Service/News

Starred items (*) only available from New Mexico Bureau of Mines & Mineral Resources

Announcements

Las Cruces district grows

As a result of the recent merger of the Minerals Management Service (MMS) and the Bureau of Land Management (BLM), boundary changes have been made in the District Office in New Mexico. The Jornada Resource Area (Socorro County) has been consolidated with the San Augustine Resource Area (Catron County) to become the Socorro Resource Area under the Las Cruces District. The Socorro Resource Area will be headquartered in Socorro.

SEPM short course

Patterns of sedimentation, diagenesis, and hydrocarbon accumulation in Cretaceous rocks of the Rocky Mountains, a new SEPM short course, will be offered in Billings, Montana, on September 18, 1983.

Cretaceous strata of the Rocky Mountains are major reservoir and source rocks for oil and gas, much of which remains to be discovered and developed. This one-day course, organized and taught by Dudley D. Rice and Donald L. Gautier (U.S. Geological Survey), will consider the relationship of reservoir quality, resource evaluation, and exploration strategy to depositional environment, thermal maturity, and diagenetic history. Conventional reservoirs will be discussed, but emphasis will be placed on undiscovered hydrocarbons in unconventional reservoirs.

Presentation is scheduled for September 18, 1983, in Billings, MT, adjacent to the 1983 Annual Meeting of the SEPM and AAPG Rocky Mountain sections. Tuition, which includes text, refreshments, and a luncheon, is set at $150.00. For more information or reservations, write: SEPM, Continuing Education Department, P.O. Box 4756, Tulsa, OK 74159; or, phone (918) 743–9765.

Colorado field trip

The Grand Junction Geological Society will hold an annual field trip to the northern Paradox Basin–Uncompahgre uplift, October 1–2, 1983. The two-day trip will cover the area from Grand Junction to Moab via Unaweep Canyon, Gateway, Castleton–John Brown Canyon road, and the La Sal Mountains Loop road. The route back to Grand Junction from the overnight stay in Moab will be via Potash, Fisher Towers, Dewey Bridge, and either Cisco and Harley dome or Dolores Triangle and Glade Park.

A published Guidebook with road logs and pertinent articles will be included with the field trip. For more information and trip registration, please contact: Bill Chenoweth, 707 Brassie Drive, Grand Junction, CO 81501, phone (303) 242–8621, ext. 352; or Craig Goodknight, Trip Chmn., Bendix Field Engineering Corp., P.O. Box 1569, Grand Junction, CO 81502, phone (303) 242–8621, ext. 363.

New publications

NMBMMR

***Circular 177**—Geology and geothermal waters of Lightning Dock region, Animas Valley and Pyramid Mountains, Hidalgo County, New Mexico, by W. E. Elston, E. G. Deal, and M. J. Logsdon, 1983, 44 p., 7 tables, 26 figs., 1 over-size map $10.00
Covers the geology and geochemistry of Pyramid Peak, Swallow Fork Peak, Table Top Mountain, and South Pyramid Peak 7½-min quadrangles, which include the Lightning Dock Known Geothermal Resources Area (KGRA).

***Guidebook**—Guidebook for field trip to Abo red beds (Permian), central and south-central New Mexico, by Roswell Geological Society and NMBMMR, 1983, 72 p., 1 map $10.00

***Bibliography**—Bibliography and index of New Mexico geology—references added to GeoRef database during 1982, American Geological Institute, 1983, 116 p. $6.50

USGS

GEOPHYSICAL INVESTIGATIONS MAP

GP–0949—Complete Bouguer gravity anomaly map of the Rio Grande rift, Colorado, New Mexico, and Texas, by Lindrith Cordell, G. R. Keller, and T. G. Hildenbrand, 1982, lat 29° to 41°, long 102° to 109°, scale 1:1,000,000

AVAILABLE ONLY THROUGH NTIS, U.S. DEPT. OF COMMERCE, SPRINGFIELD, VA 22161

PB–83 102 723—Geologic and well-construction data for the H–7 borehole complex near the proposed Waste Isolation Pilot Plant site, southeastern New Mexico, by S. L. Drellack, Jr., and J. G. Wells, 1982, 30 p. $8.50

PB–83 104 042—Results of hydrologic tests and water-chemistry analyses, wells H–6A, H–6B, and H–6C, at the proposed Waste Isolation Pilot Plant site, southeastern New Mexico, by K. F. Dennehy, 1982, 77 p. $11.50

MISCELLANEOUS FIELD STUDIES MAPS

MF–1037—Geologic map of the Tyrone quadrangle, Grant County, New Mexico, by D. C. Hedlund, 1978, lat 32°37′30″ to 32°45′, long 108° 15′ to 108°22′30″, scale 1:24,000

MF–1344–E—Mineral resource potential map of the Hells Hole Further Planning Area (RARE II), Greenlee County, Arizona, and Grant County, New Mexico, by J. C. Ratté, J. R. Hassemer, and R. A. Martin, U.S. Geological Survey, and J. P. Briggs, U.S. Bureau of Mines, 1982, scale 1:62,500

MF–1463–A—Geophysical surveys of the lower San Francisco Wilderness study area and contiguous roadless area, Greenlee County, Arizona, and Catron and Grant Counties, New Mexico, by R. A. Martin, 1982, scale 1:62,500

MF–1464–A—Geologic map of the Manzano Wilderness, Valencia and Torrance Counties, New Mexico, by C. H. Maxwell and R. A. Wobus, 1982, scale 1:50,000

MF–1464–B—Geochemical and geophysical maps of the Manzano Wilderness, Valencia and Torrance Counties, New Mexico, by C. H. Maxwell and R. A. Wobus, 1982, scale 1:50,000

MF–1506—Geologic map of the Rincon Hondo quadrangle, Cibola County, New Mexico, by M. W. McLellan, L. R. Haschke, and L. N. Robinson, 1982, lat 34° 37′30″ to 34°45′, long 108°45′ to 108°52′30″, scale 1:24,000

MF–1509—Geologic map of the Moreno Hill quadrangle, Cibola and Catron Counties, New Mexico, by M. W. McLellan, L. R. Haschke, L. N. Robinson, and E. R. Landis, 1983, lat 34°30′ to 34°37′30″, long 108°45′ to 108°52′30″, scale 1:24,000

WATER-RESOURCES INVESTIGATIONS

82–4111—Geologic and well-construction data for the H–9 borehole complex near the proposed Waste Isolation Pilot Plant site, southeastern New Mexico, by S. L. Drellack, Jr. and J. G. Wells, 1982, 32 p., 2 figs., 7 tables, 1 over-size sheet (in cooperation with DOE)

82–4118—Geologic and well-construction data for the H–8 borehole complex near the proposed Waste Isolation Pilot Plant site, southeastern New Mexico, by J. G. Wells and S. L. Drellack, Jr., 1982, 42 p., 2 figs., 7 tables, 1 over-size sheet (in cooperation with DOE)

U.S. Bureau of Mines

MLA 27–83—Mineral investigation of the west face Sacramento Mountains roadless area, Otero County, New Mexico, by J. P. Briggs, 1983, 17 p., 1 plate (not reproducible)

MLA 33–83—Mineral investigation of an addition to the White Mountain Wilderness, Lincoln County, New Mexico, by J. P. Briggs, 1983, 13 p., 1 plate

FOUR CORNERS GEOLOGICAL SOCIETY

The Four Corners Geological Society has a limited number of their publication *Oil and gas fields of the Four Corners area,* volumes I and II, still available at the original price of $75 for both volumes including postage and handling. Publication of a third volume of the Oil and gas fields of the Four Corners area (now in preparation) will undoubtedly renew interest in the original publications and the remaining inventory is expected to move at an accelerated pace. Those persons interested in obtaining the two-volume set at the original price should send a prepaid order to: Four Corners Geological Society, P.O. Box 1501, Durango, CO, 81301.

Open-file reports

USGS

***81–0459**—Seismic-refraction data taken in southwest New Mexico and southeast Arizona, by L. H. Jaksha, A. Garcia, and E. E. Tilgner, 19 pp.

***82–0888**—Origin of the Mariano Lake uranium deposit, McKinley County, New Mexico, by N. S. Fishman and R. L. Reynolds, 56 pp.

***82–0944**—Aeromagnetic map of the west face of the Sacramento Mountains, New Mexico, 1 over-size sheet, scale 1:62,500

***82–0952**—Aeromagnetic map of parts of Taos and Colfax Counties, New Mexico, 3 pp., 1 over-size sheet, scale 1:50,000

***82–0968**—Evaluation of breccia pipes in southeastern New Mexico and their relation to the Waste Isolation Pilot Plant (WIPP) site, *with a section on* Drill-stem tests, by J. W. Mercer, R. P. Snyder, and L. M. Gard, Jr., 78 pp., 1 over-size sheet

***82–0991**—Petrographic study of sandstones from measured sections of the Morrison Formation and related units, southwestern San Juan Basin, New Mexico, by L. J. Schmitt, 63 pp.

***82–1013**—Water resources of the Zuni Tribal Lands, McKinley and Cibola Counties, New Mexico, by B. R. Orr, 1982, 178 pp., 2 over-size sheets

***82–1069**—Instrumental neutron-activation analyses of Cenozoic volcanic rocks, phenocrysts, and associated intrusions from the southern Rocky Mountains and adjacent areas, by P. W. Lipman, H. R. Bowman, R. Knight, H. T. Millard, Jr., J. S. Pallister, K. Street, H. Wollenberg, and R. A. Zielinski, 1982, 1 over-size sheet

***82–1076**—Principal facts for gravity stations in the lower San Francisco and Hells Hole study areas and vicinity, Greenlee County, Arizona, and Catron and Grant Counties, New Mexico, by R. A. Martin, J. C. Wynn, and G. A. Abrams, 1982, 10 pp.

*83-2—Geologic references index for the Navajo Indian Reservation, Arizona, New Mexico, and Utah, by J. D. Bliss, 1983, 101 pp.

