



Lexicon of Phanerozoic stratigraphy names used in the Albuquerque area

Barry S. Kues, Spencer G. Lucas, and Raymond V. Ingersoll
1982, pp. 125-138. <https://doi.org/10.56577/FFC-33.125>

in:

Albuquerque Country II, Wells, S. G.; Grambling, J. A.; Callender, J. F.; [eds.], New Mexico Geological Society 33rd Annual Fall Field Conference Guidebook, 370 p. <https://doi.org/10.56577/FFC-33>

This is one of many related papers that were included in the 1982 NMGS Fall Field Conference Guidebook.

Annual NMGS Fall Field Conference Guidebooks

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

Free Downloads

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

Copyright Information

Publications of the New Mexico Geological Society, printed and electronic, are protected by the copyright laws of the United States. No material from the NMGS website, or printed and electronic publications, may be reprinted or redistributed without NMGS permission. Contact us for permission to reprint portions of any of our publications.

One printed copy of any materials from the NMGS website or our print and electronic publications may be made for individual use without our permission. Teachers and students may make unlimited copies for educational use. Any other use of these materials requires explicit permission.

This page is intentionally left blank to maintain order of facing pages.

LEXICON OF PHANEROZOIC STRATIGRAPHIC NAMES USED IN THE ALBUQUERQUE AREA

BARRY S. KUES
Department of Geology
University of New Mexico
Albuquerque, New Mexico 87131

SPENCER G. LUCAS
Department of Geology and Geophysics and
Peabody Museum of Natural History
Yale University
New Haven, Connecticut 06511

and

RAYMOND V. INGERSOLL*
Department of Geology
University of New Mexico
Albuquerque, New Mexico 87131

INTRODUCTION

This lexicon includes the names of all Paleozoic, Mesozoic, and Cenozoic lithostratigraphic units in the Albuquerque area of north-central New Mexico formally and informally used through 1981. The area covered extends on the north to a line running from just east of Crownpoint approximately to Cochiti Pueblo, including the southern part of the Nacimiento Mountains; on the east, it includes the Hagan basin and the Sandia-Manzanita-Manzano ranges eastward to about the longitude of Estancia; on the south, it extends to the southern boundaries of Valencia and Cibola counties; and on the west, it includes Cebolleta Mesa and the Grants-Ambrosia Lake district to about the longitude of Bluewater. This lexicon does not include volcanic units associated with the Valles Caldera, except for a few units that extend south into the Jemez Pueblo area at the arbitrarily defined northern boundary of "Albuquerque Country."

Because of space limitations, it was impractical to use the exact format of earlier lexicons in New Mexico Geological Society guidebooks (e.g., Lochman-Balk, 1959, 1967; Northrop, 1973), or to provide the extended summaries of units such as were presented by Wilmarth (1938), Jicha and Lochman-Balk (1958), and Keroher and others (1966). Rather than attempt to summarize the lithological variability, history of study, and changes of nomenclature of each unit in detail, we have chosen to include a large number of key references to papers where such information may be found. Only named groups, formations, and members (including tongues and lentils) are included in this lexicon; informal units such as "lower sandstone member" are mentioned only in the discussions of the named unit of which they are a part. Some igneous flows, especially around Mt. Taylor, have not been given formal names and are omitted. In any listing of members within a formation, the members are presented in ascending order. Chronostratigraphic units such as Virgilian Series are omitted.

Each entry begins with the unit name; parenthetical insertions after the unit name give alternate usages and/or indicate the formation or group in which the unit is (or was) included. Names of validly defined, widely accepted units are capitalized; lower-case names are of valid units once used but since abandoned in the Albuquerque area (though not elsewhere); and bracketed lower-case names are of discarded or abandoned names no longer in use anywhere.

Information about each unit is given in a consistent numerical order: (1) type locality and/or derivation of name; (2) distribution in the Albuquerque area; (3) brief summary of salient lithologies in the unit; (4)

brief comments on nomenclatural or stratigraphic problems and changes in usage of the unit name; and (5) key references, especially those dealing with the unit in the Albuquerque area, that are not cited elsewhere in the discussion of the unit. Some names lack entries under one or more of the above numbers because pertinent information was unavailable or is irrelevant.

