Service/News

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

New publications

NMBMMR

***Circular 192**—Eocene tectonics and depositional setting of west-central New Mexico and eastern Arizona, by S. M. Cather and B. D. Johnson, 1984, 33 pp., 27 figs. $3.50

Discussed are the Carthage–La Joya Basin between south of Albuquerque and southeast of Socorro, the much larger Baca Basin reaching from northwest of Socorro to west of Showlow, Arizona, and the seven uplifts that border and in part delineate the two basins. Analysis includes the structural styles and geometries of the uplifts, depositional environments, and facies geometries in the basins and the influence of intrabasinal structures and adjacent uplifts on the basinal deposition.

***Circular 193**—Subsurface petroleum geology of Santa Rosa Sandstone (Triassic), northwest New Mexico, by R. F. Broadhead, 1984, 23 pp., 14 figs. $8.50

The Santa Rosa Sandstone occurs at depths of less than 2,000 ft over most of northeast New Mexico. The tar-sand deposit at Santa Rosa Lake is a classic example of an oil seep that indicates the possible presence of commercial oil accumulations in the shallow subsurface. The purpose of this report was to investigate the regional subsurface stratigraphy and structure of the Santa Rosa Sandstone with emphasis on the relationship of stratigraphy and petrography to the regional development of petroleum reservoirs.

***Geologic Map 55**—Geology of Pueblo Viejo Mesa quadrangle, Socorro and Cibola Counties, New Mexico, by J. C. Osburn, 1984, scale: 1:100,000. $3.50

Pueblo Viejo Mesa is located approximately 30 mi northwest of Magdalena. The study area lies in the Datil–Mogollon subprovince, a transition zone between the Basin and Range Province and the Colorado Province. The landscape is dominated by basalt-capped mesas and broad alluvial valleys.

NMERDI

***Map**—Geothermal resources map of New Mexico, by New Mexico Energy Research and Development Institute, 1984, scale 1:500,000

Paper base map (folded)	$5.00
Paper base map (flat)	$7.50
Full set (flat, paper base map and three mylar overlays—gravity, hydrology–geochemistry, and aeromagnetic data)	$30.00

USGS

COAL INVESTIGATIONS MAPS

C-92-B—Map showing structure contours on top of the Pictured Cliffs Sandstone and depths to the base of the Fruitland Formation, Chaco Canyon 30′ by 60′ quadrangle, San Juan, Rio Arriba, and Sandoval Counties, New Mexico, by N. W. Sweatt and J. W. Mytton, 1983, lat. 36° to 36° 30′, long. 107° to 108°, scale 1:100,000

MISCELLANEOUS FIELD STUDIES MAPS

MF-1183-Q—Preliminary map showing limonitic areas in the Silver City 1° × 2° quadrangle, Arizona and New Mexico, by G. L. Raines, 1984, lat. 32° to 33°, long. 108° to 110°, scale 1:250,000

***MF-1631-A**—Mineral resource potential map of the Sandia Mountain Wilderness, Bernalillo and Sandoval Counties, New Mexico, by D. C. Hedlund, D. E. Hendzel, and R. F. Kness, 1984, lat. about 35°07′30″ to 35°20′, long. 106°22′30″ to 106°30″, scale 1:50,000

PROFESSIONAL PAPERS

1241-A—Introduction to correlation of Precambrian rock sequences, by J. E. Harrison and Z. E. Peterman, 1984, 1 pl., 7 pp.

1286—Downstream effects of dams on alluvial rivers, by G. P. Williams and M. G. Wolman, 1984, 83 pp.

1306—Kaolin, refractory clay, ball clay, and halloysite in North America, Hawaii, and the Caribbean region, by S. H. Patterson and H. H. Murray, 1984, 56 pp., 17 tables, 22 figs.

1537-B—Porvenir Formation (new name)—and other revisions of nomenclature of Mississippian, Pennsylvanian, and Lower Permian rocks, southeastern Sangre de Cristo Mountains, New Mexico, by E. H. Baltz and D. A. Myers, 1984, 39 pp., 10 figs.

Other publications

Sedimentation, tectonism, and hydrocarbon generation in Delaware Basin, west Texas and southeastern New Mexico, by J. M. Hills, 1984: American Association of Petroleum Geologists, Bulletin, v. 68, no. 3, pp. 250–267, 13 figs.

Geologic investigations in support of a proposed carbon dioxide miscible flood in the MCA unit Maljamar–Grayburg/San Andres pool, Lea County, New Mexico, by R. W. Foster, 1984: New Mexico Energy Research and Development Institute, Final Report 2–68–3308, 236 pp., 15 oversized sheets

Santa Rosa oil sands project, by G. M. Forster, J. V. Fox, and S. S. Pao, 1984: New Mexico Energy Research and Development Institute, Final Technical Report 2–71–4604, 111 pp.

Evaluation of uranium anomalies in the southwest part of the Costilla massif, Taos County, New Mexico, by C. S. Goodknight and J. J. Dexter; *in* Goodknight, C. S., compiler, Reports on field investigations of uranium anomalies, 1984: U.S. Department of Energy, Report GJBX–1(84), part IV, 28 pp.

Evaluation of uranium anomalies in and adjacent to the Tusas Mountain granite, eastern Rio Arriba County, New Mexico, by C. S. Goodknight and J. J. Dexter; *in* Goodknight, C. S., compiler, Reports on field investigations of uranium anomalies, 1984: U.S. Department of Energy, Report GJBX–1(84), part V, 30 pp.

Geochemistry of hydrothermal sericite from Roosevelt Hot Springs and the Tintic and Santa Rita porphyry copper systems, by W. T. Parry, J. M. Ballantyne, and D. C. Jacobs, 1984: Economic Geology, pp. 72–86

U–Pb isotope systematics and apparent ages of uranium ores, Ambrosia Lake and Smith Lake districts, Grants mineral belt, New Mexico, by K. R. Ludwig, K. R. Simmons, and J. D. Webster, 1984: Economic Geology, pp. 322–337

The San Luis uplift, Colorado and New Mexico—an enigma of the ancestral rockies, by D. L. Baars and G. M. Stevenson, 1984: The Mountain Geologist, pp. 57–67

Geologic atlas of Texas, Tucumcari sheet, 1983: Bureau of Economic Geology, University of Texas (Austin), scale 1:250,000

Geologic studies during the development of the Copper Flat porphyry deposit, by P. G. Dunn, 1984: Mining Engineering, February, 1984, pp. 151–159

The Ortiz gold deposit (Cunningham Hill)—geology and exploration, by Alan Wright, 1983: Nevada Bureau of Mines and Geology, Report 36, pp. 42–51

Sampling and ore reserve estimation for the Ortiz gold deposit, New Mexico, by Mark Springett, 1983: Nevada Bureau of Mines and Geology, Report 36, pp. 152–164

Quaternary geology of the Rhodes Canyon (Ratscat) site, by J. W. Hawley, 1983; *in* Eidenbach, P. L. (ed.), The prehistory of Rhodes Canyon, New Mexico: Human Systems Research, Inc., pp. 17–32

Potentially active volcanic lineaments and loci in western conterminous United States, by R. L. Smith and R. G. Luedke, 1984; *in* Studies in geophysics: Washington, D. C., National Academy Press, pp. 47–66

Geology of gas production from "tight" Abo red beds, east-central New Mexico, by R. F. Broadhead, 1984, Oil and Gas Journal, v. 82, no. 24, pp. 147–150, 154–158, 1 table, 14 figs.

Marine and nonmarine salts of Western Interior, United States, by C. K. Wilgus and W. T. Holser, 1984, American Association of Petroleum Geologists, Bulletin, v. 68, no. 6, pp. 765–767, 1 table, 1 fig.

Potential for significant oil and gas fracture reservoirs in Cretaceous rocks of Raton Basin, New Mexico, by L. A. Woodward, 1984, American Association of Petroleum Geologists, Bulletin, v. 68, no. 5, pp. 628–636, 1 table, 5 figs.

Regional distribution of microdolomite inclusions in Mississippian echinoderms from southwestern New Mexico, by A. H. Leutloff and W. J. Meyers, 1984, Journal of Sedimentary Petrology, v. 54, no. 2, pp. 432–446, 2 tables, 9 figs.

