Service/News

Only starred items (*) are available from New Mexico Bureau of Mines & Mineral Resources

New publications

NMBMMR

***Geologic Map 59**—Geology of South Peak quadrangle, Luna County, New Mexico, by R. E. Clemons, 1985, scale 1:24,000 $4.50
(Released in August 1985; announced in February 1985.)

USGS

CIRCULARS

904–A—Geologic and hydrologic characterization and evaluation of the Basin and Range Province relative to the disposal of high-level radioactive waste; part I, Introduction and guidelines, by M. S. Bedinger, K. A. Sargent, and J. E. Reed, 1985, 16 pp. (supersedes Open-file Report 83–759).

949—USGS research on mineral resources—1985—program and abstracts (V. E. McKelvey forum on mineral and energy resources), edited by Kathleen Krafft, 1985, 72 pp.

GEOLOGICAL QUADRANGLE MAP

GQ–1583—Geologic map of the Oak Spring quadrangle, McKinley County, New Mexico, by A. R. Kirk and R. S. Zech, 1985.

MISCELLANEOUS INVESTIGATIONS SERIES MAPS

I–1522–D—Selected geologic and hydrologic characteristics of the Basin and Range Province, western United States; Pleistocene lakes and marshes, by T. R. Williams and M.S. Bedinger, 1984, scale 1:2,500,000.

I–1522–E—Selected geologic and hydrologic characteristics of the Basin and Range Province, western United States; coal, oil and gas wells, seeps, and tar sandstone occurrences, by B. T. Brady, 1984, lat. about 29° to about 44°, long. about 102° to about 123°, scale 1:2,500,000, 1 sheet.

I–1523—Map showing distribution, composition, and age of late Cenozoic volcanic centers in the western conterminous United States, by R. G. Luedke and R. L. Smith, 1984, scale 1:2,500,000.

I–1571—Chaco Culture National Historical Park—geology and archeology, by G. R. Scott, R. B. O'Sullivan, D. L. Weide, and W. B. Gillespie, 1984, scale 1:50,000.

MISCELLANEOUS FIELD STUDIES MAP

MF–1465–B—Map of Quaternary and Pliocene faults in the eastern part of the Aztec 1° by 2° quadrangle and the western part of the Raton 1° by 2° quadrangle, northern New Mexico, by M. N. Machette and S. F. Personius, 1984, lat. 36° to 37°, long. about 105° 30′ to 107°, scale 1:250,000.

MF–1726—Geologic map of the Togeye Lake quadrangle, Cibola and McKinley Counties, New Mexico, by W. J. Mapel, 1985, scale 1:24,000.

MF–1727—Geologic map of the Goat Hill quadrangle, Cibola County, New Mexico, by W. J. Mapel and W. L. Yesberger, 1985, scale 1:24,000.

***MF–1750**—Geologic map of the Fence Lake SW quadrangle, Cibola and Catron Counties, New Mexico, by E. R. Landis, M. W. McLellan, E. J. McKay, M. D. Carter, and A. L. Medlin, 1985, scale 1:24,000.

MF–1757—Geologic map of the Nicoll Lake quadrangle, Cibola and McKinley Counties, New Mexico, by W. J. Mapel, 1985, scale 1:24,000.

MF–1758—Geologic map of the Red Lake Mission quadrangle, Cibola County, New Mexico, by W. J. Mapel and W. L. Yesberger, 1985, scale 1:24,000.

WATER RESOURCE INVESTIGATIONS

WRI–82–555—Geohydrology of the central Mesilla Valley, Doña Ana County, New Mexico, by C. A. Wilson and R. R. White, 1984, 144 pp.

WRI–83–4038—Water resources on the pueblo of Laguna, west-central New Mexico, by D. W. Risser and F. P. Lyford, 1983, 308 pp., 3 sheets.

WRI–84–4205—Waste Isolation Pilot Plant, New Mexico; hydrology, by J. W. Mercer *in* U.S. Geological Survey research in radioactive waste disposal—fiscal year 1982, edited by Robert Schneider and N. J. Trask, 1984, p. 32.

WRI–84–4255—Aquifer tests at the Jackpile–Paguate uranium mine, pueblo of Laguna, west-central New Mexico, by D. W. Risser, P. A. Davis, J. A. Baldwin, and D. P. McAda, 1984, 26 pp.

WRI–84–4260—Use of selected basin characteristics to estimate mean annual runoff and peak discharges for ungaged streams in drainage basins containing strippable coal resources, northwestern New Mexico, by H. R. Hejl, Jr., 1984, 17 pp.

WRI–84–4268—Potential incremental seepage losses in an alluvial channel in the Rio Grande basin, New Mexico, by R. L. Gold, 1985, 22 pp.

WATER-SUPPLY PAPER

2241—Floods of November 1978 to March 1979 in Arizona and west-central New Mexico, by B. N. Aldridge and T. A. Hales, 1984, 149 pp., 2 sheets.

New Mexico Energy Research and Development Institute

2–71–4333—Steamflood pilots in the O'Connell Ranch Field and the T-4 Ranch Field, by F. D. Martin, J. L. Garlough, C. C. Joy, J. C. McKallip, Jr., and G. L. Scott, 1985.

Other publications

Depositional trends in Upper Paleozoic terrigenous clastic rocks, Sacramento Mountains, New Mexico, by D. L. Carr, 1985: The Mountain Geologist, v. 22, no. 1, pp. 17–27.

Ecofacies transect of the Lake Valley shelf, San Andres Mountains, New Mexico, and its relation to the Early Mississippian Orogrande Basin, by Thomas DeKeyser, W. F. Mullican, III, J. E. Barrick, and C. J. Grossnicklaus, 1985: American Association of Petroleum Geologists, Southwest Section, Transactions 1985, pp. 68–81.

Permian shelf calcrete, Shuttuck Member, Queen Formation (southeast New Mexico)—shelfal expression of Middle Guadalupian fall in sea level, by J. F. Sarg, 1985: West Texas Geological Society, v. 24, no. 8, pp. 8–16.

The petrology and geochemistry of the Ocate volcanic field, north-central New Mexico, by R. L. Nielsen and M. A. Dungan, 1985: Geological Society of America, Bulletin, v. 96, pp. 296–312.

Petrophysics of the Morrow Formation, southeastern New Mexico, by G. A. Hillis, 1985: American Association of Petroleum Geologists, Southwest Section, Transactions 1985, pp. 157–173.

Open-file reports

NMBMMR

***211**—Preliminary report on the geology and mineral-resource potential of the northern Rio Puerco resource area in Sandoval and Bernalillo Counties and adjacent parts of McKinley, Cibola, and Santa Fe Counties, New Mexico, compiled by V. T. McLemore, G. H. Roybal, R. F. Broadhead, R. M. Chamberlin, R. M. North, J. C. Osburn, B. W. Arkell, R. M. Colpitts, M. R. Bowie, K. Anderson, J. M. Barker, and F. W. Campbell, 1984, 817 pp., 45 tables, 28 figs., 22 over-sized figs., 8 appendices, 54 maps $277.40
Executive summary, 39 pp. $7.80

***223**—Uranium geology and production history of the Sanostee area, San Juan County, New Mexico, by W. L. Chenoweth, 1985, 40 pp., 1 table, 3 figs. $8.00

***224**—Paleontological inventory and proposed mitigation program, San Juan coal mine, by D. L. Wolberg, J. H. Hartman, and D. J. Bobrow, 1985, 39 pp., 3 figs. $8.30

***225**—El Llano and vicinity geotechnical study—interim report; preliminary results of ground subsidence investigation, compiled by G. D. Johnpeer, D. W. Love, J. W. Hawley, D. J. Bobrow, M. Hemingway, and R. W. Reimers, 1985, 398 pp., 1 table, 12 figs., 21 appendices, 11 trench logs, 4 geophysical profiles, 6 maps $92.35

***227**—Geology and coal resources of Wild Horse Canyon quadrangle, Catron and Cibola Counties, New Mexico, by J. C. Osburn, 1985, 29 pp., 4 tables, 2 figs., 2 over-sized, reproducible maps $8.80

USGS

***84–448**—Rainfall-runoff data in the Albuquerque, New Mexico, metropolitan area, 1976–83, by E. E. Fischer, J. J. Rote, and J. P. Borland, 1984, 306 pp.