Most of the information on Cenozoic units comes from Lucas and Ingersoll (1981).

ABO FORMATION (Sandstone)—Lower Permian

(1) Abo Canyon, S end of Manzano Mtns (Lee, 1909); type section—secs. 25, 32, 33, 35, 36, T3N, R5E and into sec. 2, T2N, R5E, near towns of Abo and Scholle, Torrance Co. (Needham & Bates, 1943); (2) Sandia, Manzano, & Nacimiento Mtns, Lucero uplift, SW of Grants; (3) Interbedded red to brown mudst, siltst, & arkosic ss with minor cgl & Is; (4) Needham & Bates (1943) removed thin fossiliferous Is from base of Lee's (1909) Abo (see Bursum Fm); Bates *et al.* (1947) assigned upper 31.7 m of Needham & Bates' (1943) Abo to Meseta Blanca Mbr of Yeso; (5) Darton (1928), Renick (1931), Read *et al.* (1944), Wood & Northrop (1946); Kelley & Wood (1946), Baars (1961a, b; 1962), Kelley (1963a), Myers (1967, 1977), Kelley & Northrop (1975), Myers & McKay (1976).

AGUA ZARCA SANDSTONE MEMBER (of Chinle Formation)—Upper Triassic

(1) Agua Zarca Creek, Rio Arriba Co. (Wood & Northrop, 1946); (2) S & W Nacimiento Mtns and San Ysidro area; (3) White to tan quartzose ss with local cgl; (4) Includes much of what was mapped as Poleo Ss by Renick (1931); Stewart *et al.* (1972a) used "sandstone mbr" of Chinle in San Ysidro area and S Nacimiento Mtns for strata assigned by Wood & Northrop (1946) to Agua Zarca; (5) Woodward & Martinez (1974), Woodward & Ruetschilling (1976). [Alamito Shale]

(4) Name used by Keyes (1906) for shale at base of Sandia Fm; rejected by Gordon (1907) and Jicha & Lochman-Balk (1958). [Albuquerque marl]

(4) Name used by Herrick (1898) for upper 0.61 m of his "Rio Grande series"; also used by Reagan (1903), and, in a different sense, by Bryan (1909). Bryan & McCann (1937) restricted usage to caliche on upland surfaces around Albuquerque.

ALBUQUERQUE VOLCANOES BASALT—Pleistocene

(1) Albuquerque volcanoes, NW of Albuquerque (Wright, 1946); (2) Albuquerque area; (3) Porphyritic basalt; (5) Lambert (1968), Kelley & Kudo (1978).

*Present address: Department of Earth and Space Sciences, University of California, Los Angeles, California 90024.

ALLISON MEMBER (of Menefee Formation)-Upper Cretaceous

(1) Near village of Allison, McKinley Co. (Sears, 1925); (2) N of Ambrosia Lake, and in a broad E-W band W of Cabezon area; (3) Gray to white interbedded lenticular ss., sh, & thin coal beds; (4) Originally defined as Allison Barren Member of Mesaverde Fm; Allen & Balk (1954) and Beaumont *et al.* (1956) reassigned Allison to mbr status in Menefee; (5) Sears *et al.* (1941), Beaumont (1971), Shomaker (1971a), Pierce & Shomaker (1971).

ANCHA FORMATION (in Santa Fe Group)-Pliocene

(1) Canada Ancha, Agua Fria quad, W of Santa Fe (Baltz *et al.*, 1952); (2) Tongue Arroyo area, Hagan basin; (3) Poorly consolidated ss, siltst, & cgl; (5) Baldwin (1956), Disbrow & Stoll (1957), Sun & Baldwin (1958), Baldrige *et al.* (1979).

[Antonito Limestone]

(4) Name used by Keyes (1915a, b) for lowermost of massive ls (basal part of "Maderan series") in S Sandia Mtns; Jicha & Lochman-Balk (1958) recommended suppression of name.

[Aqua Tones Formation]

(4) Name used by Stark & Dapples (1946) for a sequence of Lower Permian interbedded red ss & sh and gray ls below the Abo in the Abo Canyon area and Los Pinos Mtns; Lloyd (1949) pointed out that this unit had earlier been named the Bursum Fm.

