of the basin. Ship Rock is the only village along the west side, but Farmington and Aztec are in the northwestern part of the basin. Albuquerque and Santa Fe to the southeast and east of the basin enter importantly into the economy of the basin. The basin is crossed by the paved U. S. Highways 66, 84, 160, 550, and 666. One of the principal highways across the basin is New Mexico Highway 44 which crosses the basin diagonally and connects Albuquerque and Durango through Cuba and Aztec.

The narrow-gauge Denver and Rio Grande Western Railroad enters the basin from the northeast through Cumbres Pass and serves Chama, Durango, Aztec, and Farmington in the north and central part of the basin. The southern part of the basin is crossed by the Santa Fe Railroad. Frontier Airlines serves Gallup, Farmington, Durango, and Cortez.

The precipitation varies widely. In the high mountains along the north rim the mean annual snowfall is about 16 feet, whereas in the southern and central parts of the basin the annual rainfall is about 8-15 inches.

Livelihood in the San Juan Basin has diverse bases in petroleum production, coal mining, mineral mining, grazing, farming, and tourist trade. Oil which ranges from about 32°-76° gravity A. P. I. is produced from both deep and shallow horizons. Both "sweet" and "sour" gas are encountered in the basin.

Coal mining is carried on principally near Gallup on the south side of the basin and Durango on the north side. The principal metal-mining activity centers around the Shenandoah-Dives mine and mill at

Silverton in the San Juan Mountains where gold, silver, and base metals are produced. Gold is the chief metal that has been mined in the La Plata Mountains northwest of Durango. Vanadium and uranium are mined in southwestern Colorado, and the Vanadium Corporation of America operates a vanadium and uranium smelter at Durango as agent for the Atomic Energy Commission. Exploration for these metals in the northwestern part of the basin has been spurred by recently reported strikes.

Pumice and fluor spar are mined along the south side of the basin and exploration of perlite deposits is in progress.

Grazing of sheep and cattle on open and fenced lands throughout the basin is one of the principal industries and sources of income in the area. Farming is largely restricted to the principal river valleys where irrigation is possible from permanent streams. However, in many areas some dry farming is practiced. Some lands are irrigated from wells and the entire basin has a structure favorable for artesian water, but it is doubtful whether the Cretaceous or Tertiary rocks contain aquifers capable of producing quantities of water for irrigation or other large uses.

Rocks in and around the San Juan Basin range in age from pre-Cambrian to Recent. Most of the central part of the basin is covered by a circular blanket of continental sediments of early Tertiary or very late Cretaceous age. The area of outcrop of these rocks averages about 90 miles in diameter. Outside these rocks a roughly circular outcrop ring of marine and non-marine Upper Cretaceous formations circumscribes the basin. Bituminous and sub-bituminous coal seams up to 10 feet thick are common in the non-marine beds and a few exploratory wells have cut in excess of 100 feet of coal broken by shale splits. Older sedimentary formations of Mesozoic and Paleozoic age surround the Cretaceous rocks in the foothills and rim areas of the basin. The total thickness of sedimentary rocks in the center of the basin ranges from 10,000-15,000 feet. Many of the sedimentary units are thicker in the central part of the basin and thinner in the flanks of the uplifts bordering the basin. Facies changes around and within the basin occur in many of the formations, and intertonguing of marine and non-marine formations is excellently displayed on a regional scale. Overlapping unconformities and local angular unconformities occur in the flanks of the uplifts around the basin, but in the large central area the beds are probably parallel or sub-parallel throughout the section from the deeply buried early Paleozoic to the surface Tertiary beds.

Structural uplifts and platforms alternate around the broadly downwarped central part of the basin. A pronounced "monoclinical" flexure circumscribes the

central part of the basin on all but its south side. The floor of the basin inside the "monocline" is tilted northward and displacement on the "monoclines" therefore diminishes southward. Oil and gas structures consist principally of domes and faulted noses, and those that are known are located principally in the outer part of the basin. Stratigraphic traps are considered very important to the accumulation of gas.

Geologic exploration in the region of the San Juan Basin dates from the early railroad expeditions in the 1850s. Our present knowledge of the geology of the basin stems primarily from (1) the many U. S. Geological Survey papers on various aspects of stratigraphy, paleontology, structure, and mineral resources, (2) private papers on vertebrate paleontology and stratigraphy, and (3) the oil and gas bulletins of the New Mexico Bureau of Mines and Mineral Resources. Interest in petroleum exploration has been high since World War II. In 1950 the Federal Power Commission granted permission to El Paso Natural Gas Company to build a pipe line to California and as a result interest in exploration will probably continue high for some time.

A dozen or more geological parties have been active in the basin during the past several years. Geophysical exploration which has been carried on in the basin for a number of years, has been principally with seismographs, although many gravity and magnetometer surveys have been made. It is estimated elsewhere in this guidebook that, in all, about 39 crew years of geophysical exploration have been completed in the basin. Much general geologic and geophysical mapping remains to be done, and very little of the area has been mapped in detail by either geological or geophysical methods.

It is estimated elsewhere in this guidebook that of some 8,000,000 acres in the principal part of the basin that 45 per cent is public land; 38 per cent, Indian; 7 per cent, State; 6 per cent, patented; and 4 per cent, railroad.

It is impossible to visit all parts of the San Juan Basin in a satisfactory manner on a three-day field trip. Inasmuch as field trips have been conducted along the south and west sides in recent years, it was decided by the Conference Committee to schedule this trip along the east and north sides of the basin. Although the trip is routed in order to see exposures of most of the geologic column, the emphasis is probably on the pre-Tertiary part of the section. However, exposures of the upper Tertiary rocks are crossed in the Rio Grande Valley early the first day and exposures of the lower Tertiary are crossed later the first day and during the second day. The third day's trip covers the rather striking exposures of the older rocks down to the pre-Cambrian in the rugged margin of the San Juan Mountains.

The scenery throughout the conference will certainly please visitors from Texas and other plains states and in places it might even thrill those from California.

The guidebook consists of nine short papers on the geologic systems represented in the region, several papers of a regional nature which treat the sedimentary and structural history, and special papers concerning mineral resources, geophysical

exploration, drilling practices, marketing, status of land, and history of development and production. Only a little more than two month's time was available in which to compile the guidebook. It is, therefore, almost inevitable that a number of unfortunate omissions and errors will have occurred. It is hoped that these shortcomings, together with the mere existence of this work, may result in better future guidebooks.

NOTES