*83-56—Distribution of trace elements in drilling-chip samples around a roll-type uranium deposit, San Juan Basin, New Mexico, by H. C. Day, C. S. Spirakis, R. S. Zech, and A. R. Kirk, 1983, 28 pp.

Abstracts

REGIONAL GROUND-WATER FLOW IN SAN ANDRES FORMATION, TEXAS PANHANDLE AND EASTERN NEW MEXICO, by *A. R. Dutton*, Bureau of Economic Geology, The University of Texas (Austin), Austin, TX, *in* The Geological Society of America, 17th annual meeting of south-central section, Abstracts with Programs, v. 15, no. 1, January 1983.

Thick San Andres salt deposits in the Palo Duro Basin are being considered for use as a high-level nuclear-waste repository. Dolomite and limestone members of the San Andres Formation (Leonardian to Guadalupian) lie below potential repository horizons and may be capable of transmitting fluid. Most of the recharge to the karstic San Andres aquifer in eastern New Mexico is discharged to the Pecos River valley. Brine is discharged from the San Andres along its outcrop in north-central Texas. The San Andres is a major oil reservoir across the northern shelf of the Midland Basin. Transmissivity of the San Andres dolomite is low (less than 0.004 m^2/day) in the Palo Duro Basin where evaporite cement fills pore spaces. The low-transmissivity region changes the potential direction of ground-water flow from eastward in the recharge zone in New Mexico to southeastward through the Palo Duro Basin. Eastward flow takes place across the Midland Basin. Around the periphery of the Palo Duro Basin, the San Andres contains percolating meteoric water. Its chemical composition evolved through solution of limestone and gypsum at shallow depth west of the Pecos River. As water moves through the salt solution zone between the Pecos River and the western Caprock escarpment, total dissolved solids increase to more than 200 g/L and water approaches saturation with respect to halite. Total dissolved solids and apparent saturation index for halite decrease to the south away from the Palo Duro Basin. This change in water chemistry is coincident with the southward pinchout of evaporite facies.

INTERNATIONAL JOURNAL OF COAL GEOLOGY, ELSEVIER SCIENTIFIC PUBLISHING COMPANY, AMSTERDAM, THE NETHERLANDS, V. 2 (1983), PP. 261–277

PRELIMINARY REPORT ON THE DIFFUSE REFLECTIVITY OF SOME NEW MEXICO COALS, by *F. J. Kuellmer, Frank Kimbler*, and *Janet Nuter*, New Mexico Institute of Mining and Technology, Socorro, NM

Diffuse reflectivity measurements have been made on 17 analyzed coal specimens from New Mexico. Sample preparation is simple and rapid, involving cryogenic grinding and slight pressure to pelletize the sample. Using narrow-band interference filters, diffuse reflectivity was measured at 409, 450, 503, 518, 546, 577, 586, 596, 620, and 660 nm. At 409, 450, 503, 518, and 577 nm there is a correlation (equal to or less than -0.73) between volatile matter and diffuse reflectivity. The diffuse reflectance spectrum shows two maxima at 620 and 577 nm. The most intense maximum at 620 nm corresponds closely to the color of vitrinite in transmission. A minimum diffuse reflectivity is found near 450 nm. The range of diffuse reflectance for the studied range of volatile matter appears to be 1.25 to 2.4 times as sensitive as would be obtained if one were to use conventional polished sections. Diffuse reflectivity measurements may be a rapid, facile, and equally accurate method for making petrographic measurements useful in characterizing coal.

GEOLOGICAL SOCIETY OF AMERICA, BULLETIN, V. 94, PP. 543–548, 2 FIGS., APRIL 1983

THE MORROWAN–ATOKAN (PENNSYLVANIAN) BOUNDARY PROBLEM, by *P. K. Sutherland*, University of Oklahoma, Norman, OK, and *W. L. Manger*, University of Arkansas, Fayetteville, Arkansas

Recognition of the Morrowan–Atokan Series boundary of the Pennsylvanian Subsystem in North America is complicated by the presence of unconformities succeeded by poorly fossiliferous lithologies at that level in both type regions. Abandonment of the name Atokan in favor of the alternatively used name Derryan would not resolve the problem. The appearance of the fusiform fusulinid *Profusulinella* has been taken to mark the base of the Atokan Series since its proposal, yet there is no evidence to support that conclusion. A competing definition based on the appearance of the primitive fusulinids *Pseudostafella* and *Eoschubertella* seems to define better a boundary that is consistent with what is known of the Morrowan and Atokan type regions and of other faunal groups. A boundary stratotype is needed to fully resolve the problem.

NEW MEXICO ACADEMY OF SCIENCE

The New Mexico Academy of Science met on October 15, 1982, on the campus of the New Mexico Institute of Mining and Technology. Following are abstracts from talks concerning geology and mineral technology in New Mexico.

PRELIMINARY ANALYSIS OF ABO FORMATION IN CHAVES AND DE BACA COUNTIES, NEW MEXICO, by *Youssef I. Abugares*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

The Abo Formation conformably overlies the Hueco Limestone (Wolfcampian; Early Permian) in Chaves and De Baca Counties, southeast New Mexico. It is conformably overlain by Yeso Formation (Leonardian; Late Early Permian) which consists of sandstones, dolomitic limestones, and anhydrite beds. The Abo Formation ranges in age from Late Wolfcampian to Early Leonardian. The Abo Formation consists of red mudstones, very fine grained arkosic sandstones, siltstones, and some anhydrites. It has a thickness of 422 ft (129 m)–879 ft (268 m). The Abo gradually thins to the south where it forms a gently southeast dipping homocline. Folding and faulting have been recorded in the Abo southwest of the area. Preliminary analysis of the sedimentary structures and petrographic examination of this section by cores and well cuttings indicate that the Abo Formation was deposited as a delta dominated by fluvial action. The delta prograded southeastward over tidal flats and the marine shelf. The Abo sandstone suite is the primary target for natural gas drilling in Chaves and De Baca Counties, New Mexico. The Federal Energy Regulatory Commission has approved a tight gas-sand designation for the Abo sandstones. This designation enables producers of the gas from the Abo tight sands to receive a higher price per thousand ft^3 (MCF). The price rise differential is from $2.81 (MCF) to $4.92 (MCF). Gas production is from lenses and stringers of sandstones in the upper member of the Abo Formation. It develops as a combination stratigraphic and structural trap. The average depth of production is 4,500 ft (1,372 m), with an initial potential of 1 million ft^3 per day (MMCFPD) to 3 MMCFPD. No reserve calculations are available for the area at this time.

NEW RADIOLARIANS FROM LEONARDIAN BONE SPRING LIMESTONE, GUADALUPE MOUNTAINS, WEST TEXAS, by *William C. Cornell*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

An assemblage of radiolarians, associated with conodonts and sponge spicules, has been recovered from an outcrop of the Bone Spring Limestone in the Guadalupe Mountains. Quantitatively the assemblage is dominated by *Paronella*-type radiolarians. In addition, albaillellids and parafollicucullids are common, as are paleoactinommids, entactiniids, and rotasphaerids. Overall, the assemblage is an odd mixture of old Paleozoic types (paleoactinommids, entactiniids, rotasphaerids, and albaillellids), distinctly Permian parafollicucullids, and Mesozoic paronellids. It also contains rare individuals which may be early members of the rotaformid (nassallarinid) lineage. If this interpretation can be substantiated, the Bone Spring specimens will be among the few true nassallarines documented from the Paleozoic.

ORDOVICIAN ROCKS OF WEBB GAP AREA, NORTH FRANKLINS, DOÑA ANA COUNTY, NEW MEXICO, by *Robert J. Kondelin* and *David V. LeMone*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX, and *Kevin Von Finger*, Environmental Office, Fort Bliss Military Reservation, Fort Bliss, TX

Two stratigraphic sections of Ordovician System have been measured in the north Franklin Mountains. These sections are located in Doña Ana County, New Mexico; they are (from north to south): the Fort Bliss Military Reservation (SW1/4 sec. 33, T. 25 S., R. 4 E.) and North Anthony's Nose (SW1/4 sec. 15, T. 26 S., R. 4 E.). The Ordovician sequence is partially exposed at the base of the eastern slope of the range where the beds dip 30–40°W. The lithostratigraphic units are (from older to younger): El Paso Group (McKelligon and Scenic Drive formations) and the overlying Montoya Group (Upham, Aleman, and Cutter formations). The lithology of the McKelligon Formation in the north Franklins is a silty, laminated dolomite. Fauna observed includes brachiopods, pelmatozoans, and nautiloid cephalopods. Chert nodules and bioturbation are common. The Scenic Drive Formation consists of a lower sandy member of unfossiliferous, cross-laminated, dolomitic sandstones and sandy dolomites. The upper dolomitic member is fossiliferous, wavy-laminated, cherty, and contains a distinct cherty pebble conglomerate. Fossils observed include gastropods, cephalopods, and a few brachiopods. A major disconformity separates the Scenic Drive Formation from the overlying basal Upham Formation of the Montoya Group. The Upham is a massive, dark-weathering dolomite. The abundant, though poorly preserved fauna of the Upham includes pelmatozoans, corals, stromatoporoids, cephalopods, gastropods, and the uncertain affinity (?dasycladacean) *Receptaculites*. Stylolites are common. The Aleman Formation contains distinct alternating layers about 7.5 cm (3 inches) thick of black chert and carbonates. The black cherts are also found in lenses and irregular nodules. Faint laminae and locally abundant fossils are present. A distinct bed of silicified colonial corals (*Paleophyllum thomi*) with brachiopods is found near the top of a less cherty middle member. The Cutter Formation is a mostly massive, silty, light-brown-weathering dolomite, containing a few fossiliferous beds. Fossils include brachiopods, pelmatozoans, and corals. The Cutter becomes very cherty near the top of the formation. A major unconformity separates the Silurian Fusselman Dolomite from the underlying Cutter. Thicknesses obtained for the two measured sections are: 1) Fort Bliss Military Reservation section—McKelligon 16 m (53 ft), Scenic Drive 53 m (173 ft), Upham 37 m (121 ft), Aleman 57 m (187 ft), Cutter 52 m (170 ft); 2) North Anthony's Nose section—McKelligon 3 m (10 ft), Scenic Drive 60 m (197 ft), Upham 36 m (118 ft), Aleman 44 m (145 ft), and Cutter 55 m (181 ft). The Ordovician carbonates were deposited in a shallow, epeiric sea. Environments ranged from shallow subtidal to supratidal in the case of the El Paso Group. The Montoya Group apparently reflects a deeper, subtidal environment of deposition.