Turbine-drive sample spinner for x-ray diffraction, by J. Renault, 1984, Review of Scientific Instruments, v. 55, no. 5, pp. 805–806

A window into Earth, by R. E. Riecker, 1984, Earth Science, v. 37, no. 1, pp. 21–23

Open-file reports

NMBMMR

***192**—Preliminary report on the geology and mineral-resource potential of Torrance County, New Mexico, by V. T. McLemore, 1984, 211 pp., 17 tables, 34 figs., 4 appendices, 20 maps $72.20

***193**—Historical review of uranium-vanadium production in the eastern Carrizo Mountains, San Juan County, New Mexico, and Apache County, Arizona, by W. L. Chenoweth and E. A. Learned, 1984, 29 pp., 1 map $7.30

***206**—Organic geochemical analysis, Houston Oil and Minerals No. 2 Lewelling well, Otero County, New Mexico, by S. R. Jacobson, J. S. Rankin, J. D. Saxon, and S. W. Brown, 1983, 17 pp. $3.40

***208**—Bibliography of reports by U.S. Geological Survey personnel on studies of underground nuclear test sites and on Waste Management Studies at the Nevada Test Site and the Waste Isolation Pilot Plant Site, New Mexico, January

1 to December 31, 1982, by V. M. Glanzman, 1984, 17 pp. $3.40

*209—Hydrocarbon source-rock evaluation study, Getty Oil Co. No. 1 West Elephant Butte Federal well, Sierra County, New Mexico, by D. A. Muckelroy, R. R. Schwarzer, and T. J. Stiff, Jr., 1983, 91 pp. $18.20

*210—Hydrocarbon source-rock evaluation study, Getty Oil Co. No. 2 West Elephant Butte Federal well, Sierra County, New Mexico, by D. A. Muckelroy, R. R. Schwarzer, and T. J. Stiff, Jr., 1983, 92 pp. $18.40

USGS

83–203—Hydrology of area 60, northern Great Plains and Rocky Mountain coal provinces, New Mexico, Colorado, Utah, and Arizona, by F. E. Roybal et al., 140 pp.

83–696—Long-range plans for hydrologic investigations in New Mexico, by H. L. Case, III, and G. E. Welder, 29 pp.

***83–701**—Measured stratigraphic sections of uranium-bearing Upper Triassic rocks of the Dockum Basin, eastern New Mexico, west Texas, and the Oklahoma Panhandle, with brief discussion of stratigraphic problems, by W. I. Finch and J. C. Wright, 1984, 123 pp.

***84–170**—Preliminary report on the petrology of the Upper Jurassic Morrison Formation, Mariano Lake–Lake Valley drilling project, McKinley County, New Mexico, by B. A. Steele, 1984, 46 pp., 7 over-sized sheets (not reproducible)

84–225—United States earthquake data file, by C. W. Stover, B. G. Reagor, and S. T. Algermissen, 1984, 123 pp., 2 tables (New Mexico data on pp. 57–64)

This report is a revised and updated (through 1980) list of earthquakes that was originally used in a study of seismic risk in the United States (Algermissen, 1969).

***83–349**—Methodology, geology, and listing of analyses of helium samples in the Bisti, De-na-zin, and Ah-shi-sle-pah Wilderness study areas, San Juan County, New Mexico, by J. M. Been, J. R. Hassemer, and D. G. Murrey, 1984, 9 pp.

U.S. Bureau of Mines

MLA–15–84—Mineral investigation of the Cruces Basin wilderness area, Rio Arriba County, New Mexico, by B. J. Hannigan, 1984, 11 pp., 2 tables, 2 figs.

MLA–20–84—Mineral investigation of the Capitan Mountains Wilderness area, Lincoln County, New Mexico, by S. E. Tuftin, 1984, 20 pp., 5 figs.

New projects

USGS

9950–03816—Chaco seismology study, by Kenneth King. The National Park Service has requested that the USGS study the effect of increased levels of ambient and transitory ground motions (from road building, gravel mining, and traffic noise) at fragile historic sites in order to determine the level of ground motions occurring at the sites and the ground-motion level at which damage to the ruins is likely and to recommend stand-off distances to sources of ground motion that may be damaging. Projected completion date: October 1984.

9530–03823—Upper Cenozoic Tephrochronology, by G. A. Izett. The primary objectives of this study are: to make integrated studies of Oligocene to Recent volcanic ash beds in the Central U.S. region (and adjoining areas as required); to identify their source-area tephras; and to construct an isotopically dated, stratigraphic sequence of volcanic ash beds for Oligocene to Recent time where each ash bed is chemically, mineralogically, paleomagnetically, and petrographically defined. Projected completion date: September 1989.

9380–03824—Nonlinear complex resistivity logging of clay-petroleum reactions, by G. R. Olhoeft. Problems arise with borehole logging, which is necessary to oil and gas exploration, reservoir development, and royalty accounting, because of the presence of clay minerals ("shaly sand" problem). Nonlinear complex resistivity methods will be used in this project to measure clay-water and clay-organic reactions in order to improve logging measurement and interpretation. Projected completion date: October 1984.

Graduate theses

The following is a list of theses on New Mexico geology received within two years by NMBMMR. They are available for inspection from the NMBMMR Information Resource Center, Socorro, NM 87801.

Arkell, Brian W., 1983, Geology and coal resources of the Cub Mountain area, Sierra Blanca coal field, New Mexico: M.S. thesis, New Mexico Institute of Mining and Technology, 104 pp., 7 tables, 15 figs., appendix, 3 pls.

Bobrow, Danny J., 1984, Geochemistry and petrology of Miocene silicic lavas in the Socorro–Magdalena area of New Mexico: M.S. thesis, New Mexico Institute of Mining and Technology, 285 pp., 13 tables, 22 figs., 7 appendices.

Boyd, Thomas L., 1983, Geology and joint pattern study of the Turkey Mountains, Mora County, New Mexico: M.S. thesis, West Texas State University, 120 pp., 1 table, 21 figs., 3 appendices, 1 pl.

Brown, Timothy J., 1983, Facies, paleoecology, and paleoenvironment of a *Crassostrea Soleniscus* (Meek) reef complex, Cretaceous, San Juan Basin, New Mexico: M.S. thesis, University of Arizona, 116 pp., 1 table, 29 figs., appendix, 1 sheet.

Jameossanaie, Abolfazl, 1983, Palynology and environments of deposition of the Lower Menefee Formation (Lower Campanian), South Hospah area, McKinley County, New Mexico: Ph.D. dissertation, Michigan State University, 294 pp., 2 tables, 13 figs., 28 pls.

Kent, Gretchen R., 1983, Temperature and age of precious metal vein mineralization and geochemistry of host rock alteration at the Eberle mine, Mogollon mining district, southwestern New Mexico: M.S. thesis, Michigan Technological University, 146 pp., 8 tables, 41 figs, 3 appendices.

Klich, Ingrid, 1983, Precambrian Geology of the Elk Mountain–Spring Mountain area, San Miguel County, New Mexico: M.S. thesis, New Mexico Institute of Mining and Technology, 159 pp., 8 tables, 50 figs., 5 appendices, 1 pl.

Kondelin, Robert J., 1984, Stratigraphy and microfacies analysis of the Ordovician System, North Franklin Mountains, Doña Ana County, New Mexico: M.S. thesis, University of Texas (El Paso), 215 pp., 1 table, 18 figs., 4 appendices, 34 pls.

Macer, Robert J., 1978, Fluid inclusion studies of fluorite around the Organ cauldron, Doña Ana County, New Mexico: M.S. thesis, University of Texas (El Paso), 107 pp., 9 tables, 25 figs., 2 appendices, 1 pl.

Madden, H. Douglas, 1984, Stratigraphy and microfacies analysis of the Mississippian System, North Franklin Mountains, Doña Ana County, south-central New Mexico: M.S. thesis, University of Texas (El Paso), 266 pp., 2 tables, 44 figs., 3 appendices, 1 pl.

Newcomer, Robert W., Jr., 1984, Geology, hydrothermal alteration and mineralization of the northern part of the Sugarloaf Peak quartz monzonite, Doña Ana County, New Mexico: M.S. thesis, New Mexico State University, 108 pp., 17 tables, 27 figs., 2 appendices, 2 pls.

Powell, Darron L., 1983, The structure and stratigraphy of the Early Cretaceous of the southernmost East Potrillo Mountains, Doña Ana County, New Mexico: M.S. thesis, University of Texas (El Paso), 126 pp., 3 tables, 12 figs., 2 appendices, 17 pls.

Staples, Martin E., Jr., 1984, Geology and mineralization, West Lime Hills, Luna County, New Mexico: M.S. thesis, University of Missouri (Rolla), 91 pp., 3 tables, 39 figs., 2 appendices.