***84–629–A–M**—Mineral resource potential of the Silver City 1° by 2° quadrangle, New Mexico–Arizona; **A**, Geologic map; **B**, Copper resource potential; **C**, Molybdenum resource potential; **D**, Zinc and lead resource potential; **E**, Gold and silver resource potential; **F**, Tin resource potential; **G**, Iron, nickel, and cobalt resource potential; **H**, Manganese and manganese-iron resource potential; **I**, Tungsten and beryllium resource potential; **J**, Uranium resource potential; **K**, Fluorite resource potential; **L**, Zeolites and diatomite resource potential; **M**, Area in which resource potentials are designated and area in which no resource potential is designated, by D. H. Richter and W. N. Sharp, 1984, all scales 1:250,000, 1 over-sized sheet for each map.

New Project

USGS

9590–03919—Late Cenozoic mammalian paleoecology of the Basin and Range Province, by C. A. Repenning. A recent discovery of a fossil northern bog lemming at the foot of Ranier Mesa (Nevada) indicates that an environment characterized by a high water table and moist meadows or forests existed about 400,000 years ago and that such an environment could return to portions of the Basin and Range Province. If so, this would make nuclear waste storage in the presently unsaturated rocks in the Yucca Flat valley unsuitable. The purpose of this project is to document the history of climatic changes in the Basin and Range Province in as much detail as possible over the past 850,000 years, the period of maximum glaciations. Southern rodent biochronologies will be collected in central and western New Mexico.

Abstracts

New Mexico Geological Society

The New Mexico Geological Society held their annual spring meeting at New Mexico Institute of Mining and Technology (Socorro) on April 26, 1985. Following are abstracts from talks given at the meeting that concern New Mexico.

AN ISOTOPIC INVESTIGATION OF GROUND WATER IN THE CENTRAL SAN JUAN BASIN, NEW MEXICO—PALEOCLIMATIC IMPLICATIONS, by *M. K. Tansey*, IT Corporation, 2340 Alamo SE, Albuquerque, NM, and *F. M. Phillips* and *L. E. Peeters*, Geoscience Department, New Mexico Institute of Mining and Technology, Socorro, NM

Carbon-14, oxygen-18, deuterium, and noble gases were measured in 35 wells and springs in the Ojo Alamo Sandstone, Nacimiento Formation, and San Jose Formation of the central San Juan Basin, New Mexico. Carbon-14 dating was performed by five methods of correcting for dilution of ground water during recharge by nonradioactive carbon. Despite some differences between the isotopic exchange processes considered by each method, the correction techniques provided a reasonably consistent range of ground-water ages. The calculated ages ranged from modern to greater than 35,000 years B.P. and formed a hydrologically plausible age-distribution pattern. Oxygen-18 and deuterium concentrations exhibited significant correlations with ground-water ages. Paleoclimatic temperatures were calculated from the shifts in stable isotope concentrations relative to the meteoric water line. Noble gas paleothermometry provided some independent verification of the stable isotope temperatures. The temperature pattern indicates a climatic warming beginning at 23,000 B.P. continuing until approximately 17,000 B.P. This correlates well with the early melting of San Juan Mountain glaciers. Although data are limited, the Holocene period appears to be characterized by the continuation of cooler temperatures until around 7,000 B.P. when climatic warming occurred. Stable isotope shifts were also used to estimate relative ground-water recharge rates, and they provided reasonable correlation with lake level fluctuations estimated by independent methods. Indications are that higher than normal recharge occurred before 22,000 B.P. and again during the period from 19,000 to 17,000 B.P. Typical Holocene recharge rates appear to be comparable to modern ones. An important advantage of the stable isotope methods is that both temperature and precipitation, as reflected by ground-water recharge, can be separated and studied as independent factors, which is not usually possible by paleobotanical techniques.

AN INTEGRATED ISOTOPIC/PHYSICAL APPROACH TO A NUMERICAL MODEL OF GROUND-WATER FLOW IN THE SAN JUAN BASIN, NEW MEXICO, by *M. K. Tansey*, IT Corporation, 2340 Alamo SE, Albuquerque, 87106, and *F. M. Phillips*, Geoscience Department, New Mexico Institute of Mining and Technology, Socorro, NM

A quasi-three-dimensional numerical model of groundwater flow in the Tertiary aquifers of the central San Juan Basin was developed. The modeled aquifer system included the Pictured Cliffs Sandstone, Kirtland–Fruitland Shale, Ojo Alamo Sandstone, Nacimiento Formation, and San Jose Formation. In the majority of the study area, the hydrogeologic data necessary for ground-water modeling was sparse and would have been unrealistically difficult to obtain by traditional methods. However, the potential for future ground-water development makes a quantitative ground-water flow model desirable. To obtain the required data, a combination of carbon-14 ground-water ages, electrical resistivity and heat-flow logs, and water levels in wells and springs was employed. Aquifer hydraulic conductivities were determined from the groundwater ages and hydrogeological characteristics. Preliminary estimates of aquitard hydraulic conductivities were made from heat-flow data. Formation thicknesses were obtained from electrical resistivity logs. Transmissivities calculated from these data compared favorably with values determined by traditional aquifer pumping tests. The input data required at nodal points in the finite difference ground-water flow model were obtained by kriging and trend surface analysis of the observed hydrogeological parameter distributions. An additional benefit resulting from the use of kriging was the development of a quantitative index of confidence to be placed in model results. The flow model was calibrated by adjusting the hydraulic conductivity of the aquitard layers until agreement with observed water levels in the Ojo Alamo Sandstone, Nacimiento Formation, and San Juan River was obtained. After conversion of constant head to constant flux boundary conditions, a transient simulation of a proposed well field pumping 24,000 acre-ft/yr was performed. The results indicated that significant changes in regional water levels would occur and that flow in the San Juan River would be reduced slightly in the area of Navajo Reservoir within five years of the inception of ground-water pumping. The non-traditional approach employed in this study provided a means to make a preliminary assessment of the effect of a potential, major ground-water development in the San Juan Basin that would not have been possible to accomplish by customary methods.