CARNIAN (LATE TRIASSIC) MUD MOUND BIOHERMS FROM WESTERN SLOVENA, NORTHWESTERN YUGOSLAVIA, by *David V. LeMone*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX, *Bojan Ogorelec*, Slovene Geological Survey, Parmova 33, 61000 Ljubljana, Yugoslavia, and *Dragica Turnsek*, Institute for Paleontology, Slovene Academy of Science, Stari trg 3, 61000 Ljubljana, Yugoslavia ☞

The approximately 1,000-m (3,280-ft) Pseudozilian Formation is Carnian (Late Triassic) in age; it is composed primarily of a sequence of laminated black shales, sandstones, and pyroclastics. It is underlain by keratophyres, diabases, and tuffs assigned to Ladinian (Middle Triassic) age, and it is overlain by the Baca Dolomite of Norian (Late Triassic) age. Carnian biohermal mud mounds are exposed 20 km (13 mi) north-northwest of Idrija, Slovenia in the upper 300 m (984 ft) of the formation as outlined by Car, Skaberne, Ogorelec, Turnsek, and Placer in 1981. The biohermal system has three major stratigraphic components; they are: core, marginal, and peripheral (enclosing) facies. The biohermal core facies biota includes: colonial and solitary corals, hydrozoans, foraminifera, bivalves, gastropods, echinoderms, skeletal and nonskeletal algae, and ichnofauna. The bioherms are interpreted as being a low energy, bafflestone-bindstone boundstone rather than a framestone boundstone. The allochemical components are poorly sorted to unsorted, calciruditic to calcarenitic material composed of bioclasts, coated grains, pelloids, intraclasts, oncoliths, and pisoids. The nearly exclusive micritic matrix has been aggraded to microspar. The morphology of these mounds with their distinctive 40–55° slopes and stromatactoid-like structures closely resemble constructional analogs from such systems as the Ordovician, Mississippian, Permian, and Jurassic which have widely variant floral and faunal assemblages. The Lake Valley Formation (Osage–Early Mississippian or Earliest Carboniferous) "Waulsortian" mud mounds of the Sacramento Mountains in south-central New Mexico are particularly comparable to the Carnian mud mounds.

STRATIGRAPHY AND REGIONAL RELATIONSHIPS OF MISSISSIPPIAN SYSTEM NORTH FRANKLIN MOUNTAINS, DOÑA ANA COUNTY, SOUTH-CENTRAL NEW MEXICO, by *H. Douglas Madden* and *David V. LeMone*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX, and *Kevin Von Finger*, Environmental Office, Fort Bliss Military Reservation, Fort Bliss, TX

The Mississippian System of the north Franklin Mountains, Doña Ana County, New Mexico, consists of basinal to near-shore facies. Stratigraphic sections were measured in the north Franklin Mountains at the Doña Ana Firing Range, Fort Bliss (SE1/4 sec. 32, T. 25 S., R. 4 E.) and at North Anthony's Nose (SW1/4 sec. 15, T. 26 S., R. 4 E.). The basinal facies is represented by the Las Cruces (Osage–Meramec) and Rancheria (Meramec) Formations. These units are sparsely fossiliferous, fine-grained, dark, dense, thin- to medium-bedded limestones. The Rancheria Formation consists of upper and lower members containing orange-weathering carbonates with cherty layers and nodules. Laminae and cross-laminae are characteristic of the basinal facies. Planar cross-laminae indicate a generally north to south sediment transport. To the north, in the Bishop Cap Hills and in the San Andres Mountains areas, and to the northeast, in the Sacramento Mountains, the basinal strata thin to an erosional edge over the older Lake Valley (Kinderhook–Osage) Formation shelf deposits. Nearshore facies are represented by the Helms (Chester) Formation. A lower calcareous shale unit grades into an upper unit of thin limestone beds alternating with shales. The upper unit carbonates contain an excellent fauna and would seem to be indicative of a more nearshore facies in comparison to the lower shaley units of the Helms. Oolites, previously reported in the upper beds of the Helms Formation in the north Franklin Mountains and Bishop Cap Hills, have been recovered in the study area. The Helms Formation thins out to the north, in the Bishop Cap Hills area, and may represent a possible northern shoreline unit or shoaling area in the Late Mississippian sea.

INFLUENT-EFFLUENT SEEPAGE OF RIO GRANDE: 1889–1980, by *Richard A. Marston*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

River budget calculations for the Rio Grande through the El Paso–Juarez Valley reveal the significance of channel seepage as an inflow-outflow parameter. In all but eight calendar years between 1889–1980, the Rio Grande has been an influent stream, experiencing a net loss of water to the underlying alluvium. Only in years with a combination of low main-channel flow, high irrigation consumption, and high valley-floor precipitation has the river experienced a net gain; claims that the onset of heavy ground-water withdrawals in the early 1900's changed the Rio Grande from an effluent to influent stream are not substantiated with the data. The loss of river water by influent seepage has been steadily reduced from 25% of total outflows (including irrigation consumption, M & I withdrawals, and flow leaving the valley at Fort Quitman) to less than 9% in recent decades. The reduction of influent seepage is attributed to rectification of the Rio Grande channel completed in 1938, to construction of a subsurface irrigation drainage system between 1924–1936, and to cement lining of the Chamizal Channel in 1968. Rectification decreased channel length, decreased active channel width, lowered channel bed elevation, reduced transpiration by streambank vegetation, and eliminated overbank ponding areas.

FUSSELMAN DOLOMITE OF NORTH FRANKLIN MOUNTAINS, DOÑA ANA COUNTY, NEW MEXICO, by *Lloyd McEvers* and *David V. LeMone*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX, and *Kevin Von Finger*, Environmental Office, Fort Bliss Military Reservation, Fort Bliss, TX

The Early to Middle Silurian Fusselman Dolomite has been measured and sampled at the southern edge of the Fort Bliss Military Reservation, SW1/4 sec. 33, T. 25 S., R. 4 E., Doña Ana County, New Mexico. Thickness of the Fusselman at this location totals 150 m (492 ft). The lowermost recognized member is the 75-m (246–ft) Chamberino. Vague, discontinuous, wavy laminae occur in several zones of the Chamberino Member. The uppermost occurrences of these zones are wavy bedded to crossbedded and contain subangular intraclasts. The medial Flag Hill Member is 35 m (115 ft) thick. Distinct sedimentary structures were not observed in this member. The uppermost Crazy Cat Member is 40 m (131 ft) thick. The basal 1.5 m (5 ft) of this member consists of a medium- to thin-bedded, irregular, nodular dolomite. The remainder of the Crazy Cat Member is massive dolomite. Colonial corals, stromatoporids, and brachiopods are the dominant invertebrate faunal elements. Small burrows and digitate algae occur within the middle portion of the Chamberino Member. A distinct pentamerid brachiopod zone was observed at 59 m (195 ft) above the base of the Chamberino. Crinoids are common in portions of the Crazy Cat Member. Nearly all fossils have been silicified within the Chamberino and Flag Hill members. Secondary calcite is the common faunal replacement in the Crazy Cat Member. Dolomitization of the Fusselman has apparently been pervasive. Silicification of fauna is common. Drusy quartz occurs in vugs and in fracture filling. Diagenetic processes have largely obliterated the primary sedimentary structures as well as fossil morphology.

AN EARLY CRETACEOUS RUDIST BIOSTROME SEQUENCE IN EAST POTRILLO MOUNTAINS, DOÑA ANA COUNTY, NEW MEXICO, by *Craig A. Pickens*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

A sequence of rudist biostromes are located 1.6 km (1.0 mi) north of the southern end of the East Potrillo Mountains, Doña Ana County, New Mexico. These biostromes are Middle Albian in age. They occur within the limestones and silty and shaly limestones of the Restless Formation. The biostromes are interpreted as being developed in a transgressive phase on a relatively shallow shelf in a far back-reef position. The biostromes probably originated from the coalescing intergrowth of discrete, separate rudist centers. This differential growth pattern would logically produce the observed unit that thins and thickens frequently along its 900-m (2953-ft) exposure. The maximum thickness of the unit is 6.3 m (20.7 ft), while it thins to a minimum of 0.4 m (1.3 ft). In addition to swelling and contracting of the unit, it has a central stratigraphic pinchout. The biostromes crop out on the eastern flank of the 32° westward dipping beds of the Restless Formation in the East Potrillos. The erosion of the dipslope exposure of the unit near the stratigraphic pinchout provides an exceptional, horizontal, planar view of the unit perpendicular to the east flank vertical exposure. Four facies have been determined for mapping purposes; they are: a central caprinid core; a lateral, small rudist zone; a peripheral *Turritella* zone; and an outer micrite facies. All of these facies are clearly visible on the exposure of the eroded planar surface.