West, Charlotte W., 1984, Environmental stratigraphy of the Dakota Sandstone–Mancos Shale transition in the southern San Juan and eastern Black Mesa Basins (New Mexico and Arizona): M.S. thesis, University of Arizona, 100 pp., 11 figs., appendix.

Symposium

The Denver region Exploration Geologists Society will convene its 1985 symposium entitled *Organics and ore deposits* from April 25–26, 1985 at the Regency Inn, Denver, Colorado. The nature, occurrence, and interaction of organic matter and organisms with metallic mineralization will be examined; emphasis will be placed on exploration, precious metals, and ore genesis. To obtain further information on the symposium, contact Stege Communications, 7444 Queen Circle, Arvada, Colorado 80005, 303/424–0505.

USGS

TOPOGRAPHIC MAPS—NEW (scale 1:24,000)

	yr	lat.	long.	contour (ft)
Chama (NM–CO)	1978–83	36°52′30″	106°30′	20
Chromo Mountain	1978–83	36°52′30″	106°37′30″	20
Las Nutrias	1978–83	36°30′	106°30′	20
Monero (NM–CO)	1978–83	36°52′30″	106°45′	20
Toltec Mesa	1978–83	36°52′30″	106°15′	20

INTERMEDIATE BLM TOPOGRAPHIC MAPS (scale 1:100,000)

	yr	lat.	long.	contour (m)
Farmington (NM–CO)	1980	36°30′	108°	20
Oscura Mountains	1982	33°30′	106°	20
Tularosa	1981	33°	106°	20
White Sands	1982	32°30′	106°	20

Abstracts

American Association of Petroleum Geologists, Bulletin, v. 68, no. 7, July 1984

ALTERATION OF MAGNETITE AND ILMENITE IN UPPER JURASSIC MORRISON FORMATION, SAN JUAN BASIN, NEW MEXICO—RELATIONSHIP TO FACIES AND PRIMARY URANIUM MINERALIZATION, by N. S. Fishman, C. E. Turner–Peterson, and R. L. Reynolds, p. 937

NACIMIENTO UPLIFT AND ITS SIMILARITY TO FORELAND UPLIFTS WITH ASSOCIATED PRODUCTION, by M. L. Pinnell, p. 945

Geological Society of America, Northeastern Section annual meeting, Abstracts with Programs, v. 16, no. 1, 1984

PALYNOSTRATIGRAPHIC SIGNIFICANCE OF PALYNOFLORA AND SPORE-BEARING ORGANS OF TRIASSIC FERNS OF THE CHINLE FORMATION OF ARIZONA AND NEW MEXICO, by R. J. Litwin and A. Traverse, Pennsylvania State University, University Park, PA, p. 47

THE FRASNIAN–FAMENNIAN EXTINCTION EVENT AS RECORDED BY DEVONIAN ARTICULATE BRACHIOPODS IN NEW MEXICO, by J. T. Dutro, Jr., U.S. Geological Survey, Washington, D.C., p. 14

Geological Society of America, South-central Section annual meeting, Abstracts with Programs, v. 16, no. 2, 1984

MORROWAN BRACHIOPODS IN THE TYPE "DERRYAN" SERIES (PENNSYLVANIAN), NEW MEXICO, by P. K. Sutherland, University of Oklahoma, Norman, OK, and W. L. Manger, University of Arkansas, Fayetteville, AR, p. 115

GEOCHRONOLOGIC STUDY OF EVAPORITE MINERALS, DELAWARE BASIN, NEW MEXICO, by D. G. Brookins, University of New Mexico, Albuquerque, NM, p. 79

RB–SR DATING OF SEDIMENTARY ROCKS FROM THE SAN JUAN BASIN, NEW MEXICO, by D. G. Brookins, University of New Mexico, Albuquerque, NM, p. 79

New Mexico Geological Society

The New Mexico Geological Society held their annual spring meeting at the New Mexico Institute of Mining and Technology (Socorro) on April 27, 1984. Following are abstracts from talks given at that meeting. Abstracts of talks from this meeting concerning gold and silver will be published as NMGS Special Publication 11 in early 1985.

STRATIGRAPHY, STRUCTURE, AND GEOCHEMISTRY OF VOLCANIC ROCKS IN THE NORTHERN BLACK RANGE, SIERRA COUNTY, NEW MEXICO—EVIDENCE FOR THE NORTHERN MARGIN OF THE EMORY CAULDRON, LAT. 33°15′00″N., by *R. J. Abitz*, University of New Mexico, Albuquerque, NM 87131

The margin of a mid-Tertiary volcano–tectonic structure, the Emory cauldron, lies in the northern Black Range. Kneeling Nun Tuff (the ash-flow tuff of the Emory cauldron) crops out in a massive section (300 m) 2 km south of lat. 33°15′00″N. The stratigraphic sequence outside the structural caldera wall includes: Rubio Peak Formation, andesite lava and agglomerate, 335 m thick, initial Sr^{87}/Sr^{86} of 0.7061; unconformity; porphyritic andesite of North Fork Palomas Creek, intrusive lava (interpreted as the defluidized residue of the Emory cauldron magma), initial Sr^{87}/Sr^{86} of 0.7076; Mimbres Peak Formation, rhyolite tuff, breccia, intrusive lava and volcaniclastic deposits (interpreted as moat and ring-fracture deposits of the Emory cauldron), bedded deposits 165 m thick, initial Sr^{87}/Sr^{86} of 0.7141; unconformity; andesite of McKnight Mountain, lava and volcaniclastic deposits, 140 m thick; disconformity; Caballo Blanco Tuff, rhyolite ash flow, 110 m thick, initial Sr^{87}/Sr^{86} of 0.7135; disconformity; andesite of Poverty Creek, lava and lahar deposits, 235 m thick, initial Sr^{87}/Sr^{86} of 0.7060; unconformity; rhyolite of Little Mineral Creek, lithic tuff and flow-banded lava, 120 m thick, initial Sr^{87}/Sr^{86} of 0.7121; tuff of Diamond Creek, bedded ash flows, 320 m thick, initial Sr^{87}/Sr^{86} of 0.7332; unconformity; rhyolite of Franks Mountain, intrusive lava plugs; Bearwallow Mountain Formation, basalt and basaltic andesite lavas, 55 m thick, initial Sr^{87}/Sr^{86} of 0.7071. The northern Black Range is a homocline, dipping 5–40° NW. West- to northwest-striking normal faults (dip 52–68° S or SW; slickenslides plunge 46–58° SE) show greatest stratigraphic separation in Rubio Peak Formation, which suggests that they formed during collapse of the Emory cauldron, about 34 Ma. North- to northeast-striking normal faults (dip 74–85° NW or SE; slickenslides plunge 71–82° NE or SW) cut west to northwest faults and probably formed during post-20 Ma Basin and Range extension. XRF analyses show sympathetic variation of K_2O, antipathetic variation of MgO, CaO, TiO_2, $Fe_2O_3(T)$, Al_2O_3 and P_2O_5 and invariant behavior for Na_2O, if plotted against SiO_2. $K_2O + Na_2O$ versus SiO_2, A–F–M and An–Ab–Or plots suggest a subalkalic calc-alkalic classification. INAA analyses show sympathetic variation of Rb, Cs, light REE, Th, and U and antipathetic variation of Sr, Ba, Sc, V, Co, and Zn if plotted against SiO_2. Chondrite-normalized REE patterns for Rubio Peak, Poverty Creek and Bearwallow Mountain Formations have negative slopes, no Eu anomalies and REE increase with time, whereas North Fork Palomas Creek, Mimbres Peak, Caballo Blanco, Little Mineral Creek and Diamond Creek Formations have negative slopes and negative Eu anomalies. Trace elements, REE patterns and initial Sr^{87}/Sr^{86} suggest partial melting of volatile-rich upper mantle as a source for Rubio Peak, Poverty Creek, and Bearwallow Mountain Formations, lower crust for North Fork Palomas Creek, Mimbres Peak, Caballo Blanco, and Little Mineral Creek Formations, and upper crust for tuff of Diamond Creek.