CHEMICAL ANALYSES OF TIME-DEPENDENT SAMPLES OF GROUND WATER COLLECTED DURING PUMPING TESTS IN NEW MEXICO, by *W. K. Summers* and *Geraldine Schwab*, W. K. Summers and Associates, Inc., Socorro, NM 87801 and *L. A. Brandvold*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Chemical analyses of 46 time-dependent samples of ground water from 11 wells in four geologic settings illustrate the problem of obtaining a "representative water sample." Samples were obtained when seven new wells were pumped for the first time and during pumping tests of four old wells. Pumping rates ranged from <1 gpm to >200 gpm. Pumping periods ranged from <60 minutes to 48 hours. From three to six samples were collected from each well. The constituents analyzed for included: SiO_2, Ca, Mg, Na, K, Fe, Mn, HCO_3 + CO_3, SO_4, Cl, F, NO_3, P_2O_5, Se, As, Pb, Zn, Co, and Cu plus pH and specific conductance. Not all samples were analyzed for all constituents. The concentration of a specific constituent in serial samples from a well might: 1) remain the same in all samples, 2) vary systematically, or 3) differ inexplicably between samples. The systematic variations seem to represent the production of water from the casing, water in close proximity to the well, or water with components that have longer flow paths. The systematic variations reflect the use of galvanized pipe for the pump column, the effect of the atmosphere on the dissolved gasses in water stored in the casing, and terrain factors. The random variations may reflect sampling procedures, analytical techniques, or actual variations in the water sampled.

THE LAS CRUCES GEOTHERMAL FIELD—A FLOW MODEL, by *James T. Gross* and *Thomas H. Giordano*, Department of Earth Science, New Mexico State University, Las Cruces, NM

An integrated investigation of the Las Cruces geothermal field is currently in progress. A preliminary flow model based on geological, geophysical, and geochemical data is proposed. Temperature-gradient holes have defined the shape and magnitude of the heat-flow anomaly east of Las Cruces, New Mexico. A positive gravity anomaly is congruent with the thermal feature, suggesting structural and lithologic controls on reservoir flow. Magnesium-corrected Na–K–Ca and chalcedony geothermometers indicate a reservoir equilibration temperature of 75°C. Downhole temperatures at the western boundary of the surface thermal anomaly are approximately 25°C. A simple thermodynamic model for the reservoir based on data from 300- to 1,200-m-deep wells and integrated surface heat-flow data predicts a volume flux through the reservoir of 2.2 million m^3/yr. Geochemical and piezometric data indicate that discharge is to the west into the Santa Fe Group aquifers. Further geochemical and isotopic work is underway to better define the recharge area for the reservoir and to constrain physical conditions in the reservoir.

A PRELIMINARY INTERPRETATION OF SOME COMPOSITIONAL AND TEXTURAL GRADIENTS ACROSS A MAFIC FACIES OF THE ORGAN NEEDLE QUARTZ MONZONITE, NEW MEXICO, by *Joan B. Beyer, M. McCurry*, and *W. R. Seager*, Department of Earth Science, New Mexico State University, Las Cruces, NM

The Organ Needle quartz monzonite was the earliest major intrusive phase of the late Oligocene Organ Mountain batholith. An anomalously mafic facies that initially occurred at the center of the intrusion has been sampled for geochemical and petrographic analysis at approximately 85-m intervals that are perpendicular to the intrusive contacts. Preliminary petrographic and field data indicate that the mafic facies has an overall outward concentric zonation from monzodiorite to monzonite, and that it is also completely gradational into the surrounding quartz syenite. Compositional heterogeneities on a scale of centimeters to a few meters across suggest the existence of partial mechanical mixing within the body. The mafic facies probably originated as an upward pulse of relatively undifferentiated magma within a compositionally zoned magma chamber, which occurred in response to the rapid extrusion of more highly differentiated magma from the top of the chamber.

THERMAL MATURATION OF THE MESILLA VALLEY FORMATION (LATE ALBIAN) ON THE NORTH AND EAST FLANKS OF THE CERRO DE CRISTO REY PLUTON, DOÑA ANA COUNTY, NEW MEXICO, by *William D. Norland*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

Intrusion of the Muleros Andesite pluton (middle Eocene) into Cretaceous rocks in southern Doña Ana County resulted in an increase in the local geothermal gradient. Shale, siltstone, and limestone samples were collected in the Mesilla Valley Formation at 1.5-m intervals along radial traverses extending outward from its contact with the Muleros Andesite. Particulate organic matter (kerogen) was freed from these samples by acid maceration and has been examined, via light microscopy, to determine its thermal maturity, or Thermal Alteration Index (TAI). TAI values ranging from 1–5 record color changes from yellow to brown to black and indicate immature, mature, and metamorphosed facies of organic matter. Within 10 m of the Muleros Andesite–Mesilla Valley Formation contact, kerogen is highly volatilized and consists mostly of black, carbon-rich, inertinite particles whose TAI = 5. Ten to 32 m from the contact, dinoflagellate cysts, spores, pollen, and amorphogen are moderately to poorly preserved, are brown to brownish black, and have a TAI of 3–4. One hundred sixty to 200 m from the contact, color of the kerogen, including dinoflagellate cysts, spores, pollen, and amorphogen, ranges from brown to brownish black, TAI equals 3–4, and preservation is markedly improved. These TAI values indicate that temperature exceeded 200°C up to 10 m from the pluton, but was as low as 150°C 200 m from the contact. Hydrocarbons generated by contact metamorphic effects have since been lost through erosion. Outside the metamorphosed zone, TAI values of 2–3 suggest that hydrocarbon generation may be occurring in parts of the Mesilla Valley Formation. Because the kerogen is chiefly of marine origin, the formation should be oil-prone.

A MODEL FOR THE ORIGIN OF JONES CAMP DIKE MAGNETITE DEPOSITS, SOCORRO COUNTY, NEW MEXICO, by *John E. Jenkins*, Geoscience Department, New Mexico Institute of Mining and Technology, Socorro, NM

The Jones Camp dike magnetite deposits in eastern Socorro County are an example of a hydrothermal replacement-type deposit. Other similar iron deposits occur in Lincoln, Grant, and Sierra Counties. The Jones Camp deposits contain significant tonnage of high-grade ore, and they are the subject of renewed interest in mining and development. The ore occurs as conformable pods of variable thickness, strike length, and grade. They are spacially associated with the central Jones dike and subsequent dikes and sills, which provided the principal avenues for the ascending hydrothermal solutions as well as the heat source for the system. The intensely altered margins of the Jones dike are depleted in iron and are recognized as the principal source of the metal. The ore is nonspecific with respect to host rock and occurs as replacements of carbonate, sandstone, and gypsum of the Permian Yeso, Glorieta, and San Andres Formations. Lesser amounts are hosted by altered igneous rocks. Fluid inclusion data obtained from secondary calcite cogenetic with magnetite mineralization yielded temperatures of 135–185°C. The system was determined to be nonboiling and under a hydrostatic pressure of about 154 bars. Primary fluid inclusions usually contained daughter crystals of anhydrite and occasionally halite. Lack of experimental data in the literature with respect to systems high in sulfate precluded an estimate of the salinity in terms of NaCl equivalents; however, the inclusions were recognized as

hyper-saline on the basis of extreme difficulty in freezing and the occurrence of immiscible liquids on heating (Roedder, 1984). The solubility of magnetite in high-temperature saline solutions is pH dependent and decreases with temperature to a minimum in the range of 140–160°C. Magnetite is more soluble in low pH solutions. The principal chemical control on the replacement process is probably due to reciprocal reactions between the dissolution of the sedimentary rocks by hydrolysis (hydrogen-ion-consuming reactions) and the precipitation of magnetite which produces hydrogen ions according to the reaction: Fe (divalent) + 2 Fe (trivalent) + 4 H_2O = = = Fe_3O_4 (magnetite) + 8 H (univalent).