STRATIGRAPHIC NOMENCLATURE OF EAST POTRILLO MOUNTAINS, DOÑA ANA COUNTY, NEW MEXICO, by *Darron L. Powell*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

The East Potrillo Mountains are located about 30 mi (48 km) west of El Paso, Texas, in Doña Ana County, New Mexico. This range contains Permian and Cretaceous sequences which have been deformed by Laramide orogenic activity. Prior work has been done principally by Bowers (1960), R. Hoffer (1981, 1982, in press), and Craig (1972). Bowers in 1960 correlated the Hueco Limestone in the range and informally named the early Cretaceous (?; in ascending order): Noria, Little Horse, and Restless formations. Bowers measured three stratigraphic sections of which the southern section, at a marble quarry, was considered to be the most complete. R. Hoffer, the most recent worker, has remeasured Bowers' southern section. The individual selection of stratigraphic boundaries of the formations differ between Bowers and Hoffer. One critical problem that should be resolved is the profound unconformity between the Hueco (Early Permian) and the Noria (Early Cretaceous). Bowers considers the unit in question, a 10-ft (3-m) cherty, limestone rudstone, to represent the basal conglomerate of the Cretaceous. Conversely, Hoffer interprets the unit as residual Permian material. Hoffer, also, has observed and recorded an additional 150 ft (46 m) of the Hueco. The Little Horse–Noria contact is another source of variant opinion between Hoffer and Bowers. The selection of the contact may be influenced by the fact that Bowers interpreted the lithologies of the covered intervals, while Hoffer did not. The contact between the carbonates of the top of the Little Horse and the base of the Restless present no interpretative difficulties between Hoffer and Bowers as they both agree on the precise position. Details of interpretation and the selection of individual critical lithic units show some variation between the descriptions of Hoffer and Bowers. Microfacies analysis, now in progress, should help to resolve the major boundary problems currently existing between the primary authors. It should also establish or negate the concept of cyclicity, develop utilizable data for paleogeographic reconstructions, and establish a more precise chronology and biozonation for the Permian and Cretaceous sequences.

PRELIMINARY EVALUATION OF FACIES MODEL ANALYSIS OF FORT HANCOCK AND CAMP RICE FORMATIONS: WEST TEXAS AND SOUTH-CENTRAL NEW MEXICO, by *Robert Riley*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

The Camp Rice and Fort Hancock Formations are normally considered to be the upper units of the Santa Fe Group in the Hueco and Mesilla bolsons of west Texas and south-central New Mexico. These lithostratigraphic units are also extended into Bolson de los Muertos in northern Chihuahua. There is a current conflict of interpretation as to the depositional settings that were developed within the two formations. W. S. Strain designated the formations and established their type sections. His studies indicate that the Fort Hancock Formation was a lacustrine deposit which was overlain and partially incised by the fluvial Camp Rice Formation. The Camp Rice has been further subdivided into lower and upper members. On the basis of measured sections and sieve analyses, Willingham interpreted the Fort Hancock Formation sequence to be composed of two distinct lithofacies; they are: a lower floodplain unit and an upper fluvial channel unit. He has postulated that the Camp Rice Formation is composed of two lithofacies, a lower fluvial channel facies and an upper floodplain facies. He has placed the base of the Camp Rice at a lower position in the section than Strain. Work on the Fort Hancock and Camp Rice Formations, based on a facies model analysis, as described by Walker (1979), is now in progress. The purpose of this approach is to attempt to test both prior author conclusions on the near recent geologic history of the region. This study should enable the reasonable interpretation of the paleodepositional settings of the formations and their geomorphologic (climatic, tectonic) implications, and establish the position of the Fort Hancock–Camp Rice boundary.

STRATIGRAPHY OF PENNSYLVANIAN SYSTEM, NORTH FRANKLIN MOUNTAINS, DOÑA ANA COUNTY, NEW MEXICO, by *Robert C. Roark* and *David V. LeMone*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX, and *Kevin Von Finger*, Environmental Office, Fort Bliss Military Reservation, Fort Bliss, TX

The northern ridge of the north Franklin Mountains in Doña Ana County, south-central New Mexico, is capped for the most part by the cliff-forming La Tuna Formation and lower portions of the Berino Formation. The La Tuna (Morrow–Atokan) and lower Berino (Atokan–(?)Des Moines) are well exposed in this area. Both formations have stratotypes in Vinton Canyon (approximately 7 mi (11 km) south of the study area). In Vinton Canyon the La Tuna is approximately 500 ft (152 m) thick, and the Berino is approximately 510 ft (154 m) thick. This sequence thins toward the north to the Bishop Cap Hills where the La Tuna is approximately 265 ft (81 m) thick. At Anthony Gap the Berino Formation is approximately 470 ft (143 m) thick. The La Tuna Formation ranges from 344 ft (105 m) to 426 ft (130 m) in the study area. The top of the Berino Formation is not exposed. The La Tuna Formation consists of a lower, massive, cliff-forming limestone and an upper portion of thin- to medium-bedded limestones interbedded with shales which typically form covered intervals. Black chert nodules and layers are observed throughout most of the formation. The La Tuna is highly fossiliferous, containing brachiopods, crinoids, solitary corals, *Chaetetes*, algae, fusulinids, bryozoa, other foraminifera, gastropods, and colonial corals. The Berino of the study area forms a dip slope consisting of alternating layers of thin- to medium-bedded limestones and covered intervals interpreted to be shales. Chert nodules and layers are observed throughout this formation. Fossils recorded in the Berino include: brachiopods, crinoids, bryozoa, algae, solitary corals, cephalopods, gastropods, fusulinids, other foraminifera, and trilobites.

PRELIMINARY ANALYSIS: PENNSYLVANIAN STRATIGRAPHY OF ROBLEDO MOUNTAINS, DOÑA ANA COUNTY, NEW MEXICO, by *Timothy J. Roepke*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

The Robledo Mountains, which lie northwest of Las Cruces, contain a well-exposed section of Pennsylvanian strata. The Pennsylvanian crops out only in the northern portion of the range and has a measured thickness of 655 ft (200 m). The remeasured basal Derryan (Atokan) units are typically 15–25 ft (5–8 m), dark, silty cherty limestones that alternate with thin, dark shales. The Derryan directly overlies a Tertiary rhyolite sill. It seems reasonable to presume that the sill has assimilated parts of the Paleozoic section. If this is a valid assumption, the basal Derryan beds described most logically would be only remnants of a thicker, more complete Derryan sequence. The overlying Desmonesian beds are approximately 220 ft (67 m) thick. They are ledge-forming, dark, cherty limestones with interbeds of gray, calcareous shales in the basal portions. The Missourian strata are on the order of 200 ft (61 m) thick. This sequence is dominated by nodular, slope-forming limestones which are interbedded with brownish-gray shales. The massive Virgillian units are about 210 ft (64 m) thick. This sequence is typically a noncherty limestone cliff that is underlain by nodular limestones and calcareous shales, and overlain by massive, noncherty limestones alternating with nodular, steplike, thin-bedded limestones. Initial carbonate petrography of these Pennsylvanian rocks suggests a shallow, relatively stable Robledo shelf on the northwestern margin of the Orogrande Basin. The sequence probably received little significant clastic materials from the Florida Islands axis to the west. No contribution of clastics originates from the then active Pedernal landmass as it lies to the east of the Robledo shelf across the Orogrande Basin.

PRELIMINARY REPORT ON CARBONATE HILL LIMESTONE (APTIAN) OF CENTRAL PELONCILLO MOUNTAINS, HIDALGO COUNTY, NEW MEXICO, by *Michael Sandidge*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

The Cretaceous System represented in the central Peloncillo Mountains of southwestern New Mexico is restricted to middle Cretaceous sedimentary rock units; they are (in ascending order): McGhee Peak Conglomerate, Carbonate Hill Limestone, Still Ridge Formation, Johnny Bull Sandstone, and a Late Cretaceous volcanic sequence. This preliminary report will concentrate on the Carbonate Hill Limestone only. Two complete sections were measured, one located in the SE1/4 sec. 28, T. 25 S., R. 21 W., and the other located in the NW1/4 sec. 26, T. 25 S., R. 21 W., and NE1/4 sec. 27, T. 25 S., R. 21 W. The first section measured 194 ft (59 m) in thickness, whereas the second section measured 214 ft (65 m) in thickness. The Carbonate Hill Limestone lithologies primarily consist of thin- to medium-bedded, medium- to coarse-grained sandy limestone that weathers medium gray to medium brown. The overall color on a fresh surface is medium to dark gray. Thin conglomeritic beds of small subangular black chert and limestone pebbles are observed near the base of the unit. A few thin beds of calcareous sandstone occur near the top of the unit. The Carbonate Hill Limestone is represented by a diverse faunal assemblage. Some limestone beds are composed almost entirely of medium to large *Ostrea* and *Pecten* shells that crop out with a unique clastic texture. Turritelloid-type gastropods are also quite abundant throughout the unit. Internal molds of ammonites occur in the more sandy beds of the unit. The ammonite molds appear to be similar to those observed in the Oyster Limestone Member of the U-Bar Formation in the Big Hatchet Mountains located some 60 mi (96 km) to the southeast.

PERMIAN INVERTEBRATE FAUNA OF HUECO CANYON FORMATION, JARILLA MOUNTAINS, OTERO COUNTY, NEW MEXICO, by *Ronald D. Simpson* and *David V. LeMone*, Department of Geological Sciences, University of Texas (El Paso), El Paso, TX

The Jarilla Mountains are a small range of hills in the Tularosa Basin of Otero County, south-central New Mexico, which contain Early Permian (Wolfcampian) rocks. The exposed Permian strata are observed in the northern and eastern portions of the range as the Laborcita (lower) and Hueco (upper) formations. The Hueco Formation overlies the Early Wolfcampian Laborcita Formation without apparent unconformity. The Hueco is predominantly a gray to dark gray, medium-bedded, fossiliferous carbonate section with some beds of calcareous siltstones and silty shale in the medial portion of the formation. The approximately 1,000-ft (305-m) unit ranges from Middle to Late Wolfcampian in age. Additional literature citations of the invertebrate fauna include: Fusulinida–*Ozawainella huecoensis* Dunbar and Skinner; Porifera–*Wewokella* (*Talpaspongia*) *clavata* (R. H. King); Coelenterata–*Syringopora* sp.; Bryozoa–*Tabulipora* sp., *Polypora* sp.; Brachiopoda–*Enteletes costellatus* Cooper and Grant, *Derbyia* sp., *Nudauris transversa* Cooper and Grant, *Dasysaria* sp., *Pontisia franklinensis* Cooper and Grant, *Crurithyris* sp., *Composita cracens* Cooper and Grant, *Dielasma* sp.; Gastropoda–*Bellerophon* sp., *Omphalotrochus obtusispira* (Shumard), *Straparollus* (*Euomphalus*) *Cornudanus* (Shumard), *Meekospira* sp.; Cephalopoda–*Mooreoceras* sp., an unidentifiable small, silicified ammonoid; Scaphopoda–*Plagioglypta canna* (White); Bivalvia–*Streblopteria* (*Streblochondria*) sp., *Aviculopinna peracuta* (Shumard), *Septimyalina* sp. and Echinoidea–*Archaeocidaris* plates and spines. The fauna most closely resembles the Hueco Canyon Formation of the Hueco Group of the Hueco and Franklin Mountains, Texas, and is tentatively correlated to this sequence.

