Line drawing map of area shown in facing LANDSAT photo.
Scientific core hole VC-2B erupting flashed geothermal reservoir fluid during flow tests of November 1, 1991. Reservoir temperature averages 225°C. VC-2B, part of the Continental Scientific Drilling Program, was continuously cored to a depth of 5780 ft with over 99% core recovery, and bottom hole temperature of 295°C. It is the deepest, hottest, continuously cored hole in North America. Well head and valve assembly is more than 6 ft high (see Second-day road log, mile 39.9).
THE JEMEZ MOUNTAINS REGION

Editors

FRASER GOFF
BARRY S. KUES
MARGARET ANNE ROGERS
LES D. McFADDEN
JAMIE N. GARDNER

New Mexico Geological Society
Forty-Seventh Annual Field Conference
September 25-28, 1996
Cliffs of Bandelier Tuff in Ancho Canyon, Pajarito Plateau. Map units A-C (of Rogers, 1995) within the Tshirege Member of the Bandelier Tuff are shown at right.
President's Message .................................................................................................................................................. vi
Editor's Message ......................................................................................................................................................... vii
Committees .................................................................................................................................................................. viii
Field Conference Schedule and Credits .................................................................................................................... ix

ROAD LOGS

First-day road log, from Bernalillo to San Ysidro, southern Nacimiento Mountains, Guadalupe Box, Jemez Springs, Valles caldera and Los Alamos


Minipapers:

Selachian fauna from the Upper Cretaceous (Turonian) Mancos Shale near San Ysidro, New Mexico ........................................................ T.E. Williamson and B.S. Kues 6
Tectonics of the Nacimiento uplift and adjacent areas .................................................................................................................... L.A. Woodward 11
Travertine mound springs along the eastern margin of the San Juan basin, Sandoval County, New Mexico ........................................................................................................................................ R.D. Gardner; L.J. Crmsey, A. Groffman and J. Sterling 12
Warm Spring—the spring that wasn’t...................................................................................................................................................... J.E. Kelly 14
History of formation and drainage of Pleistocene lakes in the Valles caldera........................................................................... J. Rogers, G.A. Smith and H. Rouve 14
Late Paleozoic vertebrates from the Spanish Queen mine locality and vicinity, Sandoval County, New Mexico ............................ A.R. Hunt and S.G. Lucas 22
Pennsylvanian cycles in the Madera Formation of Callon de San Diego ................................................................................... D.R. Swenson 23
Late Paleozoic chondrichthians from the Abo Formation, Sandoval County, New Mexico ................................................................. A.P. Hunt, S.G. Lucas and J. Zidek 28
Pumice deposits in the Jemez Mountains, New Mexico, and pumice mining in the Jemez National Recreation Area ................ M.A. Linden and D.T. Tajo 32
Overview of the fire history in the Jemez Mountains, New Mexico ................................................................................................. C.D. Allen, R. Touchan and T.W. Swetnam 35

Second-day road log, from Los Alamos through Valles caldera and return

J.N. Gardner, E Goff and M.A. Rogers 41

Minipaper:

Reservoir geochemistry from flow tests of scientific core holes, Sulphur Springs, Valles caldera ......................................................................................................................... C.J. Janik and E Goff 52

Third-day road log, from Los Alamos through the southeastern Jemez Mountains via the Dome Road to Cochiti Pueblo and the Rio Grande


Minipapers:

Distal tephra from the Jemez volcanic center as time-stratigraphic markers in ancestral Rio Grande sediments from the Socorro area

N.W. Dunbar, W.C. McIntosh, S.M. Cather, R.M. Chamberlin, B. Harrison and P.R. Kyle 69

A conceptual model for flow in the vadose zone beneath the finger mesas of the Pajarito Plateau ................................................................................................................................. H.J. Turin and N.D. Rosenberg 74

Characteristics of springs in the western Pajarito Plateau, Los Alamos National Laboratory, New Mexico .......................................................... M.R. Dale and S. Yunicak 77

A brief history of the Cochiti mining district ........................................................................................................................................ D. Hoard 81

The terraces of Cochiti Canyon .................................................................................................................................................. S.S. Olig 86

The geology of Tent Rocks ..................................................................................................................................................... S.G. Lucas 89

Road log references ......................................................................................................................................................... 92

ARTICLES

Introduction and History

Introduction: what are the "hot" earth science projects in the Jemez Mountains region? .............................................................. E Goff 99

A history of Los Alamos, New Mexico ........................................................................................................................................ M.B. Chambers and L.K. Aldrich 101

Structure, Tectonics, Geophysics and Economic Geology

Paleotectonics of the late Paleozoic Pecosio uplift, Nacimiento region, northeastern New Mexico ........................................................................................................................................ L.A. Woodward 107

Paleomagnetic studies in the Jemez Mountains, New Mexico: a progress report on Quaternary volcanic rocks from Valles caldera VC-2A.