ARROYO PENASCO GROUP (Formation)-Mississippian

(1) Arroyo Pefiasco, S Nacimiento Mtns; type section-SW 1/4, SE1/4, sec. 5, T16N, R1E (Armstrong, 1955); (2) S Nacimiento Mtns, Tijeras Canyon, Manzano Mtns, Placitas; (3) Dense gray fine-grained to oolitic, massive to medium-bedded ls; (4) Read *et al.* (1944) and Wood & Northrop (1946) mapped possible Mississippian rocks in the Nacimiento Mtns as the "lower ls mbr" of Sandia Fm, and Henbest (1946) and Read & Wood (1947) noted presence of Mississippian strata also in Sandia Mtns. Armstrong (1955, 1958a, 1967) described these occurrences as the Arroyo Periasco Fm and Armstrong & Mamet (1974) raised the Arroyo Periasco to group rank, containing the lower Espiritu Santo and upper Tereno fms; (5) Fitzsimmons *et al.* (1956), Northrop (1961), Armstrong & Holcomb (1967); Armstrong & Mamet (1977, 1979), Kelley & Northrop (1975); Armstrong *et al.* (1979).

ATARQUE MEMBER (of Gallup Sandstone)-Upper Cretaceous

(1) Near village of Atarque, Cibola Co.; type section-secs. 32, 33, T10N, R17W (Pike, 1947); (2) Cebolleta Mesa area; (3) Gray to tan interbedded ss, sandy sh, & thin coals; (4) Equivalent to unit mapped as "lower tongue of Gallup Ss" by Thaden, Santos, & Raup (1967) in Grants area (Molenaar, 1973); (5) Molenaar (1974).

ATRASADO MEMBER (of Madera Limestone)-Upper Pennsylvanian

(1) Atrasado Arroyo, Lucero uplift, no specific type locality designated (Kelley & Wood, 1946); (2) E side of Lucero uplift; (3) Thin- to thick-bedded gray ls, and gray and red sh & cglatic ss; (4) Read & Wood (1947) reported fusulinids of Missourian-Virgilian age.

Aubrey Group

(4) Name applied by Dutton (1885) to Upper Paleozoic sequence in Zuni Mtns and E to Grants area (included Abo, Yeso, Glorieta, & San Andres Fms of modern usage). An Arizona term, no longer used in New Mexico.

BANDELIER TUFF (Rhyolite Tuff) (of Tewa Group)-Pleistocene

(1) Not stated, but presumably from rhyolite-tuff exposures near Bandelier National Monument (Smith, 1938); (2) Jemez Mtns, Sandoval Co.; (3) Two pumice falls, each overlain by a petrologically related succession of ash flows; (4) Griggs (1964) divided the Bandelier Tuff into the Guaje, Otowi, & Tshirege mbrs; Bailey *et al.* (1969) recognized the Tshirege Mbr but extended the Otowi Mbr to include the Guaje Mbr; (5) Smith & Bailey (1966), Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

BEARHEAD RHYOLITE (in Keres Group)-Miocene

(1) Bearhead Peak, S. of Valles Caldera (Bailey *et al.*, 1969); (2) S of Valles Caldera; (3) Rhyolite tuffs, flows, domes, & associated shallow intrusions; (4) Includes Peralta Tuff Mbr; sometimes termed "Bearhead Rhyolite-Peralta Tuff Mbr" (Kudo, 1974); (5) Smith *et al.* (1970).

BERNAL FORMATION-Upper Permian

(1) Bernal Butte, T13N, R16E, San Miguel Co. (Bachman, 1953); (2) E side of Sandia Mtns, Placitas, San Ysidro and Holy Ghost Spring quads, S. Nacimiento Mtns; (3) Tan or red-brown ss with local thin fossiliferous ls beds; (4) Is "upper mbr" of San Andres of Read *et al.* (1944); Kelley (1972) stated that Bernal is N-ward extension of Grayburg Fm and recommended use of Bernal for occurrences N of Santa Rosa and W of longitude of Vaughn; (5) Woodward & Martinez (1974), Kelley & Northrop (1975), Woodward & Ruetschilling (1976). [Bernalillo Shales]

(4) Name used by Keyes (1903a, b) for a sequence of red sh & ss in Manzano Mtns (Madera, Bursum, & Abo fms of modern usage); Jicha & Lochman-Balk (1958) recommended suppression of the name.