DETERMINATION OF SOURCE CHARACTERISTICS FOR RECENT MICROEARTHQUAKE SWARMS IN THE SOCORRO AREA, by *J. P. Ake, S. P. Jarpe,* and *A. R. Sanford*, New Mexico Institute of Mining and Technology, Socorro, NM 87801

During May and July 1983 two distinct microearthquake swarms occurred beneath Socorro Mountain in central New Mexico. More than 700 events (35 with magnitudes greater than 0.0) were detected at the closest station. HYP071 locations of the 60 strongest events indicate the hypocenters for both swarms were confined to a small volume of crust with an average focal depth of 8.8 km. Hypocentral migration appears to be less than 1 km. Digital data (at 100 sps) was acquired during most of the May swarm and all of the July swarm. The most striking feature of the digital data is the duplication of the P-phase up to, but not beyond, a magnitude of 1.2. The P-phase duplication is consistent throughout even though the S-phase is not well represented by a single waveform. A wide range in the S-phase to P-phase amplitude ratio ($0.20 < S/P < 6.37$) precludes the simple compositing of first motion data for fault plane solutions. This complexity further indicates that the earthquakes probably did not occur on a single straight planar fault. Rupture appears to have occurred on a rapidly curving fault or on closely spaced, separate faults with different orientations. The time between P-wave onset and first zero crossing ($T_{1/2}$) was measured and is the same (0.36 ± 0.003 sec) up to a local magnitude of 1.2. Constant $T_{1/2}$ with changing seismic moment indicates the events with magnitude less than 1.2 are merely the impulse response of the path between source and receiver. This implies the waveforms of the smaller events may be treated as empirical Green's functions for the medium (Frankel and Kanamori, 1983). This fact then allows simple calculations of rupture duration, source radius, and hence, stress drop to be made for events with magnitudes greater than 1.2.

SEISMIC WAVE ATTENUATION IN THE UPPER CRUST OF THE RIO GRANDE RIFT NEAR SOCORRO, NEW MEXICO, by *P. J. Carpenter* and *A. R. Sanford*, New Mexico Institute of Mining and Technology, Socorro, NM 87801

Spectra from more than 400 digitally recorded microearthquakes in the magnitude range −0.8 to 1.2 were used to compute apparent seismic quality factors (Q) for upper crust rocks (0–19 km) within 45 km of Socorro. In this study apparent Q is a measure of seismic wave attenuation due to intrinsic absorption and scattering. It was found that: 1) Relatively low Qp and Qs regions exist at depths of 7–10 km beneath Socorro Peak and the southwestern part of La Jencia Basin. These relatively low Q regions may result from small magmatic intrusions or a high density of fluid-filled fractures at depth; 2) Near-surface, low-Q regions have a profound effect on apparent Qp or Qs measured at the surface. Near-surface, low-Q regions vary from 0.3–2 km in thickness and exhibit Q values less than 50 and often less than 10; 3) Qp/Qs varies from less than 0.5 to approximately 1.0. The observed Qp/Qs depends on the event distance; 4) The average Qs for the upper crust in the central Rio Grande rift, excluding the near-surface, low-Q layer, is greater than 500.

PUNCTUATED EVOLUTION OF A LATE CRETACEOUS CERATOPSIAN DINOSAUR FROM NEW MEXICO, by *Adrian Hunt*, New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801 and *S. G. Lucas*, University of New Mexico, Albuquerque, NM 87131

It is difficult to test models of species-level evolution for dinosaurs because sample sizes are small, basic taxonomy is inadequate, and the stratigraphic density of samples is low. Nevertheless, a case for the punctuated origin of the long-crested ceratopsian *Torosaurus* can be made. The putative ancestor of *Torosaurus* is *Pentaceratops*, a long-crested ceratopsian known only from the Upper Cretaceous Fruitland and Kirtland Formations in the San Juan Basin, New Mexico. *Pentaceratops* is known from one species, *P. sternbergii* (*P. fenestratus*), which ranges from late Campanian (Fruitland Formation) through late Maastrichtian (Naashoibito Member of Kirtland Shale) without undergoing any evident morphological change. *P. sternbergii* thus appears to represent an isolated, evolutionarily static species for five or more million years. In the San Juan Basin, *Torosaurus* first appears in the late Maastrichtian Naashoibito Member of the Kirtland Shale. *Torosaurus* also is known from temporally equivalent (or slightly younger?) strata in Texas (Javelina Formation), Utah (North Horn Formation), Wyoming (Lance Formation), and South Dakota (Hell Creek Formation). There are no morphological intermediates between *Pentaceratops* and *Torosaurus*. The morphology and distribution in time and space of *Pentaceratops* and *Torosaurus* conform well with a punctuated model of evolution. There is an evolutionarily static and isolated ancestral species (*Pentaceratops*) and a morphologically distinct descendant species (*Torosaurus*). The temporal range of the ancestor and descendant overlap, and the descendant species achieved a much broader geographic distribution than its ancestor. However, a more detailed understanding of ceratopsian taxonomy and phylogeny is needed to further corroborate the case of punctuated evolution in *Pentaceratops–Torosaurus*.

POSSIBLE CAUSE OF AN EARTHQUAKE SWARM IN THE CENTRAL RIO GRANDE RIFT, by *S. P. Jarpe* and *A. R. Sanford*, New Mexico Institute of Mining and Technology, Socorro, NM 87801

Between February 25 and March 16, 1983, an earthquake swarm consisting of approximately 300 recorded shocks (100 above magnitude 0.0) occurred 28 km north of Socorro. Included within the swarm was a magnitude 4.0 earthquake, the largest in the Socorro area since 1961. A temporary seismograph array surrounding the swarm area, in addition to the eight permanent stations in the Socorro network, allowed precise locations of many of the larger earthquakes. Most of the earthquakes occurred at depths between 5 and 8 km, but there appeared to be no systematic migration of hypocenters with time. The 30 earthquake hypocenters with small errors (< 0.5 km) seem to define a planar area that strikes north–northwest and dips 50° to the northeast. The orientation of this plane roughly agrees with the composite fault plane solution for the swarm, which indicates normal faulting on a plane that strikes in a northerly direction. The roughly north–south trends of the hypocenters and the fault plane solution also agree well with the extensional stress regime of the Rio Grande rift, including the strikes of recent fault scarps in the area. The swarm is located at the center of a region of surface uplift defined by level-line data, and above an extensive (> 1700 km^2) layer of magma at a depth of 19 ± 0.6 km. A possible cause for the swarm is that upward migration of magma from the mid-crustal magma body produced movement on pre-existing faults.

ORTEGA QUARTZITE AT CERRO AZUL, by *Gerald J. Kepes*, University of New Mexico, Albuquerque, NM 87131

Cerro Azul is a block of Precambrian quartzite located 35 km southwest of Taos in the Rio Grande rift. The quartzite at Cerro Azul bears a marked similarity to the Ortega Quartzite exposures in the Tusas and Picuris Mountains. Cerro Azul is in close proximity to the Ortega Quartzite exposed at the Picuris cliffs, 8 km to the east. The quartzite at Cerro Azul displays structural continuity with the major trends recognized in the Picuris. The Cerro Azul quartzite displays a bedding-parallel foliation defined by dark minerals, which is commonly folded into tight to isoclinal folds. The same style of folding is common in the Ortega Quartzite at Kiowa Mountain in the Tusas. A crosscutting foliation at Cerro Azul is readily apparent in the field and is similar to a fabric present at the Kiowa Mountain exposure. The deformation best seen in the bedding-parallel foliation implies folding and shear in a ductile regime. The presence of the aluminosilicate triple-point assemblage, kyanite, sillimanite, and viridine (Mn-andalusite), indicate temperature and pressure conditions sufficiently high enough for ductile deformation. Similar structural trends, deformational fabrics, and pressure–temperature conditions suggest that the quartzite at Cerro Azul is correlative with the Ortega Quartzite in the Tusas and Picuris Mountains.

MIDDLE JURASSIC STRATIGRAPHY AND FOSSIL FISHES, BULL CANYON, GUADALUPE COUNTY, EAST-CENTRAL NEW MEXICO, by *K. K. Kietzke*, and *S. G. Lucas*, University of New Mexico, Albuquerque, NM 87131

In Bull Canyon, east-central New Mexico (S$^1/_2$, T. 9 N., R. 26 E.), a lacustrine interval within the eolian Exeter Sandstone contains numerous fossils of actinopterygian fishes. This lacustrine interval is up to 1.5 m thick and consists of three units: 1) A basal clastic unit of crossbedded sandstone, planar bedded, silty sandstone and varved shale with some sandstone lenses (70± cm); 2) a middle carbonate unit of flaggy and varved limestone overlain by varved calcareous shale (50± cm); and 3) an upper vug–limestone unit of varved limestone with vugs often filled with secondary calcite (16± cm). In SW$^1/_4$NE$^1/_4$SE$^1/_4$, sec. 29, T. 9 N., R. 26 E. fossils of actinopterygian fishes abound in the basal varved limestone of the middle carbonate unit. Two fish species, "*Pholidophorus*" *americanus* and "*Leptolepis*" *schoewei*, are very common as articulated, entire fish that are dorso-ventrally flexed on bedding planes. These fish species are the same taxa that are present in the Todilto Formation of the Colorado Plateau, the "Ralston Creek Formation" of south-central Colorado and the Sundance Formation of Wyoming, Montana, and South Dakota. This indicates that the fish-bearing limestone in Bull Canyon is of middle Jurassic (Callovian) age. It also suggests that the lacustrine interval in Bull Canyon either represents part of the Todilto Lake basin (and should be assigned to the Todilto Formation) or represents a separate lake contemporaneous with the Todilto Lake. In addition, correlation with the Todilto Formation indicates that at Bull Canyon the Exeter Sandstone below the lacustrine interval is homotaxial with the Entrada Sandstone of the Colorado Plateau, and the Exeter Sandstone above the lacustrine interval is homotaxial with the Cow Springs/Bluff Sandstones of the Colorado Plateau.