How do you want 9,347,473 acres of national forest land in New Mexico managed?, by *Tom Collins*, Minerals Management USDA, Forest Service (R–3), Albuquerque, NM

Precedent-setting land management plans are being developed for each of the six national forests in New Mexico. These plans, called "Forest Plans," will set direction for management of all natural resources (including mineral/geologic resources) on 9,347,473 acres of national forest land in New Mexico. Public participation is the prime mover in the planning process. The course and final destination of planning is a response to various public interests (recreation, environment, industry, professions, etc.) and to the resource issues and opportunities they raise. If an interest group "misses the boat," the Forest Plan may miss or treat inadequately their particular resource interest. In contrast, if an interest group gets "on board," the Forest Plan will be influenced by their interest, information, and insight. Will the planners give due consideration to mineral/geologic resources along with other natural resources? The answer depends on how much interest, information, and insight about mineral/geologic resources emerges during the planning process. The Forest Service encourages public comments on Forest Plan drafts. Your comments are invited.

Explosive rhyolitic volcanism in the Jemez Mountains—vent and caldera locations and relationship to regional structures, by *S. Self* and *J. V. Wright*, Department of Geology, University of Texas (Arlington), Arlington, TX, and *F. Goff, J. Gardner*, and *G. Heiken*, Earth and Space Science Division, Los Alamos National Laboratory, Los Alamos, NM

Explosive rhyolitic eruptions from a large, compositionally zoned magma body have occurred in the Jemez Mountains volcanic center of New Mexico for the past 3 ± 1 m.y. Grain-size characteristics, dispersal patterns, and facies variations in Plinian pumice and pyroclastic flow deposits around the Jemez Mountains indicate vent locations and their relationship to caldera sites. Early eruptions (about 3 m.y. ago) from the magma body produced at least two high-silica rhyolitic ignimbrites that are restricted to the southwest part of the Jemez Mountains. Studies of lithic breccia zones in the ignimbrites indicate that they probably came from calderas in the southwest part of the present Valles caldera. Each of the Bandelier Tuff ignimbrite eruptions (1.45 and 1.12 m.y. ago) began with a Plinian phase from a vent or vents located in the central part of the Jemez Mountains. Early pyroclastic flows issued from the same sites, then a transition to vents located along incipient caldera ring-fractures took place. Ring-fracture vents cannot be located accurately, but they may have lain where the ring-fracture system crossed the regional Jemez fault zone trend. The location of both Plinian vent sites and both calderas (Toledo and Valles) of the Bandelier eruptions were remarkably similar. Another, more conjectural, caldera lies in the site of the Toledo embayment, northeast of the Valles caldera; it may be a caldera associated with eruptions from the Tschicoma Mountain volcanic center. Eruptive vents and loci of the calderas in the Jemez Mountains caldera complex fall along a zone that coincides with the Jemez fault zone. This zone, the local expression of a Precambrian basement feature known as the Jemez lineament, has exerted a strong influence on eruptions from the Jemez Mountains rhyolitic magma system.

Silicic pyroclastic deposits of the Puye Formation, Jemez Mountains, New Mexico, by *B. N. Turbeville* and *S. Self*, Department of Geology, University of Texas (Arlington), Arlington, TX

The late Pliocene Puye Formation is a 2–3 m.y. old volcaniclastic alluvial-fan sequence that formed contemporaneously with the later stages of activity within the Tschicoma volcanic center in the northeast part of the Jemez Mountains, north-central New Mexico. Interstratified with fan sediments are significant volumes of primary and reworked pyroclastic fall, flow, and surge deposits of both mafic and felsic composition. These provide datable time planes and allow fan evolution to be monitored in detail. The petrography, granulometric characteristics, and facies relationships of silicic pyroclastic deposits can be used to constrain a model of dome growth during periods of explosive eruption and erosion of the volcanic center. The Puye fan is dominated by epiclastic material derived from intermediate to felsic volcanoes of the Tschicoma center and, to a lesser extent, by Rio Grande rift basalts. Pumice and ash are major components in many of the fluvial, lacustrine, and sediment-gravity flow deposits. Dacitic to rhyodacitic pyroclastic fall and surge deposits probably represent Plinian-style eruptions intimately associated with effusive phases that produced voluminous lava flows and domes in the Tschicoma center. Also interstratified within the fan sequence are several nonwelded pyroclastic flow deposits that can be related to both climactic explosive episodes and large-scale gravitational collapse of growing lava domes. Pyroclastics from the Tschicoma center range in composition from dacitic with two-pyroxene–pl–mt–qt assemblages to hydrous rhyodacitic pl–qt–hbl–bt assemblages. Rhyolitic tephra containing qt–pl–ksp–mt forms deposits with abundant obsidian clasts believed to have been derived from the El Rechuelos center farther north. The youngest fall deposits differ from the aforementioned compositions. They closely approximate lower Bandelier Tuff compositions and may have been derived from the same source.

Stratigraphic framework of the Pliocene Puye Formation, Española Basin, north-central Rio Grande rift, New Mexico, by *John G. McPherson, Damon B. Waresback*, and *Jack R. Flannery*, Department of Geology, University of Texas (Arlington), Arlington, TX

The Puye Formation is an infilling of the Velarde graben on the western side of the Española Basin. It overlies the Chamita Formation, in places with a gradational contact. This sedimentological transition represents a pronounced change in fluvial systems associated with the linking of contiguous and drainage-independent rift basins by a common axial drainage. The lower member of the Puye Formation (Totavi member) is a coarse-grained conglomeratic sequence of braided stream origin and represents the newly acquired axial drainage deposits. The upper unit of the Puye (San Ildefonso member) is composed of the marginally derived epiclastic and pyroclastic deposits shed from a growing dacitic Tschicoma dome complex in the northeastern Jemez Mountains. The volcaniclastics prograded eastward as a large alluvial-fan system that displaced the rift axial drainage. Concomitant basaltic volcanism in the southern Velarde graben is represented in the Puye Formation by intercalations of lavas and phreatomagmatic ashes. Recent fossil evidence has established a late Hemphillian age (4.0 ± 0.5 m.y.) for the basal San Ildefonso member in the type section. The youngest San Ildefonso beds are considered to be of early Pleistocene age and thus the member represents continuous fan sedimentation close to the time of the lower Bandelier Tuff eruption (1.4 m.y.).

Geology, geochemistry, and Sr-isotope systematics of Polvadera Group rocks, northern Jemez volcanic field, New Mexico, by *Bradley S. Singer*, Department of Geology, University of New Mexico, Albuquerque, NM

Basaltic andesite, andesite, dacite, and rhyodacite of the Pliocene Polvadera Group on La Grulla Plateau display smooth, continuous major-element trends. The northeast margin of La Grulla Plateau is the locus for structurally controlled basaltic andesite volcanism; a 100 m section of olivine-bearing basaltic andesite flows of the Lobato Formation increase from 53 to 60% SiO_2 from base to top with sympathetic Fe enrichment of olivine, orthopyroxene, and clinopyroxene phenocrysts. Uppermost flows are much reduced in SiO_2 (53–54%). The main vent is characterized by 100+ m of pyroclastic ejecta intruded by an endogenous dome of more highly evolved composition (64% SiO_2), which may represent a link to younger dacitic magmatism. Dacite and rhyodacite domes (64–70% SiO_2) of the younger Tschicoma Formation also are structurally controlled by high-angle, rift-marginal faults and are younger than the Tschicoma andesite (61–64% SiO_2) on which they sit. These dacites and rhyodacites are enriched in incompatible trace elements and radiogenic strontium relative to other similar rocks previously described from the Polvadera Group. Although major-element trends in the basaltic andesite, and possibly in more evolved rocks, could easily be accounted for by fractionation of known phenocryst assemblages, trace-element data, in addition to heterogeneous $^{87}Sr/^{86}Sr$ measurements ranging from .7051 to .7071, suggest a more complex history involving mixing of parental basaltic magma or magmas (e.g., Lobato basalt) with mid-to-upper crustal rocks in varying proportions. Combined assimilation–fractional crystallization could produce the trace-element and strontium isotopic trends in all rock types. This interpretation is supported by mineralogical evidence for contamination (such as resorbed quartz in basalts and basaltic andesites) and chemical evidence in favor of fractionation (as described above).