BLUE WATER BASALTS-Holocene

(1 & 2) San Jose valley between Bluewater and the Rio Puerco, Cibola Co. (Nichols, 1936); (3) Olivine basalt; (5) Laughlin *et al.* (1972).

BLUFF SANDSTONE (in San Rafael Group)-Upper Jurassic

(1) Near town of Bluff, Utah (Baker *et al.*, 1936; Gregory, 1938); (2) Widely exposed from Mesa Gigante westward through Laguna, Grants, and Bluewater areas; (3) Red, gray, or white quartzose, thin- to very thick-bedded ss with small crossbeds; (4) Considered a tongue of Cow Springs Ss, inseparable from it E of Ft. Wingate (Harshbarger *et al.*, 1957); considered equivalent to "white ss" & "brown-buff ss" mbrs of Morrison of Kelley & Wood (1946) and Silver (1948) by Hilpert (1963); Bluff of Moench & Schlee (1967) in Laguna area included Bluff plus "upper sandy facies" of Summerville of Harshbarger *et al.* (1957), and included overlying Zuni Ss as used by Maxwell (1976); (5) Harshbarger *et al.* (1951), Freeman & Hilpert (1956), Moench (1963b; 1964a, b), Moench & Puffett (1963a, b), Schlee & Moench (1963b), Green & Pierson (1977).

BONNEY CANYON MEMBER (of San Andres Formation)-Upper Permian

(1) Bonney Canyon, on N side of Hondo Canyon, sec. 24, T11S, R20E, Lincoln Co. (Kelley, 1971); (2) E flank of Sandia Mtns, Placitas, & Monte Largo; (3) Gray to black thin- to medium-bedded ls with intercalated white ss; (4) Only part of San Andres Fm in the Sandia Mtns area, as well as in most of central N.M. E of Rio Grande (Kelley, 1972); (5) Kelley & Northrop (1975).

BORREGO PASS LENTIL (of Crevasse Canyon Formation)-Upper Cretaceous

(1) Borrego Pass, NW of Ambrosia Lake, sec. 27, T16N, R11W (Correa, 1970); (2) Mt. Taylor, Grants, and Ambrosia Lake areas; (3) Gray fine- to coarse-grained fossiliferous ss & cgl; (4) Name applied to "stray ss of local usage" of earlier workers; (5) Sears *et al.* (1941), Pike (1947), O'Sullivan *et al.* (1972), Molenaar (1973).

BRUSHY BASIN MEMBER (of Morrison Formation)-Upper Jurassic

(1) Brushy Basin Wash, 13 km (8 mi) NW of Blanding, Utah (Gregory, 1938); (2) Widely exposed in Laguna, Acoma, Grants, and Ambrosia Lake areas, near San Ysidro, and along W flank of Nacimiento Mtns; (3) Green to variegated mudst interbedded with thin to thick locally crossbedded ss and minor gray ls & cgl beds; (5) Craig *et al.* (1955), Freeman & Hilpert (1956), Harshbarger *et al.* (1957), Hilpert (1963, 1969), Moench (1963a, b; 1964b), Moench & Schlee (1967), Flesch (1974), Maxwell (1976).

[Bruton Formation]

(4) Name used by Thompson (1942) for a unit of red sh, ss, & cgl interbedded with ls, beneath Abo Fm, said to be present in Abo Canyon, Manzano, & Sandia Mtns. Partially or entirely equivalent to Bursum Fm (Lloyd, 1949); name has been abandoned.

BURSUM FORMATION-Lower Permian

(1) Bursum triangulation point, N Oscura Mtns, SE¹/₄, sec. 1, T6S, R4E, Socorro Co. (Wilpolt *et al.*, 1946); (2) Abo Pass area, S Manzano Mtns; (3) Thick beds of red, gray, & green 'sh, with thinner beds of red arkosic ss & cgl & gray ls; (4) Needham & Bates (1943) separated an "unnamed basal Permian ls" from the base of the Abo Fm, which formed part of the red bed-limestone sequence named Bursum by Wilpolt *et al.* (1946), and "Aqua Torres Fm" by Stark & Dapples (1946). Lloyd (1949) pointed out synonymy of names and suggested equivalence with Red Tanks Mbr of Madera Fm of Kelley & Wood (1946) in Lucero uplift. Myers (1973) included Bursum as uppermost fm in his Madera Gr; (5) Bates *et al.* (1947), Kerher *et al.* (1966), Kottowski & Stewart (1970), Myers (1977).