Gravity modelling of the Valles caldera ........................................................................................................................................ D.A.G. Nouell 121

Magnetotelluric tracing of crustal isotherms under the western margin of the Jemez Mountains using SAGE and industry data


Earthquake potential and ground shaking hazard at the Los Alamos National Laboratory, New Mexico


The earthquake potential of the Pajarito fault system, New Mexico ................................................................................................. S.S. Olig, K.J. Kelso, J.N. Gardner, S.L. Reneau and M. Hemphill-Haley 143

Late Pleistocene and possibly Holocene displacement along the Rendija Canyon fault, Los Alamos County, New Mexico


Mineral resources in the Jemez and Nacimiento Mountains, Rio Arriba, Santa Fe and Los Alamos Counties, New Mexico ........................................................................................................ Virginia T. McLemore 161
Stratigraphy, Sedimentology and Paleontology

Guide to the Late Pennsylvanian paleontology of the upper Madera Formation, Jemez Springs area, north-central New Mexico ......................... B.S. Kues 169
Isotopic and trace-element compositions of Pennsylvanian brachiopods from northern New Mexico ......................... H.-S. Mil, T.E. Yancey and E.L. Grossman 189
Stratigraphy and correlation of Triassic strata around the Nacimiento and Jemez uplifts, northern New Mexico ......................... S.G. Lucas and A.B. Heckert 199
Stratigraphy and depositional environments of Middle and Upper Jurassic rocks, southeastern San Juan basin, New Mexico .................. O.J. Anderson and S.C. Lucas 205
Volcaniclastic rocks of the Keres Group: insights into mid-Miocene volcanism and sedimentation in the southeastern Jemez Mountains ......................... A. Lavine, G.A. Smith, E Goff and W.C. McIntosh 211
What is the Cochiti Formation? .......................................................................................................................... G.A. Smith and A. Lavine 219

Volcanology

Geology of the northern Valles caldera and Toldeo embayment, New Mexico .......................................................... L. J. Gardner and F Goff 225
Outline of the petrology and geochemistry of the Keres Group lavas and tuffs .............................................................. R. Ellisor, J. Wolff and J.N. Gardner 237
Simultaneous phreatomagmatic and magmatic rhyolitic eruptions recorded in the late Miocene Peralta Tuff, Jemez Mountains, New Mexico ......................... K.P. Gay and G.A. Smith 243
Temporal and geochemical trends of lavas in White Rock Canyon and the Pajarito Plateau, Jemez volcanic field, New Mexico, USA .......................................................... G. Wolde Gabriel, A. W. Laughlin, D.P. Dethier and M. Healer 251
Geochronology and geochemistry of the Cerro Toledo Rhyolite .................................................................................. T.L. Spell, P.R. Kyle and J. Baker 263
Hornblende-dacite pumice in the Tsihure Member of the Bandelier Tuff: implications for magma chamber and eruptive processes ......................... J.A. Stithac 269
Zonation of alkali feldspar compositions in the Tsihure Member of the Bandelier Tuff in Pueblo Canyon, near Los Alamos, New Mexico ......................... M.E. Caress 275
Trace element distributions in the upper Bandelier Tuff, New Mexico: zircon zoning and implications for magmatic evolution of the Valles system ........................................................................................................ C. Werner, J.A. Stithac and D. Hickmott 285
Distinguishing tectonic joints from cooling joints in the Bandelier Tuff (Pleistocene), Pajarito Plateau, Los Alamos County, New Mexico .......................................................... M.A. Rogers, K.E. Budding and C.V.L. Christie 293
Quartz in post-caldera rhyolites of Valles caldera, New Mexico: ESR finger printing and discussion of ESR ages .................................. S. Teegda and E Goff 303
Field characteristics of the El Cajete pumice deposit and associated southwestern moat rhyolites of the Valles caldera .... J.A. Wolff, J.B. Gardner and S.L. Reneau 311