BIVALVES FROM THE RED TANKS MEMBER, MADERA FORMATION (UPPER PENNSYLVANIAN–LOWER PERMIAN), OF CENTRAL NEW MEXICO, by *B. S. Kues*, University of New Mexico, Albuquerque, NM 87131

The Red Tanks Member in the Lucero Mesa area west of Los Lunas consists predominantly of alternating marine limestones, calcareous shales, and nonmarine deltaic red and green shales and siltstones. Local abundance and relatively high diversity of bivalves in some Red Tanks units provide data concerning the age of the member and the paleoenvironmental preferences of many of the species. Thin, probably brackish, black "paper shale" units immediately above and below a thin coal seam in the lower half of the member contain numerous leaf fragments, smooth-shelled ostracods, and a numerically abundant, but poorly diverse, bivalve fauna dominated by *Dunbarella whitei* and *Myalinella meeki*. Brown to dark gray shales overlying the nonmarine units are dominated by molluscs; conspicuous bivalves include large numbers of the nuculoids *Nuculopsis levatiformis* and *Phestia bellistriata*, along with *Aviculopecten basilicus*, *Edmondia* aff. *E. nebrascensis*, *Permophorus* aff. *P. mexicanus*, *Pteronites nebrascensis*, and *Myalina* (*Orthomyalina*) *subquadrata*. Occurrence of the last species is restricted mainly to a thin zone representing a dense shell layer that locally covered a nearshore seafloor. More offshore marine units, such as massive gray argillaceous limestones with calcareous shale interbeds near the middle of the Red Tanks, contain a relatively diverse bivalve assemblage (about 20 species); however, bivalves are numerically much less abundant than productoid brachiopods. Characteristic bivalve taxa in these brachiopod-dominated units include *Septimyalina burmai*, *Aviculopecten basilicus*, *Edmondia* aff. *E. nebrascensis*, *Pteronites* sp., *Pseudomonotis hawni*, and *Schizodus alpinus*. *Myalina* (*Myalina*) aff. *M.* (*M.*) *wyomingensis* occurs in large numbers in some shale beds in this marine sequence where brachiopod abundance is relatively low. Two steinkerns may represent an early occurrence of *Eoastarte*, reported previously from the Yeso and San Andres Formations of New Mexico. Bivalves are sparsely present in the green and maroon shales and concretionary limestones near the top of the Red Tanks; virtually all specimens are myalinids or *Permophorus*. As a whole, the Red Tanks bivalve fauna is similar to that of Midcontinent early Wolfcampian units. Although some long-ranging Pennsylvanian species are present in Red Tanks, such forms as *N. levatiformis*, *A. basilicus*, *P. hawni*, *S. burmai*, *M.* (*O.*) *subquadrata*, and *Eoastarte*? sp. suggest an early Wolfcampian (Early Permian) age.

BIOSTRATIGRAPHIC SIGNIFICANCE OF *CORYPHODON* SPECIES FROM THE REGINA MEMBER (LOWER EOCENE), SAN JOSE FORMATION, SAN JUAN BASIN, NEW MEXICO, by *S. G. Lucas*, University of New Mexico, Albuquerque, NM 87131

Three species of *Coryphodon* (Mammalia, Pantodonta) are present in the Regina Member of the San Jose Formation: *C. simus* (Cope, 1874); *C. molestus* [=*C. lomas* (Cope, 1874), =*C. elephantopus* (Cope, 1874), =*C. latidens* (Cope, 1875), =*C. cuspidatus* (Cope, 1875), =*C. obliquus* Cope, 1877, =*C. curvicristis* Cope, 1882, =*C. wortman* Osborn, 1898]; and *C. lobatus* Cope, 1877 [=*C. anax* Cope, 1881, =*C. ventanus* Osborn, 1898]. *C. simus* is endemic to the San Juan Basin, but is a very advanced species of *Coryphodon* (M^{1-3} lack postprotocristae; M_3 is bilophodont) that arguably is younger than early Wasatchian (Gray Bull biostratigraphic zone). In the Willwood Formation (Bighorn Basin, Wyoming), *C. molestus* first appears in the *Bunophorus* interval zone and ranges through the upper *Heptodon* range zone. In the Willwood Formation, *C. lobatus* first appears in the upper *Haplomylus–Ectocion* range zone and also ranges through the upper *Heptodon* range zone. Both *C. molestus* and *C. lobatus* also are found in the Lysite and Lost Cabin Members of the Wind River Formation, Wind River Basin, Wyoming. This distribution of *C. molestus* and *C. lobatus* in Wyoming suggests that the Regina Member, at its oldest, is equivalent to the upper Gray Bull biostratigraphic zone; however, probably it is younger and is either equivalent to the Lysite or Lost Cabin biostratigraphic zones. Therefore, earlier suggestions that the Regina Member is equivalent to the Lysite biostratigraphic zone are consistent with the *Coryphodon* species present.

COMPARISON OF COPPER-BEARING SKARN DEPOSITS IN THE CENTRAL MINING DISTRICT, NEW MEXICO, by *V. W. Lueth*, University of Texas (El Paso), El Paso, TX 79968

A detailed study of skarn mineralization in the Lake Valley Formation and Magdalena Group in the Central mining district indicates the presence of two different types of copper skarns. One type is associated with porphyry copper stocks at Santa Rita and the Continental mine and the other is a barren-stock copper skarn at Piños Altos. The porphyry types are characterized by massive texture with extensive crosscutting mineralization resulting from contemporaneous deformation and mineralization. Barren-stock copper skarns are coarse grained, mineralogically zoned, and show a preservation of early-stage skarn minerals. Three stages of skarn growth can be recognized: 1) a thermal stage characterized by isochemical recrystallization, 2) a metasomatic stage represented by extensive garnet and pyroxene zones resulting from the addition of chemical components, and 3) a retrograde stage evidenced by ore mineral deposition and hydrous alteration of previously formed minerals. Porphyry skarns show greater development of garnet, crosscut, mineralized quartz veins, and they are partial to total destruction of thermal-stage mineralization. Fluid inclusion data and detailed mineralogy of the metasomatic phases (derived from electron microprobe analysis) are being performed to determine physiochemical parameters responsible for any systematic differences in mineralization in the two types of copper skarns. Previous work indicates an increase in fluid inclusion temperatures with time in porphyry skarns (Ahmad and Rose, 1978). Petrographic work shows the lack of extensive metasomatic and retrograde phases at Piños Altos. This may be the result of a cooling of hydrothermal fluids with time or the lack of an adequate fracture system for passage of late-stage hydrothermal fluids.

PRELIMINARY SEISMIC AND D.C. RESISTIVITY SURVEYS IN MOUNTAINVIEW, NEW MEXICO, by *K. D. Mahrer* and *J. R. Wesling*, University of New Mexico, Albuquerque, NM 87131

Seismic refraction and D.C. resistivity sounding surveys were conducted in Mountainview, New Mexico, to test the feasibility of using these methods for locating the water table and possible variations in ground-water quality in this area. Mountainview, located along the Rio Grande directly south of Albuquerque, has received much attention since 1961 when high concentrations of nitrate were reported to be contaminating domestic-water supplies. The surveys were conducted on floodplain sediments of the Rio Grande, which constitute the main aquifer for the region. Two sites approximately 2.0 km apart were investigated with multiple lines run at each site. Each seismic refraction line consisted of a 12-geophone takeout with typical geophone separation of 3.0 m. Using the slope-intercept interpretation method, the seismic data consistently indicated a two-velocity profile: a low velocity, surface layer (0.20 km/sec to 0.35 km/sec) of thickness between 3.0 to 5.0 m overlaying a higher velocity layer (1.5 km/sec to 1.6 km/sec) believed to be the water-saturated zone. Schlumberger arrays with maximum AB/2 separation of 50.0 m were used in the resistivity sounding lines. Interpretation of these data sets is still in progress, but preliminary findings show a strong consistency between profiles taken at the same sites and a variation in profiles between the two sites. This variation may be an indication of a difference in water conductivity.