Caloso Formation

(4) Originally defined in the Ladron Mtns, the Caloso was reported as possibly being present as isolated remnants in the Manzano Mtns by Armstrong (1955, 1958b, 1963), but later these exposures were assigned to the Arroyo Penasco Fm (Armstrong, 1967).

CANADA PILARES MEMBER (of Zia Sand Formation)-Miocene

(1) Along N side of Canada Pilaes, N1/2, N1/4, SW1/4, sec. 7, T12N, R1E, Sandoval Co. (Gawne, 1981); (2) Along E side of Rio Puerco, NW of Albuquerque; (3) Mainly red clayst, with local pink ss; (4) Part of "middle red" mbr of Santa Fe Fm of Bryan & McCann (1937); included but unnamed in Zia Sand by Galusha (1966).

CANAS GYPSUM MEMBER (of Yeso Formation)-Lower Permian

(1) Lomo de las Callas, a range of hills 14.5 km (9 mi) E of Socorro; type section-secs. 4, 5, T2S, R2E & sec. 33, T1S, R2E, Socorro Co. (Needham & Bates, 1943); (2) S end of Manzano Mtns; (3) Basal dolomitic ls interbedded with gypsum, and upper laminated gypsum; (5) Hunter & Ingersoll (1981).

CANO MEMBER (of Mesaverde Formation)-Upper Cretaceous

(1) Cano Ranch at Hagan (Stearns, 1953b); (2) Hagan Basin; (3) Massive lenticular ss with dark brown concretions; (4) Defined as basal mbr of Mesaverde by Stearns (1953b); reinterpreted as part of Hosta tongue-Dalton Ss "turn-around" by Black (1979).

CANOVAS CANYON RHYOLITE (in Keres Group)-Miocene

(1) Canovas Canyon, near Bear Springs Peak, Jemez Mtns (Bailey *et al.*, 1969); (2) Bear Springs area and Borrego Mesa, S Jemez Mtns, Sandoval Co.; (3) Rhyolite flows, tuffs, domes, & associated intrusions; (5) Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

Carlile Shale

(4) A widespread Midcontinent unit, the Carlile Shale was said to be present in the Rio Puerco area by Rankin (1944) and was reported in the Cerrillos area by Stearns (1953a, b). In the Albuquerque area, Carlile beds have been included in the Mancos Shale by most workers.

Carmel Formation

(4) The lowest formation in the San Rafael Group over much of the Colorado Plateau, and reported present beneath the Entrada Ss (= Wingate Ss of earlier usage) in the Laguna to Bluewater area by Baker *et al.* (1947). Harshbarger *et al.* (1957), however, stated that the sub-Entrada unit is not correlative with the Carmel, and Moench & Schlee (1967) noted that this unit is the middle siltst unit of the Entrada.

CEJA MEMBER (of "Santa Fe Formation")-Pliocene

(1) S side of El Rincon, NE¹/₄, SE¹/₄, sec. 19, T10N, R1E (Kelley, 1977); (2) Southern Albuquerque basin, Bernalillo and Sandoval Co.; (3) Grayish sand and pebbly cgl; (4) Essentially equivalent to the "upper buff mbr" of the Santa Fe of Bryan & McCann (1938); (5) Tedford (1981).

CHAMISA MESA, BASALT OF (in Keres Group)-Miocene

(1, 2) Chamisa Mesa, Sandoval Co. (Bailey *et al.*, 1969); (3) Thin multiple flows of olivine basalt; (5) Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

CHAMISA MESA MEMBER (of Zia Sand Formation)-Miocene

(1) Sec. 25, T16N, R2E & sec. 30, T16N, R3E (Galusha, 1966); (2) Northern Albuquerque basin, Sandoval Co.; (3) Predominantly gray friable ss; (5) Galusha & Blick (1971), Gawne (1975, 1976, 1981), Kelley (1977), Manley (1978), Tedford (1981).