NEW MEXICO TECH GRADUATE RESEARCH CONFERENCE

This year the 4th annual New Mexico Tech Graduate Student Association Geoscience Research Conference met in conjunction with the New Mexico Geological Society spring meeting. The meeting took place April 29, 1983; following are abstracts of talks presented during the conference.

GEOLOGY AND JOINT PATTERN STUDY OF TURKEY MOUNTAINS, MORA COUNTY, NEW MEXICO, by *T. L. Boyd* and *J. A. Campbell*, Department of Geosciences, West Texas State University, Canyon, TX

The Turkey Mountains, a northeasterly trending breached anticline, are in the southern Raton Basin, northeastern New Mexico. Strata exposed include rocks of Upper Triassic to Upper Cretaceous age. Late Tertiary and Quaternary volcanic rocks of the Ocate volcanic field occur along the north, east, and southeast flanks of the mountains. The Turkey Mountain anticline was probably produced by a late Tertiary (?) intrusion which is not exposed at the surface, but has been penetrated by a drill hole near the crest of the anticline. Northerly trending, alkaline lamprophyre dikes occur in the Turkey Mountains and are probably associated with the Tertiary (?) intrusion that underlies the anticline. A potassium-argon date of 15.6 ± 0.7 m.y. on biotite from one of the dikes indicates that emplacement of the dikes occurred during Miocene time. A study of systematic joints in the Dakota Sandstone (Cretaceous), which encircles the range and has been deformed by the uplift, was undertaken in an effort to determine the deformative stress field that produced the uplift. The primary systematic joints in the Dakota Sandstone comprise a set with a mean vector of N. 20° W. A secondary set, approximately orthogonal to the primary set, was observed but is not systematic, based on the statistical techniques used in this study. The systematic set appears to be associated with a regional pattern that predates the local uplift; therefore, no relationship appears to exist between the systematic joint pattern in the Dakota Sandstone and the stress field that produced the uplift.

LOCAL GEOMAGNETIC ANOMALIES IN ALLUVIAL FANS OF SANDIA MOUNTAINS, NEW MEXICO, by *C. R. Bradley* and *K. D. Mahrer*, Department of Geology, University of New Mexico, Albuquerque, NM

A land-based geomagnetic survey was conducted over an alluvial fan complex at the northwestern end of the Sandia Mountains on the eastern border of the Rio Grande rift. Local total-field magnetic anomalies were found. These anomalies correspond to the topographic relief associated with the major arroyos draining the fan. Running data lines perpendicular to the drainage direction gave data that show magnetic highs near the arroyo edges and magnetic lows in the channel bottom. The data range of these anomalies was as great as 200 gammas, while maximum background noise was under 30 gammas. These anomalies were modeled using a "Talwani" (magnetics) computer code. The computer-generated data agreed extremely well with the measured field data. The model found that the anomalies were due to the missing material represented by the cross sectional area of the arroyo (i.e., NRM of the fan) and were not due to the surficial deposits (i.e., heavy minerals) in the main channel of the arroyo. Further analysis of the data/model shows a correspondence between downfan location and strength of magnetization. Variation of the deposition environment (i.e., decreasing flow regime downfan) is believed to account for this magnetization variation. In retrospect, land-based magnetic surveying has been found to be a tool in determining depositional character.

GEOCHRONOLOGIC STUDIES OF GRANITES AND METAMORPHIC ROCKS, SANDIA MOUNTAINS, by *D. G. Brookins* and *A. Mujumdar*, Department of Geology, University of New Mexico, Albuquerque, NM

Several geochronologic studies have been carried out on Precambrian rocks from the Sandia Mountains. Early studies, summarized by Brookins (1972), showed U–Pb, Th–Pb and Rb–Sr ages ranging from 1.47 to 1 BYBP, with a best estimate of 1.45 BYBP (error uncertain). More recent studies by the writers (DGB; DGB and AM) confirm that many of the granitic rocks crystallized at 1.44 ± .04 BYBP, based on a 23 data Rb–Sr whole-rock isochron. In addition, detailed study of biotites from nine granite samples yields Rb–Sr ages of 1.33 ± 0.006 BYBP, which we interpret as a low-grade thermal event affecting the granite at this time. This date is consistent with K–Ar mineral ages of muscovites from the metamorphic rocks of the Juan Tabo Series as well as from pegmatite minerals. Earlier work by Taggart and Brookins (1975) yielded a Rb–Sr whole rock age of 1.60 ± 0.08 BYBP for gneisses of the Cibola Gneiss. We here report the first attempts at dating the Juan Tabo Series by the Rb–Sr whole-rock method, with an age of 1.62 ± 0.07 BYBP. In addition, folded pegmatites from the Rincon area of the Sandia Mountains yield an age of 1.47 ± 0.12 BYBP. We also have investigated the proposed division of the Sandia granite into northern and southern plutons (Condie and Budding, 1979). Our chemical, geochronologic, petrographic, and field work do not support such a division of the Sandia granite. However, Rb–Sr whole-rock studies do suggest a younger granite in the Juan Tabo–La Cueva picnic areas of about 1.38 BYBP based on whole-rock Rb–Sr analyses, which may possibly be correlated with the suggestion by Berkley and Callender (1979) that there were several pulses of granite formation on the northern part of the Sandia Mountains.

GEOCHRONOLOGIC STUDY OF EVAPORITES, SOUTHEASTERN NEW MEXICO, by *D. G. Brookins*, Department of Geology, University of New Mexico, Albuquerque, NM

Evaporite minerals from southeastern New Mexico have not been previously extensively studied by geochronologic methods. The writer (Brookins, 1981) has summarized the earlier work of Schilling (1973), Tremba (1971), Register and Brookins (1980), and Brookins and others (1980). Based on this earlier work, several important conclusions were reached: 1) Primary evaporite minerals, including polyhalite, langbeinite, and sylvite, yield Rb–Sr mineral and K–Ar (except for sylvite) mineral ages of 200–230 MYBP, which is interpreted as either a formational or diagenetic age. 2) Sylvites yield K–Ar ages from a few MYBP to 180 MYBP, and the amount of age lowering is random for this method. 3) Clay minerals from a Pleistocene rubble chimney are detrital as evidenced by scattered Rb–Sr ages in the range of 330–400 MYBP. 4) Evaporite mineral systematics in the vicinity of a 34 MYBP lamprophyre dike are reset within one meter of the contact with the dike. 5) No direct evidence for major tectonic or other events affecting Rb–Sr and K–Ar mineral systematics between about 200 and 34 MYBP has been noted. We have now expanded our research to include systematic study of other evaporite minerals, as well as to continue to compile data on minerals studied earlier. New langbeinite analyses (n = 4) yield K–Ar and Rb–Sr dates from 178 to 215 MYBP, while new sylvite K–Ar and Rb–Sr dates (n = 3) range from 176 to 190 MYBP. Kieserite, due to its high water content, is difficult to analyze by the K–Ar method, as is leonite, and these minerals yield K–Ar apparent dates of 100 and 13 MYBP respectively. Yet Rb–Sr study of these minerals yields dates from 110 to 240 MYBP, showing that the Rb–Sr systematics are less affected than K–Ar systematics. An impure mixture of magnesite and talc, mixed with sylvite (180 MYBP), yields an anomalously high K–Ar date of 297 MYBP and a Rb–Sr date of 183 MYBP. It is interesting to note that the excess Ar in the carbonate-silicate mix can be explained by incorporation of that proposed to have been lost from the sylvite with which it is mixed. In support of earlier work, no geochronological evidence for thermal or other events disturbing the evaporites between near 200 MYBP to 34 MYBP is noted.

TIN MINERALIZATION IN TAYLOR CREEK RHYOLITE, BLACK RANGE, NEW MEXICO, by *Ted L. Eggleston* and *David I. Norman*, Department of Geoscience, New Mexico Institute of Mining and Technology, Socorro, NM

Two periods of alteration and possible mineralization have been defined in the north-central Black Range of New Mexico. Tin as cassiterite and wood tin occurs with specular hematite in veins hosted by Tertiary rhyolite lava domes and flows. The host rock, the Taylor Creek Rhyolite, is a high-silica (76–78% SiO_2), high-potassium (4–6% K_2O), and high-fluorine (as much as 5,000 ppm) rhyolite. The Taylor Creek Rhyolite is part of a biomodal assemblage of basaltic andesitic flows and high silica lavas and ash-flow tuffs erupted 22 to 28 m.y. ago. The volcanic rocks underlying the Taylor Creek Rhyolite are dominantly felsic ash-flow tuffs and mafic lava flows. Mafic lava flows, felsic ash-flow tuffs, and basin-filling sedimentary rocks overlie the Taylor Creek. Mineralization is restricted to the Taylor Creek Rhyolite as is the alteration, suggesting a genetic and temporal relationship. The mineralization consists of discontinuous hematite-cassiterite veins with minor wood tin, quartz fluorite, and cristobalite. Locally, hematite and cassiterite are disseminated through the host rock. Preliminary $^{18}O/^{16}O$ determinations suggest that the fluids responsible for the alteration were cool magmatic water or enriched meteoric water. Alteration ranging from propyllitic to quartz-sericite accompanies a group of rhyolite porphyry intrusives near the crest of the Black Range. Pyrite is locally present in the quartz-sericitic alteration. The intensity of the alteration increases toward the intrusives and has been noted 2–3 km from them. The age of these intrusives is unknown, but they intrude and alter rocks that are about 24–28 m.y. old. As with the Taylor Creek alteration, preliminary $^{18}O/^{16}O$ determinations suggest cool magmatic water or enriched meteoric water.