RATES AND AMOUNTS OF QUATERNARY FAULTING ON THE VLA FAULT SCARP, NORTHEASTERN SAN AGUSTIN PLAINS, by *C. M. Menges*, *G. H. Kawaguchi*, *J. Ritter*, and *L. D. McFadden*, University of New Mexico, Albuquerque, NM 87131 and *R. P. Lozinsky*, New Mexico Tech, Socorro, NM 87801

Fault scarp morphology and soil–geomorphic studies of a major north–south-trending fault scarp (VLA scarp) offsetting late Quaternary surficial deposits in the northeastern San Agustin Plains, west-central New Mexico, define the amounts, timing, and rates of Quaternary displacements. A soil chronosequence (Ritter and others, this volume, p. 86) that developed on geomorphic surfaces near the scarp suggests a mid–early Pliocene age for Q1 pediment fans, an older late Pleistocene age for Q2 inset fill terraces, and Holocene to late Pleistocene ages for Q3 valley fill terraces. Topographic profiles of the VLA scarp indicate that the Q1 and Q2 surfaces have been offset along 20–30 m composite scarps and 2–5 m single rupture scarps, respectively, whereas Q3 surfaces extend unruptured across the fault trace, thereby constraining the age of most recent rupture to a late Pleistocene interval. Linear regression analyses of the log of scarp height (H) versus maximum scarp slope angle (A; 7–12°) for single-event scarps ($A = 3.78 + 8.9 \log H$; $r^2 = 0.68$; $n = 5$) further indicate an older late Pleistocene age (10^5 yrs B.P.) for the most recent rupture, an estimate supported by the nearby, independently dated La Jencia fault scarp (Machette and McGimsey, 1983). The soil observed on the VLA fault scarp slope exhibits a morphology (eg., St. II–III calcite horizon) intermediate between Q2 and Q3, but closer to the former, thereby supporting the morphologic estimate for the most recent rupture. Comparisons between the heights of composite and single rupture VLA scarps indicate 5–10 events since the formation of the Q1 surface, implying a probable 10^5 yr recurrence interval. These rates/magnitudes of Quaternary activity are less than estimated for the Great Basin and northern Rio Grande rift (RGR), but they do resemble those reported for southeastern Arizona and southwestern New Mexico (including the southern RGR).

AN INVESTIGATION OF TRONDHJEMITE MIGMATITES AT ASPEN BASIN, SANTA FE COUNTY, NEW MEXICO—A PRELIMINARY REPORT, by *R. V. Metcalf*, University of New Mexico, Albuquerque, NM 87131

The Aspen Basin migmatites are part of a large (≥ 8 km²) pelite roof pendant contained within the Proterozoic plutonic rocks of the central Santa Fe Range. Three lithologic types dominate the plutonic rocks: quartz diorite, granodiorite, and two-mica granite. The quartz diorites and granodiorites are porphyritic and exhibit weak to moderate foliations. The two-mica granite is rarely foliated and, along with associated pegmatite and aplite dikes, intrudes the foliated plutonic rocks. The migmatites consist largely of concordant layers ot paleosome and neosome. The paleosomes are thought to represent layers of unmelted, original pelite. These contain assemblages of plagioclase + quartz + biotite + muscovite + oxides and exhibit textural evidence of metamorphic equilibrium. The neosomes (layers once melted) consist of leucosome (solidified melt) and melanosome (mafic-rich residual solids). Leucosomes are trondhjemites with plagiocase + quartz ± muscovite ± biotite assemblages and igneous textures. Melanosome assemblages are dominated by foliated biotite with minor muscovite ± garnet ± sillimanite and are depleted in quartz and plagioclase. Also present within migmatites are discordant dikes of trondhjemite. It is suggested that migmatite leucosomes formed by grain boundary melting of plagioclase + quartz (+ water). This implies the production of a trondhjemite (K-poor) magma by partial melting of a K-rich pelite. Utilizing the above melting reaction, the presence of sillimanite, and the stability of quartz + muscovite, the metamorphic P–T conditions at Aspen Basin are constrained to 680–770° C and 5–9 kb. Although the evidence is not conclusive, migmatite formation may be contemporaneous with intrusion of the two-mica granite.

DEVONIAN AND MISSISSIPPIAN STRATIGRAPHY AND DEPOSITIONAL ENVIRONMENTS IN THE BIG HATCHET MOUNTAINS OF SOUTHWESTERN NEW MEXICO, by *Darrell Moore*, Texas Tech University, Lubbock, TX 79409

Petrographic and stratigraphic characteristics of Upper Devonian and Lower Mississippian strata in the Big Hatchet Mountains were examined. The Upper Devonian Percha Shale rests unconformably on the Upper Ordovician Montoya Formation and is overlain by strata referred to the upper part of Sabin's (1957) Portal Formation. To date, this is the farthest east the Portal has been observed. Devonian rocks record a shallowing upward sequence that goes from quiet, uncirculated water, which deposited the lower Percha (Ready Pay–Box Members), to high energy grainstones deposited at or above wave base in the Portal. The Portal yielded Upper Devonian (Famennian) conodonts indicative of Sandberg's (1976) shallow water *polygnathidicriodid* biofacies. Mississippian strata, represented by the Escabrosa Group, contain Early Mississippian (Osagean) conodonts at the base. The Devonian–Mississippian contact is placed at the base of the first cliff. Lower Mississippian strata record two Osagean cycles of submergence and emergence. Encroachment began in early Osagean time (*isosticha–upper crenulata* zone) and deposited the basal oolitic grainstones of the Bugle Member of the Keating Formation. A shallowing upward sequence followed that culminated in the deposition of high energy grainstones of the upper Bugle. The end of Bugle time is marked by a second submergence (*lower typicus–anchoralis latus* zone) where argillaceous wackestones were deposited. This deepening continued into the basal Witch Member. Regression began within the Witch with the sequence going from fine-grained mudstones to high energy grainstones with intraclasts. This shallowing sequence continues into the lower Hatchita Formation.

GEOLOGY OF THE CARRIZO MOUNTAINS, LINCOLN COUNTY, NEW MEXICO, by *D. J. Pertl* and *J. A. Campbell*, West Texas State University, Canyon, TX 79016, and *A. M. Kudo*, University of New Mexico, Albuquerque, NM 87131

The Carrizo Mountains are located in the northern part of a folded, faulted, and intruded uplift complex that forms the Sacramento, Sierra Blanca, and Jicarilla Mountains in south-central New Mexico. The core of the Carrizo Mountains is a steep-sided, partly fault-bounded stock, with associated sills on the north and northwest sides. Small plugs and numerous dikes occur on the east and southeast sides of the stock. It is composed of two steeply dipping, vertically oriented rhyolite bodies with an intervening quartz monzonite. Field and microscopic examination indicate that differentiation of a silicic magma body had a key role in the formation of the stock. However, the possibility of multiple intrusive phases cannot be ruled out. Chemical data reveal apparent close affinities between the Carrizo stock and the Three Rivers intrusive phase of the Sierra Blanca Mountains. Three Rivers activity occurred between 24.7 and 28.0 m.y. ago (Thompson, 1972, p. 2,350), which suggests a late Oligocene age for the Carrizo stock. The stock intrudes the Mesaverde Formation (Upper Cretaceous), which is composed of three members: a lower sandstone; a medial interbedded shale, sandstone, and coal; and an upper sandstone. Quaternary units include pediment gravels, alluvial fans, talus, and alluvium. Dikes in the eastern part of the area are composed of diabase, olivine ☞

diabase, and olivine diabase porphyry. Intrusion of these bodies probably occurred in middle Miocene time.