CHINLE FORMATION-Upper Triassic

(1) Chinle Valley, NE Arizona (Gregory, 1915, 1916); (2) Lucero uplift, E flank of Sandia Mtns, Placitas, Monte Largo, S & W parts of Nacimiento Mtns, Laguna, Acoma, Grants, Bluewater areas; (3) Thick red to locally gray, green, or purple mudst with several local to widespread red, white, or brown cross-bedded ss units; (4) Undivided in Sandia Mtns (Kelley & Northrop, 1975) and Acoma (Maxwell, 1976, 1979) areas; has been subdivided elsewhere as follows: "lower red shale" & Correo Ss mbrs in Lucero uplift (Kelley & Wood, 1946); Agua Zarca Ss mbr, Salitral Sh tongue, Poleo Ss lentil, & "main body" (= "red shale mbr") along S & W sides of Nacimiento Mtns (Wood & Northrop, 1946); "lower shale mbr," "red sandstone mbr," & Correo Ss Mbr near Laguna and to SW (Silver, 1948); Petrified Forest Mbr & Correo Ss Mbr in Laguna area (Moench & Schlee, 1967); "lower mbr," "Sonsela Ss bed of Petrified Forest Mbr," "middle mbr," & "upper mbr" in Grants area (Thaden, Santos, & Raup, 1967); Agua Zarca Mbr, "sandstone mbr," & Petrified Forest Mbr in San Ysidro-White Mesa area (Stewart *et al.*, 1972a); Agua Zarca Mbr & "upper mbr" in Holy Ghost Spring quad (Woodward & Martinez, 1974); Agua Zarca Mbr & Petrified Forest Mbr in San Ysidro area (Woodward & Ruetschilling, 1976); Monitor Butte Mbr & Petrified Forest Mbr, which includes the Sonsela Ss bed in the lower part and the Correo Ss Mbr in the upper part, in the Ambrosia Lake area (Rautman, 1980). (Separate citations for named members are found elsewhere in this lexicon); (5) Darton (1928), Renick (1931), Stewart *et al.* (1972c), O'Sullivan (1977).

[Chupadera Formation]

(4) Name used by Wells (1919), Darton (1922, 1928), and others for combined Yeso and San Andres fms, on the basis that they could not be separately mapped in many areas. Needham & Bates (1943) redefined these formations and discarded Chupadera; the units in it are routinely assigned to Yeso, Glorieta, and San Andres fms (Jicha & Lochman-Balk, 1958).

CLAY MESA SHALE TONGUE (of Mancos Shale)-Upper Cretaceous

(1) Clay Mesa, about 5 km (3 mi) NW of Laguna; type section-NE¹/₄, SE¹/₄, sec. 20 & SW¹/₄, NW¹/₄, sec. 21, T10N, R5W, Cibola Co. (Landis *et al.*, 1973); (2) Laguna-Grants area; (3) Gray clay sh, silty in part, with bentonite, limy concretion, ls & ss beds; (4) Clay Mesa is name assigned to unnamed shale unit immediately above the lowest of three sandstones in the "lower part of Mancos" reported by Hunt (1936), Moench (1963b), & Moench & Schlee (1967). The Clay Mesa and Whitewater Arroyo tongues are undivided in Acoma area (Landis *et al.*, 1973; Maxwell, 1976); (5) Cobban (1977).

CLEARY COAL MEMBER (of Menefee Formation)-Upper Cretaceous

(1) Cleary mine, 3.2 km (2 mi) W of La Ventana, SW¹/₄, sec. 31, T19N, R1W, Sandoval Co. (Beaumont *et al.*, 1956); (2) N of Ambrosia Lake, E-W band W of Cabezon area, Seboyeta-Marquez area; (3) Interbedded gray to tan ss, dark gray sh, & coal beds; (4) Equivalent to Hunt's (1936) "upper Gibson Coal Mbr"; (5) Shomaker (1971a), Pierce & Shomaker (1971), Kottlowski *et al.* (1971), Beaumont (1971).