The geology, petrology and weathering of extrusive rocks, Tetilla Peak, New Mexico, by *Michael E. Jackson*, Department of Geology, University of New Mexico, Albuquerque, NM

Detailed geologic and petrologic studies of extrusive rocks from Tetilla Peak, New Mexico, permit evaluation of the influences of geomorphic and pedogenic processes on the chemical and mechanical weathering of parent materials. Basaltic andesites, andesites, and dacites of Tetilla Peak were extruded approximately 2.5 m.y. ago. The oldest flow in the area is a low silica (54.6%) basaltic andesite with large phenocrysts of hornblende, plagioclase, and trace hypersthene and augite. Above this are hornblende andesites (SiO_2 = 57.2%) grading into a hornblende-poor, pyroxene-rich andesite (SiO_2 = 61.9%). Capping the volcano is a dacite flow (SiO_2 = 63.6%) with microcrystalline plagioclase, acicular hornblende and Fe–Ti oxides. Mechanical weathering resulted in the formation of two pediment surfaces with soil profiles that reveal a continuous coating of dense, laminar secondary carbonate. Andesite clasts within the calcic horizon and fresh andesite parent material are chemically identical. Moreover, weathered material shows no chemical alteration at the andesite–carbonate interface. This suggests the formation of the carbonate rind produces a barrier that impedes chemical alteration of the andesite. The carbonate is neither a product of chemical alteration nor a result of precipitation from ground water but a result of eolian influx of dust, which subsequently precipitates to form a pedogenic calcic horizon.

Petrology and geochemistry of inclusions in alkali–olivine basalts, Elephant Butte area, New Mexico, by *John C. Kelly, Bradley S. Singer*, and *Albert M. Kudo*, Department of Geology, University of New Mexico, Albuquerque, NM

Eruption of alkali-olivine basalt has dominated Quaternary volcanism in the area east of Elephant Butte Reservoir. Cinder cones with 60–70 m of relief are built on thick sequences of pyroclastic debris, basalt flows, cone sheets, and radial dikes. The base of South Larson cone's northern flank is underlain by a volcanic vent breccia. Several varieties of lithic and single-crystal inclusions occur both within this breccia and in adjacent flows. Lithic inclusions include granulites (hypersthene + oligoclase + sanidine + quartz) and spinel lherzolites (forsterite + bronzite + augite + spinel). Megacrysts include anhedral vitreous augite, subhedral anorthoclase, and rare olivine. Petrological and geochemical data suggest a cognate origin for the megacrysts with respect to host basalts. Trace-element compositions for both augite and anorthoclase megacrysts relative to host basalt compare favorably to experimental partition coefficients. Similar initial $^{87}Sr/^{86}Sr$ values for the anorthoclase megacryst and host basalt (.7038 and .7036, respectively) further support a cognate origin. Lherzolite xenoliths possessing a metamorphic fabric could represent upper mantle residua related to generation of the basalts. Elevated present $^{87}Sr/^{86}Sr$ values of .7239 and .7385 for two granulite inclusions indicate a crustal origin. Two-pyroxene geothermometry on spinel lherzolite inclusions yield equilibration temperatures in the range of 1170–1240°C. A pressure-dependent two-feldspar geothermometer was used to calculate upper and lower limit temperatures of 800 and 950°C for granulite inclusions. ☞

BEDROCK INFLUENCE ON SEMIARID DRAINAGE BASIN EVOLUTION IN THE SOUTHEASTERN COLORADO PLATEAU, NEW MEXICO—IMPLICATIONS FOR EVALUATION OF STABLE LANDSCAPES, by *Thomas F. Bullard*, Department of Geology, University of New Mexico, Albuquerque, NM

Soils–geomorphic studies and basin morphometric and morphologic analysis form the basis for evaluating the influence of differing bedrock lithology on the geomorphic evolution of Kim-me-ni-oli Wash drainage basin. Evolution of tributary basins within the study area, preservation and distribution of surficial deposits, soil development, landscape stability, and erosion and transport of sediment have been influenced by bedrock. Early basin history was marked by uniform degradation relative to dynamic erosion and deposition during the Holocene. Ephemeral, discontinous Kim-me-ni-oli Wash (1,200 km^2), a southern tributary to Chaco River, traverses gently north-dipping Cretaceous strata. Mudstones and resistant channel sandstones dominate lower and middle basin regions (lower 55 km); sandstones and shales underlie upper basin regions (upper 35 km). Middle and upper basin regions preserve landscapes possessing well-developed soils. Isolated remnants of older landscapes in lower basin regions are associated with resistant bedrock and record former base levels. Small tributary basins in upper basin regions have consistent ranges in relief; relief ratio decreases proportional to increasing distance of tributary basin outlet to Kim-me-ni-oli Wash; basin shape and hypsometric integral increase proportionally with distance (i.e., basins are more circular and less eroded as distance increases). Lower basin regions did not respond uniformly or systematically to base-level lowerings despite proximity to Chaco River; resistant sandstones inhibited uniform base-level migration and resulted in wide ranges in relief, variable hypsometry, and areas of temporary landscape stability. Local, stable landscapes are dissected where tributary basin rejuvenation occurs by breaching of resistant sandstones and/or modification of valley fill by complex geomorphic response, which results in local base-level change. Stripping of sandy surficial mantles increases exposure of less permeable bedrock units and results in variable sediment yield and basin hydrology.

GIGANTIC BELLEROPHONTID GASTROPODS FROM THE PENNSYLVANIAN OF THE MUD SPRINGS MOUNTAINS, NEW MEXICO, by *Barry S. Kues*, Department of Geology, University of New Mexico, Albuquerque, NM