Geomorphology and Soils

Pliocene and Quaternary history of the Rio Grande, White Rock Canyon and vicinity, New Mexico ............................................. S.L. Reneau and D.P. Dethier 317
Buried early Pleistocene landscapes beneath the Pajarito Plateau, northern New Mexico ..................................................... D.E. Braxton and S.L. Reneau 325
Quaternary stratigraphy, tectonic geomorphology, and long-term landscape evolution of the southern Sierra Nacimiento, New Mexico ................................................................. M.L. Formento-Trigilio and F.J. Pazzaglia 335
Climatic influences on Quaternary alluvial stratigraphy and terrace formation in the Jemez River Valley ............................................. J.B. Rogers and R.A. Smartt 347
General soil-landscape relationships and soil-forming processes in the Pajarito Plateau, Los Alamos National Laboratory area, New Mexico .......................................................... L.D. McFadden, P.M. Watt, S.L. Reneau and E.V. McDonald 357
Soil-forming processes on the Pajarito Plateau: investigation of a soil chronosequence in Rendija Canyon .................................................. E.V. McDonald, S.L. Reneau and J.N. Gardner 367
Natural major and trace element background geochemistry of selected soil profiles, Los Alamos, New Mexico ............................................................. E.V. McDonald, P.A. Longmore, P.M. Watt, R.T. Royl and S.L. Reneau 373
Eolian dust as a factor in soil development on the Pajarito Plateau, Los Alamos area, northern New Mexico ........................................ P Eberly, L.D. McFadden and P.M. Watt 383
Holocene evolution of canyons and implications for contaminant transport, Pajarito Plateau, New Mexico ......................... P.G. Drakos, J. Lazzaros and C. Inoue 399

Hydrogeology and Hydrology

 Vadose zone infiltration beneath the Pajarito Plateau at Los Alamos National Laboratory ............................................. D.B. Rogers, B.M. Gallaher and E.L. Vold 413
Analysis of water level fluctuations in Pajarito Plateau wells .............................................................................. S.G. McLin 421
The influence of topography, stratigraphy and barometric venting on the hydrology of unsaturated Bandelier Tuff .......... D.A. Neper and R.H. Gilkeson 427
Reference conditions for Los Alamos Laboratory streams using benthic macroinvertebrate assessment in upper Pajarito Canyon ........................................ R.E. Ford-Schnid 441
Some fundamental hydrologic issues pertinent to environmental activities at Los Alamos National Laboratory, New Mexico ......................... W.J. Stone 449

Aqueous Geochemistry

In situ tritium production and fluid mean residence times in the two subsystems of the Valles caldera hydrothermal system, New Mexico . L. Shevenell and E Goff 455
Application of the 31P isotope system to the tracing of hydrothermal fluids at Valles caldera, New Mexico ............................... U. Rao, U. Fehn, E Goff and R. Teng 463
Preliminary assessment of radionuclide transport via storm-water runoff in Los Alamos Canyon, New Mexico ......................... M.R. Dale 469
Arsenic stratification in the Santa Fe Formation, Bernalillo, New Mexico ........................................................................ T.E. Kelly and S. Reinert 481
This guidebook is dedicated to the memory of Pat Dunigan, who developed the philosophy of protection and preservation of this unique natural wonder, the Valles caldera; and additionally to those of the Baca Land & Cattle Co. who have carried this philosophy through to this day.

Pat Dunigan grew up in the oil business. His grandfather ran an oil field shop in Pennsylvania. His father expanded that business into Oklahoma and then Texas where he was considered one of the real pioneers in oil development. Pat Dunigan expanded the family business further.

Before entering college in 1945, he served in the Army Air Corps during World War II. He held degrees from The University of Texas at Austin and New York University. Trained in banking and finance, he joined his father's firm, Dunigan Tool & Supply Co., in 1950 and became president in 1962. Besides the energy field, Pat Dunigan's interests included the financial, banking, investment, and development fields. His purchase of the 100,000 acre Baca Ranch in 1963 served a variety of his interests. The ranch tract, part of an exchange for a disputed Spanish land grant, contains the Valles caldera.

The Baca is a working ranch where Pat Dunigan explored geothermal resources and established the selective cutting of timber from old stands of trees.