COCHITI FORMATION-Miocene

(1) Badlands W & SW of Cochiti Pueblo (Bailey *et al.*, 1969); (2) From Bodega Butte and Borrego Mesa eastward to the Rio Grande and S of the Jemez Mtns to S end of Santa Ana Mesa, Sandoval Co.; (3) Volcanic gravel and sand, consisting of basalt, andesite, dacite, & rhyolite detritus; (5) Smith *et al.* (1970), Kudo (1974), Manley (1978).

[Colorado Group]

(4) Midcontinent term, used for sequence of Graneros, Greenhorn, Carlile, & Niobrara fms in northern New Mexico. In Albuquerque area, these units are referred to the Mancos Shale by most workers.

CORREO SANDSTONE MEMBER (of Chinle Formation)-Upper Triassic

(1) S edge of Mesa Gigante, 1.6 km (1 mi) N of Correo, Valencia Co. (Kelley & Wood, 1946); (2) Lucero uplift, Mesa Gigante, Laguna area, Bluewater area; (3) Mainly dark red-brown, but locally tan irregularly crossbedded ss & cgl; (4) Stewart *et al.* (1972a) considered Correo to be a bed within Petrified Forest Member of Chinle; (5) Silver (1948), Moench & Schlee (1967).

COW SPRINGS SANDSTONE-Upper Jurassic

(1) In cliff along N face of Black Mesa, Arizona, 6.4 km (4 mi) E of Cow Springs along Reservation Highway 3 (Harshbarger *et al.*, 1951); (2) Bluewater area; intertongues with Recapture Mbr of Morrison and Bluff Ss to east; (3) Light gray to brown crossbedded quartzose eolian ss; (4) Harshbarger *et al.* (1951) stated that Summerville, Bluff, & Recapture Mbr of Morrison graded westward into Cow Springs. Harshbarger *et al.* (1957) considered the Bluff a tongue of the Cow Springs; also a tongue of the Cow Springs was what Kelley & Wood (1946) and Silver (1948) had called the "white sandstone mbr" of the Morrison in the Lucero uplift; (5) Thaden *et al.* (1966), Thaden & Ostling (1967), Green & Pierson (1977).

[Coyote Sandstone Member]

(4) Name used by Herrick (1900a) & Herrick & Johnson (1900) for a ss-cgl unit in upper Madera in Manzanita Mtns; Gordon (1907) noted that Coyote is a local development and rejected use of name.

CREVASSE CANYON FORMATION (in Mesaverde Group)-Upper Cretaceous

(1) N fork of Catron Creek, 4.8 km (3 mi) SW of mouth of Crevasse Canyon, San Juan Co. (Allen & Balk, 1954); (2) E flank of Cebolleta Mtns, Grants-San Mateo-Ambrosia Lake area, S of Cebolleta Mesa; (3) Interbedded nonmarine sh, siltst, coal beds, & thin ss; (4) Includes Dilco, Dalton, & Gibson Mbrs; Borrego Pass Lentil (= "stray sandstone") is locally present above Dilco (e.g., Santos, 1966b; Santos & Thaden, 1966; Thaden *et al.*, 1966); (5) Beaumont *et al.* (1956), Dane, Wanek, & Reeside (1957), Moench & Schlee (1967), Beaumont (1971), Shomaker (1971b), Molenaar (1973), Tschudy (1976).

CUBERO SANDSTONE TONGUE (of Dakota Sandstone)-Upper Cretaceous

(1) E side of Cubero Mtn, about 13 km (8 mi) W of Laguna; type section-NE¹/₄, SE¹/₄, sec. 20 & SW¹/₄, NW¹/₄, sec. 21, T10N, R5W (Landis *et al.*, 1973); (2) Grants, Laguna, & Acoma areas; (3) Mainly fine-grained ss with local siltst, clay-sh, & carbonaceous units; (4) Merges with main body of Dakota W of Grants & Acoma; is name applied to lowest of three ss units in "lower part" of Mancos reported by Hunt (1936) and Moench & Schlee (1967); (5) Maxwell (1976), Cobban (1977).