STATUS REPORT ON EPITHERMAL GOLD-SILVER EXPLORATION, by *Paul I. Eimon*, Pioneer Nuclear, Inc., Amarillo, TX

Current economic conditions have made epithermal or "bonanza" gold-silver deposits attractive exploration targets. The emphasis on exploration for such deposits has given impetus to: 1) resurgence in research on the epithermal model, 2) intensive investigations of the geochemistry of active hot springs environments, and 3) the application of new exploration techniques in fossil geothermal zones. While research and exploration have put certain epithermal models in focus, understanding the processes of deposition is, the author believes, even more critical in finding gold and silver bonanzas. Zoning—of alteration, vein mineralogy, temperature of deposition, metal content, and trace element values as related to structure and host rock formations—is crucial. Understanding zoning provides "road signs" to ore. Notable recent epithermal discoveries include Homestake's McLaughlin deposit in northern California and St. Joe's El Indio deposit in Chile. Known epithermal districts throughout the world are being scientifically re-examined in the light of newly developed and developing knowledge of the epithermal model and depositional processes. Examples are expansion of gold production at the Verespatak mine in Transylvania and of development of new high-grade silver ore at Fresnillo and Taxco in Mexico. Exploration for epithermal deposits in New Mexico is increasing. Notable epithermal deposits of New Mexico and southeast Arizona include Mogollon and the Commonwealth mine in southeast Arizona.

TECTONIC MAP OF TEXAS—A PROGRESS REPORT, by *T. E. Ewing, C. D. Henry, M. P. A. Jackson, C. M. Woodruff, Jr., A. G. Goldstein,* and *J. R. Garrison*, Bureau of Economic Geology, The University of Texas (Austin), Austin, TX

The Bureau of Economic Geology is compiling a new tectonic map of Texas—a detailed, up-to-date display at 1:700,000 of surface and subsurface structural history for the entire state and adjoining areas of New Mexico, Oklahoma, Mexico, and the continental shelf and slope. This is the first comprehensive structural mapping of Texas since E. H. Sellards' "Structural Map of Texas" some 40 yrs ago. A companion illustrated text also is being compiled to systematically describe and synthesize the tectonic evolution of the state from Proterozoic to Recent. Deformed Precambrian crust is exposed in the Llano uplift and in western trans-Pecos Texas. It is subdivided by the tectonic setting of the sedimentary rocks and by the timing of intrusion and deformation. The late Paleozoic basins and the intervening fault-bounded basement uplifts of west Texas are shown by 200-m and 100-m contours on the top of Precambrian or the top of Ellenburger, depending on the nature of well control. The principal features of the buried Ouachita overthrust belt are displayed, along with a more detailed rendition of the exposed Ouachita rocks in the Marathon region. The East Texas, Maverick, and Sabinas Basins and the inner Gulf Coastal Plain are shown by contours on the Edwards Limestone and the Austin Chalk; features due to salt tectonism, growth faulting, and Cordilleran deformation are prominent. Seaward of the Cretaceous shelf margin, the growth-fault trends of the Gulf Coast are shown with contours on the Tertiary formations most affected. Available offshore data have been integrated to provide a picture of the shelf slope, and a corner of the Sigsbee abyssal plain. In the multiply deformed trans-Pecos region, the surface expressions of structures related to Laramide folding and thrusting, middle Tertiary volcanism, and Miocene to Recent basin-and-range faulting are shown, in addition to the Precambrian and Ouachita–Marathon structures where exposed. The final edition will be multicolor, with colors emphasizing subsurface contour horizons and depths, tectonic units in deformed or volcanic areas, salt domes, igneous bodies, faults, and axial traces of folds. Faults will be identified, where possible, by their age. Inset maps will include basement age and lithology, gravity, magnetics, and topography. The map and text will provide a valuable summary of Texas structural geology and suggest new approaches to the search for energy resources.

PRELIMINARY BASIN ANALYSIS OF PICTURED CLIFFS TO OJO ALAMO SEQUENCE IN WESTERN AND SOUTHERN SAN JUAN BASIN, NEW MEXICO, by *Adrian Hunt*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Coastal environments of the Pictured Cliffs Sea were from northwest to southeast, deltaic, barrier shoreline, and tidal flat. The major source area was southeastern Arizona. The shoreline trend was northwest-southeast, but a major deflection occurred during *Didymoceras cheyennense* time, reflecting the beginning of a volcanic uplift in southwestern Colorado. This new uplift started contributing sediment to the basin in upper Fruitland time, in the northwest of the area in the form of airfall ash, and during Kirtland time became the dominant source area. The Farmington Sandstone is a clastic wedge of braided stream material eroding this uplift. The Animas Formation represents the final erosion of this highland, producing rhyolitic and andesitic debris. This highland is now only represented by a few laccoliths, and the Cimarron Ridge Formation. The Ojo Alamo Sandstone also derives from this uplift. The unconformity at the base of the Ojo Alamo is not angular, evidenced by depositional thinning from northwest to southeast, intraformational unconformities in the Fruitland–Kirtland in the southeast and subcontinuity of a volcanic-rich facies, locally termed the Naashoibito, from Farmington to Cuba. The hiatus represented by the unconformity is of short temporal duration. In the northwest of the area, there is an upward-coarsening sequence from suspended load-mixed load-bed load streams from Fruitland to Ojo Alamo, reflecting increased erosion of an active tectonic high. Virtually all pre-Naashoibito vertebrate fossils are restricted to upper delta plain-lower alluvial plain facies behind the major delta in the northwest of the area.

SILVER-NICKEL-COBALT-URANIUM MINERALIZATION AND ASSOCIATED ALTERATION IN BLACK HAWK DISTRICT, GRANT COUNTY, NEW MEXICO, by *Kathleen E. Johnson*, Albuquerque, NM

The Black Hawk district of southwestern New Mexico contains veins of the Ag–Ni–Co–U type. Mineralization consists of native silver, nickel, and cobalt arsenides and sulpharsenides in carbonate gangue. The sequence of ore mineralization is pitchblende-native silver-Ni and Co arsenides and sulpharsenides-sulfides. The sequence of gangue mineralization is calcite-siderite-ankerite-rhodochrosite. These sequences are interpreted to indicate decreasing oxygen fugacity, and constant, low temperatures. Intermediate argillic alteration developed next to the veins suggests H^+ metasomatism adjacent to the veins, while the development of propylitic alteration farther away indicates that CO_2 metasomatism is more significant out into the wall-rock. This corresponds to acidic conditions in the fluids, and increasing pH out into the wall rocks. The veins are inferred to have formed as a result of the intrusion of a dioritic porphyry stock into a volcanic/sedimentary rock sequence. Thermal convection of meteoric waters, probably mixed with a magmatic component, leached ore elements from the country rocks, and reaction of the oxidized fluids with reducing wall rocks initiated the precipitation of the veins.

PROTEROZOIC PILLOW BASALTS AND PILLOW BRECCIAS FROM PECOS GREENSTONE BELT, SANGRE DE CRISTO MOUNTAINS, NORTH-CENTRAL NEW MEXICO, by *Ingrid Klich* and *James M. Robertson*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Metabasalts (now amphibolites) with well-preserved pillow structures occur within an extensive early Proterozoic (1.68–1.72 b.y.) compositionally bimodal volcanic terrane in the southern Sangre de Cristo Mountains of north-central New Mexico, and represent the first well-documented occurrence of such structures in the Precambrian of New Mexico. Narrow, arcuate selvages define individual pillows that are up to 1.5 m in diameter, elliptical to circular in cross section, and poorly exposed in the third dimension. Horizons of pillow breccia are also present and consist of smaller (typically <30 cm), irregularly shaped fragments and pods, with or without well-developed selvages, set in a mafic matrix. Pillows contain variable amounts of amygdules and range from massive, nonamygdular varieties to those displaying abundant amygdules arranged in well-defined zones roughly concentric about the core of the pillow. Junctions among pillows may be voids but commonly are filled with interpillow breccia consisting of small (1–3 cm) subangular to subrounded selvage and pillow fragments in a fine-grained mafic matrix. Chemical analyses of aphanitic to fine-grained amphibolites that are intermixed with and may locally crosscut pillow-bearing horizons indicate those mafic volcanic rocks are subalkaline, mainly low-K, tholeiites, with an average TiO_2 content of 1.1% and flat REE to slightly light REE-depleted patterns. The submarine environment, bimodal volcanic suite, chemistry, and nature of the associated felsic volcanic, volcaniclastic, and sedimentary rocks are all compatible with deposition in an immature back-arc basin.

CLAY MINERALOGY AND GEOCHEMISTRY OF UPPER CRETACEOUS STRATA, SOUTHEASTERN SAN JUAN BASIN, NEW MEXICO, by *S. T. Krukowski*, Department of Geoscience, New Mexico Institute of Mining and Technology, Socorro, NM

The Upper Cretaceous rocks of the southeastern San Juan Basin, New Mexico, resulted from a series of transgressions and regressions. Seventy-eight samples were chosen as representative of the clay-bearing Upper Cretaceous sequence, Mulatto Tongue of the Mancos Shale through the Fruitland Formation, and analyzed for clay mineralogy, whole-rock mineralogy, and whole-rock geochemistry. Whole-rock mineralogy and geochemistry show only slight variations in the stratigraphic interval. However, the Fruitland Formation shows a relative decrease in quartz and Al_2O_3, and an increase in sodic plagioclase and Na_2O. The principal clay mineral species is smectite. This may suggest a new sediment source in Fruitland times. Vertical and lateral variations in clay mineralogy in the other shale units were observed. Kaolinite generally was observed increasing from marine to nonmarine facies (Menefee Formation), and illite, chlorite, and random interstratified illite-smectite increased towards marine depositional sites (Mancos Shale, La Ventana Tongue, and Lewis Shale). Clay mineral assemblages follow the prescribed pattern set forth in lateral distributions study by Parham (1966). Lateral variations in clay mineralogy within stratigraphic units can also be ascribed to particle-size sorting, *e.g.* upper Menefee Formation lithologies. Finer grained humic shales (distal from channel sands) contain less kaolinite and more platy clay minerals (interstratified illite-smectite) than coarser grained shales and mudstones (proximal to channel sands). This is the result of particle size sorting in the fluvial-paludal depositional environment. Kaolinite in the upper Menefee shales is probably related to provenance, diagenesis, or both.