A PRELIMINARY SOILS CHRONOSEQUENCE FOR THE SAN AGUSTIN PLAINS, WEST-CENTRAL NEW MEXICO, by *J. B. Ritter, G. H. Kawaguchi, C. M. Menges,* and *L. D. McFadden,* University of New Mexico, Albuquerque, NM 87131, and *R. P. Lozinsky,* New Mexico Tech, Socorro, NM 87801

Morphological, textural, and chemical data for soils formed on andesitic alluvium form the basis for a preliminary soil chronosequence for the piedmont and shoreline deposits of the San Agustin Plains, west-central New Mexico. Middle Holocene soils (Aridic Haplustolls) on inset valley-fill terraces (Q3) possess thick mollic epipedons (0.6–2.8% organic carbon), cambic or argillic horizons (maximum clay percentage increase = 11.6%; maximum reddish color = 10YR 5/3), and stage I secondary carbonate morphology. Early Holocene soils (Typic Calciustolls) have developed on shoreline deposits of the late Pleistocene Lake San Agustin (11,000–13,000 yrs B.P.) and have thin, organic-matter-rich ochric epipedons, moderately developed argillic horizons (maximum clay percentage increase = 15.1%; maximum reddish color = 7.5YR 5/4), and stage II secondary carbonate morphology. Late? Pleistocene soils (Typic Paleargids) on older inset fill terraces (Q2) exhibit thin, organic-matter-rich ochric epipedons, strongly developed argillic horizons (maximum clay percentage increase = 20.3%; maximum reddish color = 5YR 4/6) and massive, stage III secondary carbonate morphology. Mid- to early? Pleistocene soils (Ustollic Haplargids) on extensive fan deposits (Q1) exhibit only weakly developed ochric epipedons and weak Bt horizons, but overlie a stage IV laminated calcic horizon. The present ustic, mesic climate of the study area clearly favors rapid accumulation of organic matter in the gravelly soils and accumulation of silicate clay in the B horizons. Additionally, calcic horizons at (10–60 cm deep) have formed despite the relatively moist climate, significant vegetal cover, and noncalcic parent materials. This suggests a locally high influx of externally derived carbonate, clay and silt; possible sources include playa-lacustrine deposits of San Agustin basin or erosion of a formerly well developed soil on the oldest piedmont surface (Q1).

HEAT FLOW IN THE MESILLA BOLSON, SOUTHERN RIO GRANDE RIFT, NEW MEXICO, by *J. T. Snyder* and *C. A. Swanberg,* New Mexico State University, Las Cruces, New Mexico 88003

An extensive heat-flow data base representing more than 140 shallow and intermediate geothermal test wells is presented for the Kilbourne Hole–East Potrillo Mountains area of the southern Mesilla Bolson, New Mexico. The data include temperature/depth information and laboratory determinations of thermal conductivity for wells typically 300, 500, and 2,000 ft deep. Heat flow has been calculated by standard techniques. Background heat flow in the bolson was measured at 95 ± 21 mWm^{-2}, a value consistent with reported Basin and Range and Rio Grande rift heat flow. A zone of anomalously high heat flow was observed in the limestones of the East Potrillo Mountain horst block, and it continued south beneath the alluvium as far as the Mexican border. The average heat flow within the anomalous zone was 222 ± 125 mWm^{-2}; the highest value was measured at 668 mWm^{-2}. Intermediate depth wells (2,000 ft), located between the East Potrillo Mountains and the Mexican border, penetrate limestones of the horst block at 600 to 1,900 ft where the temperatures are 50 to 60° C and the gradients are isothermal. This suggests that a significant, convective, low temperature geothermal reservoir exists in the limestone with a subsequent steep geothermal gradient above the aquifer, a phenomenon characteristic of horizontally convective geothermal systems.

PRECAMBRIAN STRATIGRAPHY, STRUCTURE, AND METAMORPHISM IN THE TUSAS MOUNTAINS, NEW MEXICO—A PROGRESS REPORT, by *M. L. Williams,* University of New Mexico, Albuquerque, NM 87131

Precambrian rocks of the Tusas Mountains of northern New Mexico can be divided into two main lithologic units. The older unit ranges from schistose quartzite with interlayered metarhyolite, amphibolite,pelite, and metaconglomerate to a section dominated by mafic volcanics. The younger unit is a massive crossbedded quartzite ranging from several hundred to more than a thousand meters in exposed thickness. It is proposed that these two units correlate with the Vadito Group and Ortega Quartzite of the Ortega Group as mapped in the Picuris, Truchas, and Rio Mora uplifts. Rocks in the Tusas Mountains show evidence of at least two deformations with a minor overprint of one or more younger generations of folds. Viridine, Mn-andalusite, occurs in a 50- to 100-m-thick horizon at or slightly above the base of the massive Ortega Quartzite throughout the Tusas Mountains. This horizon probably represents a continuation of the Mn-rich layer that occurs just below the Ortega Quartzite in the Picuris and Rio Mora uplifts. The presence of the viridine in the Tusas supports the proposed stratigraphic correlation within the range and with the other Precambrian uplifts of northern New Mexico. Kyanite, andalusite, and sillimanite occur in the Ortega Quartzite in the Tusas Mountains. Kyanite is the most common Al_2SiO_5 polymorph. Sillimanite occurs alone and with kyanite in the southern parts of the range, whereas andalusite coexists with kyanite in several samples from the northern part of the range. The relative distribution of kyanite and sillimanite suggests that isograds may be subhorizontal, planar surfaces, similar to those described in the Picuris, Truchas, and Rio Mora uplifts. Such a geometry would constrain metamorphic conditions throughout the range to be not far removed from the aluminum-silicate triple point at approximately 500° C and 3.75 kb. The Tusas Mountains, therefore, further increase the unusually large area of relatively constant metamorphic conditions in northern New Mexico.

MINING REGISTRATIONS
(APRIL 30, 1984 THROUGH JUNE 27, 1984)
State Mine Inspector 2340 Menaul N.E. Albuquerque, NM 87107

Date and operation	Operators and owners	Location
4–30–84 gold, silver	Operator—Golden Gulch Mining Co., Inc., 910 Juniper, Truth or Consequences, NM 87901; Person in charge—Glen Schwab, same address, phone: 894–7370; Property owner—Golden Gulch Mining Co., Inc.	Sierra Co.; sec. 24, T. 15 S., R. 7 W.; private and state land; open pit; Animas mining district; directions to mine: on the Latter Ranch, approximately 16 mi southwest of T or C, NM
4–30–84 limestone	Operator—Wheeler Construction Co., Inc., Box 3352, Albuquerque, NM; Gen. Supt.—J. D. Wheeler, 1501 Georgia NE, Albuquerque, NM; Person in charge—Don Simmons, Los Lunas, NM; Property owner—Tommy Stranton	Guadalupe Co., sec. 26, T. 5 N., R. 16 E.; private land; directions to mine: 1.5 mi north of Vaughn
4–30–84 gold, silver	Operator—Jenny Mining, Inc., 7000 Phoenix NE, #509, Albuquerque, NM 87110; Gen. Mgr.—Dick Kerekes, same address; Other official—Peter Olsen, Pres., same address; Property owner—Golden Gulch Mining Co., Inc.	Sierra Co.; sec. 20, T. 17 S., R. 17 W.; private land; directions to mill: 26 mi south and west of T or C, NM, 7.2 mi west of I–25 on NM–90, then north on dirt road to Ladder air strip, then west 1.25 mi
6–6–84 silver, gold	Operator—Grand New Mexico Project, St. Cloud Mining Co., P.O. Box 1670, Truth or Consequences, NM 87901; Gen. Mgr.—Parrick S. Freeman, 1006 Kopra St., T or C, NM 87901, phone: 894–7739; Gen. Supt.—James Ray Nations, General Delivery, Winston, NM, phone: 894–7495; Other official—Walter Palass, same address as company; Property owner—The Goldfield Corp., P.O. Box 1899, Melbourne, FL 32901	Sierra Co.; sec. 27, 34, 35, 2, 3, T. 10 S., R. 9 W.; Chloride mining district; private and federal land; directions to mine: approximately 12 mi north of Winston on paved highway; working areas between 0.5 mi south to 1 mi north of highway
6–19–84 gold, silver	Operator—Sunset, Bland Mining, P.O. Box 484, Cedar Crest, NM 87008; Gen. Mgr.—Jack Flannery, same address, phone: 281–1271	Sandoval Co.; Cochita mining district; state land; directions to mine: 0.5 mi west of Exchange Hotel
6–27–84 silica	Operator—Robin Claire, Lucina Mining Co., 1812 Mesquite, Lordsburg, NM 88045; Gen. Mgr.—LeRoy Jones, same address, phone: 542–9525; Other official—Lucina Jones, same address and phone; Property owner—LeRoy and Lucina Jones	Hidalgo Co.; sec. 1, 36, T. 21 S., R. 17 W.; Gold Hill mining district; directions to pit: 1 mi southwest of WD Ranch

(TO BE CONTINUED NEXT ISSUE)

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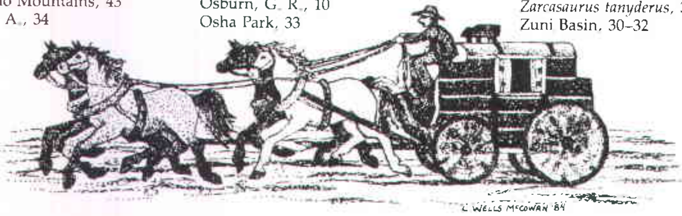

Staff notes

(*continued from p. 88*)

Land Management (BLM) for coal-surface-mined lands. The report on mineral potential of Torrance County, done for the BLM, was written by Ginger McLemore, with parts by Bob Colpitts, Dick Chamberlin, George Austin, JoAnne Osburn, Gary Johnpeer, Ron Broadhead, Bob North, and Jim Turner. A similar report by Ginger on Sandoval and Bernalillo Counties included the same contributors in addition to Sam Thompson, Frank Kottlowski, Lynn Brandvold, Dave Menzie, Mark Bowie, and Kent Anderson. It was drafted by Kathy Parker, Linda Wells–McCowan, and James Brannan, edited by Deborah Shaw, and typed by Lynne McNeil and Lisa Zangara.