The Mud Springs Mountains, a few miles northwest of Truth or Consequences, contain a Pennsylvanian section more than 1,700 ft thick (Kottlowski, 1960). The paleontology of the Pennsylvanian units is incompletely known, and the mollusc faunas have not been studied. In the summer of 1984, two UNM geology students discovered unusually large bellerophontid shells in a thin, dark-gray shale in the NW1/4 sec. 30, T. 13 S., R. 4 W. (0.7 mi east of Mud Mountain). Subsequent collecting by me has produced more than 60 specimens, together with a small sample of the associated fossils. The stratigraphic position of this assemblage is about 375 ft above the base of the Pennsylvanian, and its age is Desmoinesian, based on Kottlowski's determination of the Atokan–Desmoinesian boundary at 225 ft and the presence of the characteristic Desmoinesian brachiopods *Mesolobus* and *Antiquatonia hermosana* in a limestone immediately below the gastropod unit. The bellerophontids, an undescribed species of *Bellerophon* (*Bellerophon*), are far larger than most members of this subgenus—the largest individual has a length of about 80 mm and a maximum width at the anterior margin that slightly exceeds the length. These specimens are also characterized by a broad, conspicuously elevated median ridge containing the selenizone. The only other North American Pennsylvanian species that attains this size, *Bellerophon giganteus* Worthen, is based on steinkerns, and the name is considered a *nomen dubium* (Yochelson, 1960). Steinkerns of *B.* cf. *giganteus* have been reported from the Missourian and Virgilian of the Nacimiento uplift in north-central New Mexico (Wood and Northrop, 1946). The Mud Springs Mountains specimens appear to be the first giant representatives of *Bellerophon* from the Pennsylvanian that are known from well-preserved shells. The shale unit that yielded these specimens contains a sparse, generally poorly-preserved, mollusc-dominated fauna. Other gastropods identified are *Strobeus* sp., *Straparollus* (*Amphiscapha*) sp., *S.* (*Euomphalus*) sp., *Naticopsis* sp. *Stegocoelia* (*Taosia*) sp., *Worthenia* cf. *tabulata*, cf. *Paragoniozona multilirata*, and *Microdoma*? n. sp. The last three species and all of the genera are also present in the Desmoinesian part of the Flechado Formation near Taos (Kues, 1984).

PALEOCURRENT AND FACIES ANALYSIS OF THE ABO FORMATION IN THE ZUNI MOUNTAINS, NEW MEXICO, by *John R. MacMillan*, Geoscience Department, New Mexico Institute of Mining and Technology, Socorro, NM

At least two siliclastic facies occur within the exposed lower two-thirds of the Permian red bed Abo Formation where it nonconformably overlies the Precambrian crystalline core of the Zuni Mountains. A ≤ 2-ft-thick carbonate micrite–biomicrite/mudstone–wackestone with dominantly molluscan macrofauna occurs within the basal 70 ft of the Abo on both the northeast and southwest flanks of the Zuni Mountains. Below the carbonate unit the Abo Formation contains alluvial-fan deposits of interbedded gray, tan, and red mudrocks and pebbly, moderately to poorly sorted, very coarse to coarse-grained, dominantly internally structureless sandstones, which have erosional lower contacts and locally contain medium-scale (5 cm to 1 m) tabular–planar and trough–tangential sets of crossbeds. Higher in the Abo, the abundance of mudrocks increases; thin (< 5 ft) fine-grained overbank sandstones and thicker medium-grained, braided-channel sandstones occur as lenses in the mudrocks. On the southwest flank of the Zuni Mountains the vector mean paleocurrent direction is S. 40 W. in the alluvial-fan facies and S. 15 W. in the overlying braided-channel facies. On the northeast flank of the Zuni Mountains the vector mean paleocurrent direction is N. 28 W. in the alluvial-fan facies and N. 13 W. in the braided-channel facies. Both these facies and their paleocurrent directions document the Zuni–Defiance uplift as the local source area of the Abo Formation in the Zuni Mountains.

FLUVIAL EVOLUTION IN THE PERMIAN ABO AND LOWER YESO FORMATIONS, SAN DIEGO CANYON AREA, SANDOVAL COUNTY, NEW MEXICO, by *Jeff P. Crabaugh* and *John G. McPherson*, Department of Geology, University of Texas (Arlington), Arlington, TX

The Abo and lower Yeso Formations in the southeastern Nacimiento and southwestern Jemez Mountains constitute an alluvial-plain red bed sequence. The mudstones, feldspathic sandstones, and intraformational conglomerates represent the deposits of an evolving fluvial system within the distal reaches of a large clastic wedge. Three major lithofacies associations, two within the Abo Formation and one within the overlying Yeso Formation, delineate distinct fluvial settings. The lowermost division (unit A) is mudstone dominant with isolated fine- to medium-grained, composite channel sandstone sheets. These sandstones commonly show a progressive upward decrease in the scale of internal bedforms with a lower scour surface containing intraformational conglomerate. Associated overbank mudstones contain fully developed, laterally extensive caliche horizons attesting to prolonged periods of subaerial exposure. The middle division (unit B) is characterized by thick multilateral channel sandstones and thinner mudstones. The sandstones are coarse-grained and contain intraformational conglomerate. The uppermost division (unit C; lower Yeso Formation) is dominated by ripple-laminated and horizontally bedded, very fine grained sandstone sheets and is gradational with overlying Yeso eolian deposits. The fluvial sequence from unit A to unit B represents the transition from a mixed-load to a bedload fluvial system. The transition to unit C reflects a change to sheetflood, ephemeral-stream-controlled sedimentation. Tectonism and climate serve as the first-order controls on these fluvial transitions.

SEDIMENT TEXTURAL CHARACTERISTICS OF THE POINT LOOKOUT FORMATION, SOUTHEASTERN SAN JUAN BASIN—RELATION TO DEPOSITIONAL PROCESSES, by *Robyn Wright*, Department of Geology, University of New Mexico, Albuquerque, NM

Five major depositional environments preserved within the progradational sequence of the Point Lookout Sandstone are: offshore transition zone, shoreface/delta front, foreshore, lower coastal/delta plain, and upper coastal/delta plain. Reflecting the relative influence of low wave energy, moderate tidal strength, and locally moderate fluvial input, these environments are stacked vertically into two idealized sequences dominated by wave and deltaic processes, respectively. Total distribution in sand size for the Point Lookout falls within the narrow 2.0–4.0 phi range transported within the fluvial channels of the Menefee Formation. In spite of this narrow range in source material, subtle vertical differences in mode, standard deviation, and modal constancy serve to distinguish lower shoreface, upper shoreface, delta front/estuarine, and fluvial sandstones. Typically applied bivariate plotting methods are unsuccessful in distinguishing these facies. A distinct sediment textural progression characterizes each of the two basic vertical sequences and can be used to augment paleoenvironmental interpretations based on independent field relationships. Results suggest that vertical textural progressions may be a useful diagnostic tool in ancient sandstones, including those for which the total range in grain size is narrow and which display diagenetic complications.

CF. *EDMONTOSAURUS* SP. AND TURONIAN SCAPHITE FROM THE MAASTRICHTIAN NAASHOIBITO MEMBER, KIRTLAND SHALE, SAN JUAN BASIN, NEW MEXICO, by *Spencer G. Lucas*, *C. Wayne Oakes*, and *Adrian Hunt*, Department of Geology, University of New Mexico, Albuquerque, NM

University of New Mexico (UNM) specimen FKK-200 is a partial skeleton of a hadrosaurian dinosaur, cf. *Edmontosaurus* sp. It was collected in the NE1/4NW1/4NW1/4 sec. 7, T. 24 N., R. 11 W., San Juan County, New Mexico, from fine-grained, clayey, white to pinkish-gray sandstone of the Naashoibito Member of the Kirtland Shale, 6.8 m below the Naashoibito–Ojo Alamo Sandstone contact. Longitudinal fractures on some bones of UNM FKK-200 ("stage I weathering") and the skeletal elements present (girdles, sacrum, ribs) and their degree of disarticulation in the sediment suggest less than three years of subaerial weathering was followed by burial of an incomplete, though fairly coherent, carcass in a stream channel. The probable occurrence of *Edmontosaurus* documented by UNM FKK-200 is consistent with assignment of a Lancian age to the Naashoibito. The matrix within the ribs of UNM FKK-200 contained a complete adult body chamber of the scaphite *Scaphites whitfieldi* (UNM FKK-201; identification confirmed by W. A. Cobban, written comm. 1984). *S. whitfieldi*, a Turonian scaphite typically found in the Juana Lopez Member and D-Cross Tongue of the Mancos Shale in New Mexico, must be reworked in the Naashoibito because this unit is demonstrably Maastrichtian and terrestrial in origin. Two possibilities follow: 1) the hadrosaur ingested a fossil scaphite while feeding, possibly to serve as a gastrolith, or 2) part of the source terrain of the Naashoibito exposed Turonian marine rocks from which the scaphite was removed and redeposited by streams.