A MIDDLE PLEISTOCENE MAMMOTH FROM SOUTHEASTERN NEW MEXICO, by *T. R. Logan*, and *S. G. Lucas*, Department of Geology, University of New Mexico, Albuquerque, NM

UNM (University of New Mexico)–P–1 is a right ramus bearing M_3 of *Mammuthus imperator.* This specimen was collected from Quaternary alluvium along Salt Creek on the Marley Ranch northwest of Roswell. The following features justify assignment of UNM–P–1 to *M. imperator:* 1) M_3 has 11+ plates. 2) M_3 length = 218 mm and maximum width = 95 mm, making it a relatively broad tooth. 3) M_3 lamellar frequency = 5, an upper limit considering how highly worn this tooth is. 4) Enamel thickness: n = 20, $\bar{X}$ = 2.7 mm. 5) Enamel to enamel thickness of a plate: n = 18, $\bar{X}$ = 14.9 mm. 6) Thickness of dentin between enamel walls: n = 18, $\bar{X}$ = 9.2 mm. 7) Thickness of cementum separating enamel plates: n = 18, $\bar{X}$ = 6.0 mm. 8) Length of one complete loph and cementum separator: n = 17, $\bar{X}$ = 21.5 mm. 9) Lack of a well-developed anterior symphyseal process. *M. imperator* is a relatively primitive Pleistocene mammoth typical of middle Pleistocene (late Irvingtonian) localities.

POSSIBLE EXPLANATION FOR UNIQUE CHARACTER OF RIO GRANDE IN ELEPHANT BUTTE AREA, SIERRA COUNTY, NEW MEXICO, by *Richard P. Lozinsky*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM

Throughout most of its course in New Mexico, the Rio Grande has incised a channel into erodable basin-fill sediments of the Rio Grande rift. However, in the Elephant Butte area the river crosses the basin-margin Hot Springs fault at three localities to cut into more resistant bedrock of a marginal uplift. At the two northern localities, the Rio Grande has migrated 1 km or less east of the Hot Springs fault. At the southern locality, the river has migrated more than 2 km east of the fault and follows a complicated course around a prominent sandstone ridge, Long Ridge. The two northern crossings probably resulted from laterally cutting meanders where the Hot Springs fault juxtaposed Santa Fe Group sediments with erodable shales of the McRae Formation. A stream piracy model is proposed for the southern crossing. In this model, the Rio Grande originally flowed west of the Hot Springs fault. East of the fault, a tributary of the Rio Grande eroded northward between Long Ridge and Elephant Butte and eventually captured the river north of Long Ridge. Plugging or partial plugging of the Rio Grande channel by debris aggrading at the mouth of a major western tributary, Cuchillo Negro Creek, may have aided in diverting the river into its new course, Elephant Butte Canyon. Evidence supporting piracy includes: 1) Long Ridge is topographically higher than any other basin-fill deposits, 2) no fluvial deposits occur on Long Ridge, 3) resistant nature of sandstone comprising Long Ridge hinders migration, 4) absence of the two oldest terrace levels in Elephant Butte Canyon, and 5) Cuchillo Negro terraces shift south in conjunction with piracy. Piracy probably occurred during middle to late Pleistocene time.

FOSSIL MAMMALS AND EOCENE-OLIGOCENE BOUNDARY IN NEW MEXICO, by *S. G. Lucas*, Department of Geology, University of New Mexico, Albuquerque, NM

In New Mexico (NM) no fossil mammals of Oligocene age are known, but there are three areas in which Duchesnean (late Eocene) fossil mammals are relevant to the local placement of the Eocene–Oligocene boundary. Fossil mammals from the upper part of the Galisteo Formation in north-central NM and from the Baca Formation in west-central NM indicate that these strata are of Duchesnean age. These age determinations are consistent with Oligocene K/Ar dates from the Espinaso (overlying the Galisteo) and Spears (overlying the Baca) Formations. Therefore, the Eocene–Oligocene boundary can be placed at or near the Galisteo–Espinaso contact in north-central NM and at or near the Baca–Spears contact in west-central NM. A brontothere jaw from just west of the Winston graben in the northern Black Range (southwestern NM) is derived from a unit stratigraphically equivalent to the Rubio Peak Formation and previously termed "Spears (?) Formation" or "early andesite volcanic sequence." This jaw represents a relatively advanced though small brontothere (length M_1 = 4.6 cm, no postcanine diastemata, P_1 absent, P_{3-4} molariform) that pertains to the typical late Eocene genus *Duchesneodus.* It indicates a Duchesnean age for the horizon from which it was derived that is consistent with K/Ar dates from other areas that suggest the Rubio Peak Formation transgresses the Eocene–Oligocene boundary.

GRAVITY AND MAGNETIC STUDIES IN RIO GRANDE RIFT NORTH OF ALBUQUERQUE, NEW MEXICO, by *K. D. Mahrer* and *T. B. Reynolds*, Department of Geology, University of New Mexico, Albuquerque, NM

This abstract reports work in progress involving gravity and magnetics measurements in the eastern portion of the Rio Grande rift directly north of Albuquerque, New Mexico. The study was undertaken to determine local variations in the basement structure. To date, three east-west gravity lines and one magnetics line have been run in a region spanned by the Sandia Mountains to the east and I–25 to the west. Each line is approximately 6 km long with measurements taken every 0.5 km. The usual "text-book" data reduction methods have been performed on the data. These data show a substantial reduction in gravity of approximately 30.0 to 50.0 mgal from east to west. This result is completely consistent with previous geological and geophysical studies that indicate a westward deepening of the basin by a series of stepped normal fault blocks. To model the data, a two-dimensional "Talwani" (computer) modeling scheme is being employed. A mass contrast between basin fill and crystalline basement of 0.5 gm/cc is used. Preliminary results of the modeling assume the westward steeping of the basin from very shallow (10's of meters or less) at the eastern edge of the data lines to 4 to 6 km deep at the western edge of the lines. The modeling seems to indicate a southward steeping of the basin and a "pinching out" of some of the faults between data lines. More analysis and data gathering is needed before more definitive statements can be made.

GEOCHRONOLOGIC STUDIES OF IGNEOUS ROCKS FROM FLORIDA MOUNTAINS, NEW MEXICO, by *R. K. Matheney* and *D. G. Brookins*, Department of Geology, University of New Mexico, Albuquerque, NM

The igneous rocks of the Florida Mountains, near Deming, New Mexico, consist of a core complex of syenites, alkali granites, and some quartz monzonite, with lesser amounts of gabbro, diorite, and syenodiorite. These rocks, together with Paleozoic and younger sedimentary rocks, are abundantly cut by Tertiary rhyolitic and andesitic dikes. The core complex has been extensively studied by several investigators during the past 12 yrs. Corbitt (1971) and Corbitt and Woodward (1973) assigned a Mesozoic (?) age to these rocks, based on very limited geochronologic data, coupled with their interpretation of an intrusive origin for several syenite-sedimentary rock contacts. Denison (*in* Brookins, 1974) reported K–Ar and Rb–Sr mineral ages for syenites ranging from 420 to 550 MYBP, although he considered the older ages suspect. Brookins (1974, 1980) reported dates ranging from 400 MYBP for syenites, up to 1 BYBP for certain granites, with most of the ages falling in the early- to mid-Paleozoic. Clemons (1982), however, has stated that the syenites are Precambrian, reinterpreting several of Corbitt's intrusive contacts as faults and unconformities, and explaining the young dates for syenites as being a result of Tertiary resetting related to volcanic activity. Our present studies now include Rb–Sr whole rock analyses of some 35 samples of syenite, alkali granite, and gabbro, all of which define a 420 ± 20 MYBP isochron. To explain this age as being due to a resetting event demands perturbation of Rb–Sr whole rock systematics to an extent never before demonstrated. We consider this unlikely. Further, our recent field studies indicate the possibility of intrusive or low-angle fault contacts at sites where unconformable contacts have recently been proposed. If these observations are verified by additional field, petrographic, and chemical work, then Paleozoic plutonism is again proposed for some of the core rocks of the Florida Mountains.