Ginger McLemore and Dick Chamberlin are cataloguing, with considerable help, 1,200 maps from the Bendix and Department of Energy (Grand Junction) offices. These are NURE element-distribution maps of stream sediments and element-distribution maps of ground-water samples, as well as sample-location maps; for each of the 21 1° × 2° quadrangles in New Mexico, there are from 36 to 44 elements that are plotted by element on individual quadrangle maps.

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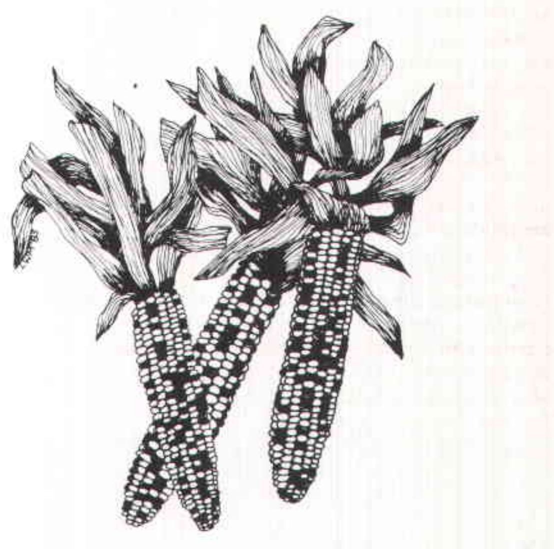

New Mexico Geological Society news

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New Mexico Bureau of Mines and Mineral Resources staff notes

Vickie Pollman joined the staff as our receptionist–secretary; Lisa Zangara left to live in Albuquerque. Teresa Mueller went to Flagstaff to attend the University of Northern Arizona and Wess Mauldin retired after five years as our driller. Robert Bieberman had served 34 years in June and Frank Kottlowski had served 33 years in July.

Orin Anderson and Gary Stricker gave a talk entitled "Stratigraphy and coal occurrences of the Tres Hermanos Formation and Gallup Sandstone in the Zuni Basin" at the October Rocky Mountain Coal Conference in Billings. George Austin compiled an article about mineral exploration in New Mexico during 1983 that was published in *Mining Engineering* (May 1984). George Bachman's Circular 184, *Regional geology of Ochoan evaporites, northern part of Delaware Basin*, was edited by Jiri Zidek and drafted by Teresa Mueller.

Jim Barker and Mike Harris visited mines and mills in the Silver City area and in the northern part of the state. Dallas Peck, Director of the U.S. Geological Survey, was the New Mexico Tech commencement speaker; he was escorted on geologic field trips by George Austin and Jane and Dave Love. Diane Murray checked the locations and texts for the geologic highway marker signs in southern New Mexico, a project done in cooperation with Bill Hatchell (Energy and Minerals Department) and Stan Hordes (State Historian). Don Wolberg conducted two two-week paleontologic field courses for high school teachers in the fossil stump field area of the San Juan Basin.

Ron Broadhead's Circular 183, *Stratigraphically controlled gas production from Abo red beds (Permian), east-central New Mexico* was published in April; it was edited by Marla Adkins–Heljeson and Deborah Shaw and drafted by James Brannan. At the Ogalalla Aquifer Symposium in Lubbock, John Hawley gave a talk on the Ogalalla Formation in eastern New Mexico and Bill Stone discussed his preliminary estimates (from studies where chloride was used in the unsaturated zone) of Ogalalla aquifer recharge in the Curry County area. New publications cards 39 and 40 were issued by Carol Hjellming. Chuck Chapin sent an abstract for the Reno Geological Society of America meeting on the extensional history of the Rio Grande rift; Dick Chamberlin and Bob Osburn sent an abstract for the same meeting on extensional domains in the Socorro area; Bob Osburn, Bob North, and Dick Chamberlin aided with the geologic field trip in the Socorro area that was sponsored by Longview College. A paper entitled "Growth in Acanthodes, date and implications" was sent by Jiri Zidek to *Paleontologische Zeitschrift*.

John Hawley, Dave Love, Gary Johnpeer, and Lee Gile reviewed the Cox fault, which is about 2,000 yrs old, on the northeast flank of the Organ Mountains. Bob North and Ginger McLemore's Open-file Report 191 on gold and silver is a popular item. Mike Harris was accepted as a New Mexico Professional Engineer. The postcard geologic map of New Mexico, now available for $.25, was done by Bob North, Teresa Mueller, Debbie Vetterman, and Jane Love. Ron Broadhead's article, "Geology of gas production from tight Abo red beds" was published in *Oil and Gas Journal* (June 11, 1984). Sam Thompson's Open-file Reports 206, 209, and 210 on organic geochemical analyses for wells in Otero and Sierra Counties are now available.

Bill Stone's project to check ground-water recharge in the Salt Lake coal field and Dave Love and John Hawley's project to review alluvial valley floors in that coal field region, were approved by the Energy and Minerals Department; Bill is also working on the Navajo mine recharge project with Utah International. Don Wolberg's paleontology field course was described in an article in the Albuquerque Journal's magazine *Impact;* Don, with Rick Lozinsky and Adrian Hunt, arranged with the Bureau of Reclamation to collect vertebrate materials from the Elephant Butte area. The new U.S. Bureau of Mines project to prepare mineral-potential maps of federal lands in New Mexico will involve essentially all of our economic geologists who are concerned with oil and gas, coal, hard-rock minerals, leaseable minerals, geothermal prospects, and uranium.

Gary Johnpeer and Dave Love conferred with the Civil Emergency Preparedness Office in Santa Fe and, as a result, they and other staff members will be working on a Quaternary fault map of New Mexico. John Hawley, Bill Stone, and Frank Kottlowski are reviewing the final drafts of reports done in cooperation with the U.S. Geological Survey's Water Resources Division on general areas for possible radioactive-waste-disposal sites in the Basin and Range region of New Mexico. Bob Weber gave seminars at Red Rock State Park as part of the State Archaeological Program. Jamie Robertson edited the Society of Economic Geologists' volume entitled *Fluid-mineral equilibria in hydrothermal systems.*

Jim Barker and Mike Harris have set up the perlite testing lab, and they are already working on contracted projects; Frank Campbell and Gretchen Roybal's Open-file Report 207 on the Fence Lake (1:50,000) Quaternary geology and coal resources is now available; preliminary work on the proposed second phase of New Mexico Energy Research and Development Institute's project, "Strippable coals of New Mexico—quality assessment" is in progress. Gary Johnpeer's abstract on coal mine subsidence in New Mexico was accepted by the Association of Engineering Geologists for their October meeting. Jim Barker chaired two sessions at the AIME Denver meeting in October on economic geology and production of borates. John Hawley's abstract on identification of possible sites in New Mexico for disposal of hazardous waste will be presented at the November Geological Society of America meeting in Reno. Roberta Eggleston and Marshall Reiter's paper, "Terrestrial heat-flow estimates from petroleum bottomhole temperature data in the Colorado Plateau and eastern Basin and Range Province," is being published in *Geological Society of America Bulletin*.

Mike Harris is working with Gold Fields engineers at the Ortiz mine on gold leaching tests. The so-called New Mexico paleontology migration plan, formulated at a meeting in Farmington several years ago, appears to be acceptable to the Bureau of

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Staff notes

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