SHOULD THE TERM "SANTA FE GROUP" BE ABANDONED?, by *Spencer G. Lucas*, Department of Geology, University of New Mexico, Albuquerque, NM

In 1869 Hayden originally applied the term "Santa Fe marls" to the "recent marls and sands which seem to occupy the greater portion of the valley of the Rio Grande above and below Santa Fe." Subsequently, Darton (1922) and Denny (1940) recognized the Santa Fe Formation with its type area being "the region north of Santa Fe, New Mexico, between the Sangre de Cristo and Jemez Mountains," i.e., the Española Basin. Baldwin (1956) and Spiegel and Baldwin (1963) raised the term Santa Fe to group status, and the term Santa Fe Group has long been used by most geologists to include all Upper Cenozoic (Miocene and younger) rocks in the Rio Grande rift. Such broad application of the term Santa Fe Group needs to be reconsidered for two reasons: 1) Santa Fe Group as presently used refers to a very heterogenous and diverse array of sedimentary and volcanic rocks deposited in different basins under a wide range of structural and volcanic settings, and 2) with minor exceptions, rocks of the Santa Fe Group in each of the many basins of the Rio Grande rift have been formally divided into formations and members. These two observations suggest that the term Santa Fe Group either is misleading (it creates a false impression of lithologic homogeneity for rocks in the Rio Grande rift) or is unnecessary (more precise stratigraphic terms are available for virtually all rocks in the Rio Grande rift). In light of this, either the term Santa Fe Group should be abandoned or its usage should be restricted to refer to rocks of its type area.

EOCENE SEDIMENTATION AND TECTONICS, SAN JUAN BASIN, NEW MEXICO, by *Larry N. Smith*, Department of Geology, University of New Mexico, Albuquerque, NM

The fluvial San Jose Formation was deposited unconformably across pre-Eocene rocks during early Eocene–Laramide tectonism in the San Juan Basin and the San Juan, Brazos–Sangre de Cristo, and Nacimiento uplifts. The basal sheet sandstone of the San Jose, the Cuba Mesa Member, is overlain by the mudrock-dominated Regina, and sandstone-dominated Llaves Members. Most San Jose sandstones have sheet-like geometries. The sheets are composed of crosscutting multistoried channels that contain basal, intraformational mudrock and quartzite conglomerate and very coarse grained, large-scale, trough cross-stratified sandstone. Small-scale and epsilon cross stratification and mudrock-filled channels are preserved locally. Sediment-dispersal patterns were derived from paleocurrent analysis of trough cross-stratified sandstones throughout the formation's 8,500 km^2 outcrop area. Data for the Cuba Mesa and Regina Members indicate paleotransport towards the south and southwest, away from the San Juan and Brazos–Sangre de Cristo uplifts, and around a subdued Nacimiento uplift. Llaves Member paleotransport directions are to the west and southwest, away from the Brazos–Sangre de Cristo uplift. The Cuba Mesa Member is interpreted to have been accreted laterally by south-flowing streams during base-level stability following tectonism and erosion. Disconnected sandstone bodies and angular unconformities along the eastern margin of the basin in the Regina Member, and west-directed paleoslopes in the Llaves Member suggest basin subsidence concurrent with uplift of the Brazos–Sangre de Cristo and Nacimiento blocks. This early Eocene tectonism may have been a precursor of segmentation of the southern Sangre de Cristo uplift that occurred during middle Eocene Galisteo–El Rito Basin initiation.

PREDICTION AND TESTING OF COLLAPSING SOILS IN NEW MEXICO, by *Richard L. Reimers* and *Gary D. Johnpeer*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

The increasing occurrence of structural failure due to foundation conditions has prompted a number of geotechnical investigations in New Mexico. An important cause of some of these failures is collapsible soil. Collapsing soils generally consist of loose, open-structured, low-density, dry, medium- to fine-grained material that compacts appreciably when wetted. Applied loads can cause differential settlement that can lead to the total destruction of a structure. Damage to roads crossing collapsing soils that have been insufficiently prepared has also been reported in New Mexico. Thorough geotechnical studies are both expensive and time-consuming. There is little agreement among workers as to which techniques best define collapsing soil. To define and delineate areas of collapsible soil the following series of field and laboratory techniques is suggested to predict soil stability: aerial photographic interpretation, grain-size analyses, Atterberg Limit soil tests, moisture content testing, and standard penetration and dry density tests. Other tests that may enhance the above techniques include SEM and x-ray diffraction analyses for soil structure and clay mineralogy. Finally, modified and double consolidation tests and direct shear strength tests on soil with natural water content and in a saturated condition complete the suggested suite of tests for predicting collapsible soils. The choice and extent of preconstruction soil treatment such as wetting, compacting, or grouting can be better determined if soil properties, determined with these techniques, are known.

Energy and Minerals Department, Annual Resources Report, 1984

URANIUM, by *W. O. Hatchell*, Bureau of Geology, Energy and Minerals Department, Santa Fe, NM, pp. 39–52.

New Mexico's share of total U.S. uranium recovery declined to 24% in 1983, ending a 27-yr period when the state consistently led the nation in uranium recovery. New Mexico has traditionally accounted for 45–50% of total annual U.S. uranium recovery since 1956. With overall domestic production continuing to decline in response to an oversupply of uranium and reduced growth projections for the electrical utility industry, the total share of uranium recovered from in situ and by-product operations in the U.S. has increased from 18% in 1981 and 24% in 1982 to 28% in 1983. In situ and by-product recovery is low cost in comparison with recovery from ore. In New Mexico, where uranium is produced using conventional underground mining and milling, production has declined by 70% from the peak year of 1978 compared to much smaller declines from peak production years in Wyoming (56%), in Texas (51%), and in the U.S. as a whole (52%). During 1983, uranium production was reported from 13 mines, all in Cibola and McKinley Counties, operated by Quivira (subsidiary of Kerr-McGee), Homestake, and Gulf. Total production was at only 44% of mine production capacity with 813,078 tons of ore mined, together with 86,322 tons of stockpiled material, and shipped to the two operating mills—Quivira and Homestake. Average mined ore grade was 0.238% U_3O_8 compared to 0.121% in 1981 and 0.179% in 1982. Average production depth was 1,282 ft. All production was from sandstone-type deposits in the Westwater Canyon Sandstone and Brushy Basin Members of the Morrison Formation (Jurassic). Licensed mill capacity was 10,400 tons per day with only 41.8% of that utilized for the year. Average mill recovery of U_3O_8 contained in millfeed was 96.7%. Approximately 108 tons of the 2,550 tons of U_3O_8 recovered came from mine waters processed through ion exchange (IX) units. Undisclosed quantities of both molybdenum and vanadium concentrates were also recovered. The average full-recovery cost for all New Mexico producers in 1983 was $32.23 per lb of U_3O_8. State receipts for severance, resource excise, and conservation taxes amounted to $4.6 million. Compared to the peak production year of 1978, uranium-generated revenues declined by more than 78%. Approximately 1,350 people were employed in the uranium mining and milling sector in 1983. These workers accounted for approximately 28% of total domestic uranium mining and milling employment. Uranium-related employment in New Mexico exceeded 7,000 in each year from 1977 through 1980.