GEOCHEMICAL STUDY OF ESTANCIA VALLEY PLAYAS, NEW MEXICO, by *H. A. Vogler* and *D. G. Brookins*, Department of Geology, University of New Mexico, Albuquerque, NM

We report on the geochemistry of playas from the Estancia Valley, New Mexico, as part of a generic study of playas from the western United States. To date some 80 solid playa samples have been analyzed by neutron activation analysis, primarily for trace elements, and some 40 waters analyzed by various methods for TDS and constituent chemistry. In addition, a few samples have been analyzed by stable isotopic analysis (C. J. Yapp, analyst) for D/H ratios. Solid playa samples are divided into those that are from surface, gypsiferous crusts; from clay mineral-rich zones 0.5–2 m below the surface; from 0 to 0.5 m (usually mixtures of clays with gypsiferous samples); and from dune deposits. Careful inspection of rare earth element (REE)/shale composite plots indicates mechanical mixing of surface with subsurface materials with no redox-controlled reactions active for the REE. This interpretation is corroborated by some 30 elemental variation diagrams. The playas are representative of both closed hydrologic basins and partially to largely open hydrologic basins. In the former, del-D values are −3 to −4 ‰, whereas for the latter a range in del-D from −30 to −77 is noted. Elemental concentrations in all samples show the following: 1) Most samples yield concentrations of As, Br, Se, Sb, I, Sr, Cl, U, and Cs above crustal average values for these elements. 2) Br, I, Cl, Sr, and U are enriched above average shale values, and As, Sb, and Se are marginally enriched above shale values. 3) Elements depleted in the playa samples include the REE, Fe, Mn, Co, Cr, Ta, Th, and Ba. 4) No trace elements are either enriched or depleted in the dune deposits relative to playa samples. Gradual accumulation of highly mobile elements (I, Cl, Br, U, Cs, Se, As, and Sb) in the playas is evident, and the depletion of the elements Mn, Fe, Ta, Th, Co, Cr, and the REE is due to their removal from transporting solutions far removed from the playas. These last elements do correlate with authigenic sulfides in the subsurface as expected. A complete material balance between solid and water samples is being attempted at present.

COMMENTS ON ECONOMIC VOLCANOLOGY BETWEEN REDROCK, NEW MEXICO, AND CLIFTON, ARIZONA, by *D. E. Wahl, Jr.*, P.O. Box 27285, Tempe, AZ

The 3,000 km^2, northwest-trending area from Redrock, New Mexico, to Clifton, Arizona, is composed chiefly of mid-Tertiary volcanic rocks which fill the wedge-shaped Blue Creek basin between basement highs at Redrock and Clifton. Calcalkaline Oligocene (35–30 m.y.) flows and tuffs are unconformably overlain by a more alkalic bimodal Miocene suite (25–18 m.y.). Composite mid-Tertiary thickness is 4$^+$ km in central parts of the Blue Creek basin. Within this substantial volcanic terrain, several environments of possible economic significance have been identified: 1) The southern ring-fracture zone of the Schoolhouse Mountain cauldron is mineralized. Other portions of the ring-fracture zone could offer exploration targets, especially where ring domes intrude porous moat-facies tuffs and volcaniclastic sediments. 2) Three widespread areas of intense argillic to quartz-alunitic alteration in the Steeple Rock district probably are loci of past near-surface (venting?) geothermal activity and could contain disseminated precious metal deposits. Much younger (Holocene) geothermal venting has deposited a fragile, well-preserved, selenite-bearing sinter in Bitter Creek. 3) Preliminary geochemical studies indicate that some of the youngest Blue Creek basin felsic intrusives are well differentiated, enriched in lithophile elements, and could potentially host porphyry molybdenum and precious metal deposits. One such intrusion contains anomalous precious metal values in a brecciated near-surface vent zone. The youngest, most highly differentiated high-silica rhyolites are approximately 18 m.y. old. Adularia associated with East Camp vein precious metal and fluorite mineralization has yielded similar ages. A causative relationship between late-stage rhyolite intrusion and some Steeple Rock district vein mineralization is suggested. ☞

STRATIGRAPHY AND PALEOENVIRONMENTS OF AN UPPER CRETACEOUS MARINE TO FLUVIAL FACIES TRANSITION, SIERRA COUNTY, NEW MEXICO, by *E. Timothy Wallin*, Department of Geology, New Mexico Institute of Mining and Technology, Socorro, NM

The Engle coal field of south-central New Mexico contains approximately 3,000 ft of interbedded Upper Cretaceous pebble conglomerates, sandstones, siltstones, mudrocks, and coals. These terrigenous clastics represent a marine to fluvial facies transition deposited during the widespread late Turonian–early Coniacian regression of the Western Interior seaway. The Rio Salado Tongue of the Mancos Shale is overlain by the tripartite Tres Hermanos Formation. The Atarque Sandstone Member represents deposition of a distributary mouth bar in a very shallow epeiric sea. Deposition of the Atarque provided a near sealevel platform upon which thin channel and crevasse-splay sandstones and carbonaceous mudrocks were deposited. Transgression of the seaway across these marginal marine and fluvial deposits is recorded by the Fite Ranch Sandstone Member, which consists of a thin transgressive lag deposit, and a thicker, regressive coastal barrier sandstone. The D-Cross Tongue of the Mancos Shale represents open marine conditions and contains three unnamed tongues of the Gallup Sandstone deposited during several minor progradational episodes. The overlying Mesaverde Group consists of nearshore marine and continental deposits. Well-developed shoreface and beach deposits of the Gallup Sandstone overlie the D-Cross Tongue of the Mancos Shale. The Crevasse Canyon Formation consists of a lower coal-bearing member, a middle barren member, and the Ash Canyon Member. Marginal marine and continental deposits of the Crevasse Canyon represent lagoonal, washover fan, coal swamp, and fluvial environments. Fluvial subenvironments are represented by channel thalweg, point bar, natural levee, crevasse-splay, swamp, and overbank deposits.

GEOLOGY OF COPPER OCCURRENCE AT COPPER HILL, PICURIS MOUNTAINS, NEW MEXICO, by *Michael L. Williams*, Department of Geology, University of New Mexico, Albuquerque, NM

Copper Hill, in the Picuris Mountains of northern New Mexico, is the expression of a west-plunging anticline of Ortega Quartzite. The Ortega Quartzite at Copper Hill has been divided into three stratigraphic units: massive quartzite (Og_1), kyanite quartzite (Og_2), and andalusite quartzite (Og_3). During structural deformation, the lower two quartzite units behaved brittlely, while Og_3 and the overlying Rinconada schists behaved ductilely. These ductile units formed an impermeable cap to a series of N. 10° east-trending quartz veins that cut the lower quartzite units. Oxidized copper minerals with silver, arsenic, and antimony occur in Og_1 and Og_2 quartzite and in the quartz veins on Copper Hill. The deposit, of probable Precambrian age, has been subjected to considerable metamorphism, deformation, and oxidation. Although a genetic model involving original strata-bound copper mineralization must be considered for the deposit, most evidence supports an origin involving epigenetic, although pre- or synmetamorphic, emplacement of copper minerals from a source at depth. □

Bryozoan and crustacean *(continued from p. 55)*

Lucas, S. G., 1981, Dinosaur communities of the San Juan Basin—A case for lateral variations in the composition of Late Cretaceous dinosaur communities; *in* Lucas, S. G., Rigby, J. K., Jr., and Kues, B. S. (eds.), Advances in San Juan Basin paleontology: University of New Mexico Press, Albuquerque, New Mexico, pp. 337–393.

Pearse, A. S., and Gunter, G., 1957, Salinity; *in* Hedgpeth, J. W. (ed.), Treatise on marine ecology and paleoecology: Geological Society of America, Memoir 67, v. 1, pp. 129–158.

Reeside, J. B., Jr., 1924, Upper Cretaceous and Tertiary formations of the western part of the San Juan Basin of Colorado and New Mexico: U.S. Geological Survey, Professional Paper 134, 70 pp.

Robison, C. R., Hunt, A., and Wolberg, D. L., 1982, New Late Cretaceous leaf locality from lower Kirtland Shale member, Bisti area, San Juan Basin, New Mexico: New Mexico Geology, v. 4, pp. 42–45.

Russell, L. S., 1975, Mammalian faunal succession in the Cretaceous System of western North America; *in* Caldwell, W. G. E. (ed.), The Cretaceous System in the Western Interior of North America: Geological Association of Canada, Special Paper 13, pp. 137–161.

Ryland, J. S., 1970, Bryozoans: London, Hutchinson & Co., 175 pp.

Shaw, N. G., 1967, Cheilostomata from Gulfian (Upper Cretaceous) rocks of southwestern Arkansas: Journal of Paleontology, v. 41, pp. 1,393–1,432.

Stanton, T. W., 1916, Contributions to the geology and paleontology of San Juan County, New Mexico, 3. Nonmarine Cretaceous invertebrates of the San Juan Basin: U.S. Geological Survey, Professional Paper 98–R, pp. 309–326.

Tidwell, W. D., Ash, S. R., and Parker, L. R., 1981, Cretaceous and Tertiary floras of the San Juan Basin; *in* Lucas, S. G., Rigby, J. K., Jr., and Kues, B. S. (eds.), Advances in San Juan Basin paleontology: University of New Mexico Press, Albuquerque, New Mexico, pp. 307–332.

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1982 bibliography released

The New Mexico Bureau of Mines and Mineral Resources has issued a second bibliographic publication in cooperation with the American Geological Institute and GeoRef Information System, *Bibliography and index of New Mexico geology*. This edition, containing approximately 1,000 references and cross references, represents published and unpublished material that was added to the GeoRef database in 1982. The components of this annual bibliography are: serials list, citations by senior author with cross references, subject index, county index, and rock-unit index.

Collecting and formating the references contained in this volume were done entirely by the staff of GeoRef Information System. Many publications released in 1982 are included; however, nearly 1/3 of the papers cited were released in 1981. Consequently, this volume is a valuable supplement to the previous edition, *Bibliography and index of New Mexico geology* for 1981, the first bibliography to be produced by GeoRef for the New Mexico Bureau of Mines and Mineral Resources. Neither volume is a comprehensive annual bibliography. Both contain additional citations for papers and reports released in earlier years; therefore, many citations may duplicate those appearing in earlier Bureau bibliographies or in its forthcoming bibliography for 1976–1980 (Bulletin 109).

The editors recognize the need for an annual reference volume to give researchers access to the most current literature on New Mexico geology. The New Mexico Bureau of Mines and Mineral Resources will continue to issue an annual bibliography as a supplement to its other bibliographic literature. Users of this volume and our other bibliographies are encouraged to contact the Bureau editing staff when errors or omissions are discovered and to comment critically on scope and format. We anticipate that annual coverage of the literature will become increasingly more comprehensive with each successive edition.

This 1982 edition of *Bibliography and index of New Mexico geology* sells for $6.50 and is available from the Publications Office, New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico 87801.

—Jane Calvert Love

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