Margaret Anne Rogers
“They were the youngest of mountains, they were the oldest of mountains...” Where else in the world can we stand in a fifteen mile-wide Quaternary caldera and look ten miles west for the record of a Proterozoic crustal collision? The Valles Caldera of the Jemez Mountains and the Precambrian remnants of the Yavapai and Mazatzal terranes exposed in the Nacimiento Mountains represent some of the youngest and oldest evidence exposed in New Mexico of the spectacular geologic history that came before geologists to New Mexico. This region, in close proximity to Los Alamos National Laboratories, is the setting for the 1996 New Mexico Geological Society Fall Field Conference.

Your New Mexico Geological Society is very healthy financially, with liquid assets over $210,000 and a publications inventory valued at over $350,000! Last year was an excellent, albeit anomalous year. We logged $109,000 of income against $71,000 of expenses, primarily due to generous scholarship donations and the exceptional performance of our investments. Publication sales continue to be our strongest source of income, constituting one-third of the total. NMGS will award over $7,000 of scholarships in 1996, to support both undergraduate and graduate geoscience education in New Mexico. Through prudent management of our assets, we're able to offer our members world-class field conferences and high-quality guidebooks at reasonable prices.

Our 1997 Fall Field Conference will be held in the Four Corners region of northwestern New Mexico and adjacent areas of Utah, Colorado, and Arizona. Trip leaders Orin Anderson and Spencer Lucas promise enlightening stops and exciting presentations. In 1998, we'll visit the "Las Cruces country" of south-central New Mexico, showcasing many of the new geological insights gained since our last trip there in 1975! In 1999 we'll hold the 50th NMGS field conference, and we're planning an appropriately "golden" Fall Field Conference and guidebook. Also scheduled for completion in 1999 is a revised Highway Geological Map, based on the new digital geologic map of New Mexico being assembled by the NMBM&MR and including the latest satellite imagery.

The first NMGS Field Conference was held in 1950, with Vin Kelley as general chairman, Charlie Read as road logging chairman, and Clay Smith as logistics coordinator. Harrison Schmitt was NMGS president, and E.J. Workman and Tom Popejoy welcomed the society to their turf. This year we owe our gratitude and appreciation to General Co-Chairmen Margaret Anne Rogers and Barry Kues. Margaret Anne has made an especially significant contribution this year, well beyond the "pulling a rabbit out of a hat" that our chairmen historically accomplish. Margaret Anne was instrumental in securing access for our contingent onto the rarely visited Baca Ranch, comprising some of the most scenic and geologically significant portions of the Valles Caldera. We sincerely thank the Baca Land and Cattle Company and Walt Cramer, its president, for permission to spend the second day of the field conference on their land. Support from geoscientists at Los Alamos National Laboratory has also been critical to the success of this field conference, reflected in the numerous papers, major road-logging participation, and financial support to publish a longer guidebook than in previous years. With 50 papers and about 500 pages, this hard-cover guidebook will be the largest publication the society has ever produced. Barry has performed double duty this year, as co-chairman and managing editor of this year's voluminous guidebook. Margaret Anne and Barry have also managed the Herculean task of road logging, trip logistics and organizing the efforts of many volunteers. Charles Chapin has been a contributing member of the New Mexico Geological Society for many years, and Chuck continues to support NMGS as Director of the New Mexico Bureau of Mines and Mineral Resources. Norma Meeks (publications) and Debbie Goering (membership) are two NMBM&MR staffers whose dedicated service continues to keep NMGS running through annual Executive Committee transitions.

Many other volunteers too numerous to name have contributed to the success of this year's field conference and guidebook. I encourage and challenge all members to become more actively involved. Your NMGS is one of this country's premier regional geological societies, due to the quality of its membership and the hard work of an army of volunteers. THANKS TO YOU ALL!

David Schoderbek
EDITOR'S MESSAGE

This is the first time that a New Mexico Geological Society Field Conference has focused entirely on the Jemez Mountains region. Previous trips through this area were long ago and relatively brief—the third day of the 1962 conference (Albuquerque-Jemez Springs-Los Alamos-San Felipe Pueblo), and the third day of the 1974 conference (Abiquiu-Los Alamos-Jemez Springs-Bernalillo). Articles or photos touching upon the geology of the Jemez Mountains region have also appeared in Guidebooks 30 (1979), 33 (1982), 35 (1984), 43 (1992) and 46 (1995). It seems that the Jemez Mountains region is a part of a lot of people's "country," but has never received a thorough examination by the N.M.G.S. before. This conference is overdue, as the Jemez Mountains combines wonderful scenery, diverse and world-renowned geological features, and intensive recent studies by many investigators, some from perspectives not available or considered important in the 1960s and 1970s. The great interest in the Jemez region by dozens of earth scientists at numerous institutions is amply demonstrated by the size of this guidebook—with 50 papers, three detailed road logs, and about 500 pages, this is the largest single volume ever published by the New Mexico Geological Society.