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COMPOSITIONS OF BRINES IN HALITE FROM THE LOWER SALADO FORMATION, SOUTHEASTERN NEW MEXICO, by C. L. Stein and J. L. Krumhansl, p. 667.

New Mexico Bureau of Mines and Mineral Resources staff notes

Robert Weber retired in July after 35 years of service and was appointed Emeritus Senior Geologist by the New Mexico Tech Board of Regents. Richard Chamberlin, Dave Love, Donald Wolberg, and Jiri Zidek were awarded tenure by the Regents. John Hawley is on sabbatical leave at Los Alamos from July to December to work on Quaternary geology of New Mexico and the young fault zones in the Jemez Mountains area. Mike Gobla joined us as Manager of the Information, Resource, and Service Center. Stella Smith replaced James Brannan, who moved to Albuquerque, as a drafter; Cecilia Rosacker is the new Coal Lab Technician. Anniversaries of people who had five or more years of service from March to August were Robert Bieberman, 35; Frank Kottlowski, 34; Charles Chapin, 15; Judy Vaiza, 11; Norma Meeks and Marshall Reiter, 10; Barbara Popp, Bob Osburn, and Jeanette Chavez, 7; Orin Anderson, Richard Chamberlin, Frank Campbell, and Ruben Archuleta, 6; and Lynne McNeil, Gretchen Roybal, Dave Love, and Virginia McLemore, 5.

The interim report on the ground subsidence study in Española, called "El Llano and vicinity geotechnical study," was available in April. Contributors include Gary Johnpeer, Dave Love, John Hawley, Danny Bobrow, Mark Hemingway, George Austin, and Fritz Reimers. Much overtime work was done by professional staff as well as by James Brannan, Lynne McNeil, Judy Vaiza, and Cherie Pelletier with help from Kathy Campbell, Irean Rae, Lois Devlin, Jeanette Chavez, and Marie Chavez. In May, Gary Johnpeer, George Austin, Dave Love, and John Hawley reported on the Española Subsidence Project to state officials in Santa Fe.

Chuck Chapin was an invited speaker at Washington University in St. Louis, where he gave lectures on the Rio Grande rift, ash-flow tuffs, and Eocene tectonics and sedimentation. Bob Osburn also gave a talk there on volcanic stratigraphy.

Bill Stone visited people working on the Salt River project in Phoenix about a ground-water study for the proposed Fence Lake-area coal mine. A paper by Bill, "Dakota aquifer system in New Mexico," was published in the proceedings of the *Dakota Aquifer Symposium*. An article by G. B. Allison, Bill Stone, and M. W. Hughes entited "Recharge in karst and dune elements of a semi-arid landscape as indicated by natural isotopes and chloride" was published in *Journal of Hydrology*. Bill Stone will give a talk at the 2nd International Congress on Mine Waters entitled "Assessing impact of surface mining on recharge."

Orin Anderson and Gary Stricker gave a talk entitled "Pre-Laramide tectonics—a possible control on the locus of Turonian–Coniacian paralic coal basins in west-central New Mexico" at the AAPG Rocky Mountain Section meeting in Denver. Ron Broadhead gave a poster session at the same meeting on the Santa Rosa Sandstone in east-central New Mexico. Orin Anderson gave a talk at the Bureau–Geoscience seminar on the Pleistocene geology of southwestern Afghanistan, and, at the EMD task force meeting in Grants, he gave a talk called "Abandoned uranium mines in Grants, Poison Canyon, and Ambrosia Lake areas." At the EMD meeting Kay Hatton reported that the 1984 coal production for New Mexico was 21,222,803 tons and that it sold for $407 million.

Bob North gave a talk in Las Vegas on "Mineral collecting localities in New Mexico" for the Great Basin Chapter of Friends of Mineralogy; he also set up a mineral exhibit at the Albuquerque Gem and Mineral Show. Jim Barker gave a talk at the Sevilleta National Wildlife Refuge Research Conference entitled "Origin of Riley travertine"; he also spoke at the AIME meeting on "Commodity agreements in the elemental sulfur industry."

Frank Kottlowski participated in the Department of Interior's Mineral Policy Workshop in Reno; he also chaired the Federal Liaison Committee of the Association of American State Geologists (AASG) for their session in Washington, D.C. with Secretary Hodel, Assistant Secretaries Broadbent and Griles, and representatives from the USGS, USBM, BLM, MMS, OM, EPA, and congressional subcommittees. Judy Vaiza scheduled the arrangements for the federal meeting. Frank is now the President of AASG.

Jane Love, Deborah Shaw, and Carol Hjellming participated in the regional Society for Technical Communication workshops on technical editing and writing. Jeanette Chavez, Marie Chavez, Lynne McNeil, Norma Meeks, Guadalupe Williams, and Judy Vaiza attended a telephone techniques seminar in Albuquerque.

Dave Love represented the Bureau at the New Mexico Geographic Information Advisory Committee meeting in Albuquerque. Dave plans to give a poster session at the 3rd International Fluvial Sedimentology Conference entitled "Sediment sorting in bedforms of the Rio Grande in central New Mexico," which was part of a talk he gave at the Tech hydrology seminar last spring. Jim Barker, Ron Broadhead, and Fred Phillips have been chairing and scheduling papers for the Bureau–Geoscience seminar series.

Bob Eveleth and Jane Ohl co-wrote the 1983 *USBM Minerals Yearbook* chapter entitled "Mineral industry of New Mexico." Mark Bowie gave his talk on the Dripping Springs and Buckhorn zeolites, co-written with Jim Barker, at the Industrial Minerals Symposium.

At the Denver x-ray conference, Mark Tuff gave a talk on "Contamination of silicate rock samples due to crushing and grinding" and Jacques Renault gave two talks, "Geochemistry XRF in an academic/service environment" and "Multiple regression approach to quantitative XRD analyses."

Don Wolberg was appointed to the Paleontologic Advisory Committee of the New Mexico Natural History Museum. Jiri Zidek is our representative on the Energy Publications Council. Diane Murray, Ron Broadhead, Mike Harris, Carol Hjellming, Ted Eggleston, and Jamie Robertson were judges at the state Science Fair. JoAnne Osburn and Brian Arkell wrote and checked roadlogs for the Cretaceous coal field trip for the Southwest AAPG meeting. Diane Murray prepared the Information, Resource, and Service Center monthly reports for January through March. Mike Gobla attended the sedimentation-ponds hearing conducted by the Bureau of Surface Mining in Santa Fe. Mike Harris talked about metallurgy at the Native Americans symposium.

George Austin chaired the spring technical meeting of the New Mexico Geological Society in Socorro; Ron Broadhead was the registration chairman, and he was assisted by Jeanette Chavez and Annabelle Lopez; Norma Meeks and Orin Anderson handled publications; John MacMillan was the program chairman. Abstracts from the talks given at the meeting that concern New Mexico can be found in this issue (pp. 64–67).

Funding was obtained for the cooperative project with the BLM on mineral assessment of large parts of northwest New Mexico. George Austin will be the administrative manager; Virginia McLemore will be the principal investigator, aided by Richard Chamberlin, Jim Barker, Ron Broadhead, Bob North, Mike Gobla, Diane Murray, Orin Anderson, JoAnne Osburn, Gretchen Roybal, Brian Arkell, and Frank Campbell.