This field conference was first proposed by Cochairman and Coeditor Margaret Anne Rogers in 1986, as a possibility for 1989. It has taken 10 years for this Jemez Mountains conference to become a reality, and the fact that we will be seeing and learning about this area in detail in 1996 is in large part due to Margaret Anne's tenacious efforts at all levels through the years. The conference was conceived and proposed to represent the incredible variety of geoscience research that has been, and is being conducted in this region. We hope that this conference and guidebook do justice to these goals. The composition of this guidebook speaks for those who truly believe that significant scientific advances can be made from our collective observations, studies and experiences.

We enjoy, with this guidebook and conference, the rich geoscientific offerings of this region only with the extraordinary hard work and commitment and generous cooperation of many people. Production of this book was aided greatly by support from Los Alamos National Laboratory, by the careful word-processing of edited manuscripts by Lynne Hemenway and Terry Tellis (N.M. Bureau of Mines and Mineral Resources), and by the traditional high-quality work of the folks at UNM Printing Services, especially Don Leister. Walt Cramer and Brian Dunigan, Baca Land and Cattle Company, allowed access to Baca Ranch lands for road logging and photography, the results of which constitute the second-day road log. And of course, there would be no guidebook without the contributions of the authors of its contents. This year, more than 130 different individuals participated as authors of the articles and road logs, bringing together an enormous amount of information that will make this volume an indispensable reference for all who are interested in the geology and geological environment of the Jemez Mountains.

We also acknowledge the contributions of many other individuals and institutions below, who assisted with the guidebook and/or the field conference, although we realize that there may be some who contributed whose names do not appear here. To all of these folks, our heartfelt thanks are no less sincere.

In somewhat random order, we thank EES-1, CST-7, the Environmental Restoration Program, Seismic Hazards Program and Geothermal Program at Los Alamos National Laboratory; Pat Longmire, Bill Sprouse, Diane Banegas, Anthony Garcia, Eric McDonald and Cindy Werner, Los Alamos National Laboratory; Christie Rogers, University of Texas, Austin; Jemez and Zia Pueblos; Santa Fe National Forest; John Corbin of Sulphur Springs; Ken Horton, Los Alamos Police Department; George Young, La Mesa Search and Rescue; Heddy Dunn, Los Alamos Historical Society; Georgia Strickfaden, Buffalo Tours; John Rhoades, Bradbury Science Museum; the Los Alamos Chamber of Commerce; Los Alamos Aquatronics Swim Team, United Methodist Women of Los Alamos; Tom Merson, Los Alamos Geological Society; and the County of Los Alamos.

Fraser Goff Barry Kues, Margaret Anne Rogers, Les McFadden, Jamie Gardner
COMMITTEES

1996 EXECUTIVE COMMITTEE

David A. Schoderbek, President................................................................. Meridian Oil
James C. Wither, Vice President ................................................................. New Mexico State University
Gretchen K. Hoffman, Treasurer ............................................................... New Mexico Bureau of Mines and Mineral Resources
Gary A. Smith, Secretary ......................................................................... University of New Mexico
Richard M. Chamberlin, Past President .................................................. New Mexico Bureau of Mines and Mineral Resources

FIELD CONFERENCE

Barry S. Kues, General Co-chairman ..................................................... University of New Mexico
Margaret Anne Rogers, General Co-chairman ....................................... MARA, Inc., Los Alamos

GUIDEBOOK

Fraser Goff, Editor.................................................................................. Los Alamos National Laboratory
Barry S. Kues, Managing Editor ................................................................. University of New Mexico
Margaret Anne Rogers, Editor ................................................................. MARA, Inc., Los Alamos
Leslie D. McFadden, Editor ................................................................ University of New Mexico
Jamie N. Gardner, Editor ........................................................................ Los Alamos National Laboratory

ROAD LOGS

Fraser Goff ............................................................................................. Los Alamos National Laboratory
Margaret Anne Rogers ............................................................................. MARA, Inc., Los Alamos
Barry S. Kues ........................................................................................... University of New Mexico
Steven Reneau ........................................................................................ Los Alamos National Laboratory
Gary A. Smith ........................................................................................ University of New Mexico
Frank J. Pazzaglia .................................................................................. University of New Mexico
Lee A. Woodward .................................................................................... University of New Mexico
Spencer G. Lucas ................................................................................... New Mexico Museum of Natural History
David Broxton ........................................................................................ Los Alamos National Laboratory
Patrick Longmire .................................................................................... Los Alamos National Laboratory
Giday WoldeGabriel ............................................................................. Los Alamos National Laboratory
Alexis Lavine ........................................................................................ University of New Mexico
Scott Aby ................................................................................................ University of New Mexico

REGISTRATION

Barry S. Kues ........................................................................................... University of New Mexico

LOCAL ARRANGEMENTS

Margaret Anne Rogers ............................................................................. MARA, Inc., Los Alamos
Tom Merson ............................................................................................ Los Alamos Geological Society

TECHNICAL ASSISTANCE

Halliburton Logging Services ................................................................. Mobile Sound Equipment

PUBLICATIONS COMMITTEE

James M. Barker ..................................................................................... New Mexico Bureau of Mines and Mineral Resources
Richard Chamberlin ............................................................................. New Mexico Bureau of Mines and Mineral Resources
Bruce Hart ............................................................................................... New Mexico Bureau of Mines and Mineral Resources

PUBLICATION SALES

Norma Meeks ........................................................................................ New Mexico Bureau of Mines and Mineral Resources
FIELD CONFERENCE SCHEDULE

Wednesday, September 25—Registration Day
4:00-8:00 p.m. Registration at Sheraton Uptown Hotel, northeast corner of Menaul and Louisiana, Albuquerque
5:00-8:00 p.m. Icebreaker and snacks, Sheraton Uptown

Thursday, September 26—First Day
7:00 a.m. Assemble at First Day starting point, north side of Bernalillo
12:00 noon Lunch provided
6:00 p.m. Arrive in Los Alamos
6:30 p.m. Banquet buffet at Fuller Lodge, Los Alamos; tours of nearby Los Alamos Historical Museum and Los Alamos Lab Museum
8:30 p.m. Speaker: Hal K. Rothman, Historian, "The Pajarito Plateau Before the Bomb."

Friday, September 27—Second Day
6:00 a.m. Breakfast at Sullivan Field, Diamond Drive, Los Alamos
7:00 a.m. Depart from Sullivan Field in 15-passenger vans
12:00 noon Lunch provided
5:30 p.m. Return to Los Alamos
6:00 p.m. Barbecue dinner at North Mesa picnic grounds, Los Alamos

Saturday, September 28—Third Day
6:00 a.m. Breakfast at Sullivan Field, Los Alamos
7:00 a.m. Depart from Sullivan Field
12:00 noon Lunch provided
5:30 p.m. Field Conference ends at Tent Rocks, near Cochiti Pueblo

CREDITS

Front Cover: Generalized map of the Jemez Mountains region, Fraser Goff, Los Alamos National Laboratory.

Front End Sheets: Satellite photo of the Jemez Mountains region, courtesy of Los Alamos National Laboratory.

Logistical Assistance: Los Alamos Chamber of Commerce; Tom Merson, Los Alamos Geological Society; Capt. Ken Horton, Los Alamos Police Department; Santa Fe National Forest; John Corbin, Sulphur Springs; Los Alamos First United Methodist Women.

Extraordinary Assistance: General thanks to Los Alamos National Laboratory, EES and CST Divisions, for financial support, logistical assistance, and access to some LANL areas.

Photography and Figures: Filler photos and captions provided by Los Alamos National Laboratory; figure preparation, Anthony Garcia of EES-1 (LANL), and Kathryn Glesener, N.M. Bureau of Mines and Mineral Resources.


Printing and Graphic Design: University of New Mexico Printing & Quick Copy Services.

COPYRIGHT© 1996 by the New Mexico Geological Society, Inc.

The articles and road logs in this guidebook were prepared for the 47th annual field conference of the New Mexico Geological Society, held in north-central New Mexico on September 25-28, 1996. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the New Mexico Geological Society, Inc.