DAKOTA SANDSTONE (Formation)-Upper Cretaceous

(1) Hills back of town of Dakota, Nebraska (Meek & Hayden, 1862); (2) N end of Lucero uplift, E side of Sandia Mtns, Placitas, Hagan basin, Mesa Gigante, Rio Puerco area, W side of Nacimiento Mtns, White Mesa-San Ysidro area, Laguna, Acoma, Mt. Taylor, Grants, San Mateo, Bluewater, and Ambrosia Lake areas; (3) Tan, orange, gray, & white ss, interbedded with gray to black sh, thin coal beds, and local cgl; (4) Intertongues extensively and complexly with Mancos Sh in W half of Albuquerque country (Hunt, 1936; Thaden *et al.*, 1966; Thaden, Merrin, & Raup, 1967; Moench & Schlee, 1967; and others); individual tongues and members of upper Dakota and lower Mancos given formal names by Owen (1966) and Landis *et al.* (1973). Complete sequence in Laguna-Grants area is: Oak Canyon Mbr, Cubero Ss tongue, Clay Mesa Sh tongue (Mancos), Paguete Ss tongue, Whitewater Arroyo Sh tongue (Mancos), Two-wells Ss tongue; Oak Canyon, Cubero, & Paguete merge to become "main body of Dakota" to W; (5) Lee (1912, 1917), Darton (1928), Renick (1931), Wood & Northrop (1946), Kelley & Wood (1946), Stearns (1953b), Dane (1960), Santos (1966b), Santos & Thaden (1966), Thaden & Ostling (1967), Dane *et al.* (1971), Owen (1973), Woodward & Martinez (1974), Kelley & Northrop

(1975), Siemers *et al.* (1975), Woodward & Ruetschilling (1976), Molenaar (1977), Owen & Siemers (1977).

DALTON SANDSTONE MEMBER (of Crevasse Canyon Formation)-Upper Cretaceous

(1) Dalton Pass, Gallup area (Sears, 1934); (2) Seboyeta, Laguna, San Mateo, Grants, and Ambrosia Lake areas and Hagan basin (?); (3) Two orange to gray fine-grained ss separated by a middle siltst; (4) Originally defined as a mbr of Mesaverde Fm; reallocated by Allen & Balk (1954) as a mbr in Crevasse Canyon Fm. Black (1979) considered Cano Mbr of Mesaverde Fm in Hagan basin to be part of Hosta-Dalton "turnaround"; (5) Hunt (1936), Sears *et al.* (1941), Sabins (1964), Santos & Thaden (1966), Santos (1966b), Thaden, Santos, & Raup (1967), Moench & Schlee (1967), Beaumont (1971), Kottlowski *et al.* (1971), Kottlowski & Parkhill (1971).

D-CROSS TONGUE (of Mancos Shale)-Upper Cretaceous

(1) Near D-Cross Mtn, secs. 17 & 18, T3N, R8W, Socorro Co. (Dane, Wanek, & Reeside, 1957); (2) Cebolleta Mesa area; (3) Gray sh with minor thin ss; (4) Divides upper and lower parts of Gallup Ss in type area, and considered to extend N-ward to Mt. Taylor & Ambrosia Lake area (Dane, Bachman, & Reeside, 1957); however, later workers referred this interval to "main body" of Mancos (*e.g.*, Santos & Thaden, 1966) or believed it to merge with "lower part" of Mancos S of Acoma (Molenaar, 1973). D-Cross is unit referred to as Pescado tongue of Mancos by Pike (1947) in type area but is actually higher than Pescado (Dane, Wanek, & Reeside, 1957).

De Chelly Sandstone

(4) Baars (1961b, 1962) maintained that Meseta Blanca Mbr of Yeso, as defined in Nacimiento Mtns by Wood & Northrop (1946), is lithologically identical to the De Chelly, and that the De Chelly should replace Meseta Blanca in north-central New Mexico.

DEL PADRE SANDSTONE MEMBER (of Espiritu Santo Formation)-Mississippian

(1) Bluff at junction of Rito del Padre and Pecos River, Rio Arriba Co. (Sutherland, 1963); (2) S Nacimiento Mtns, Sandia Mtns; (3) Quartz cgl, ss, siltst, & thin sh; (4) Unnamed basal mbr of Espiritu Santo Fm in Sangre de Cristo Mtns (Baltz & Read, 1960); established by Sutherland (1963) as the Del Padre Ss, a separate formation; assigned as mbr of Espiritu Santo Fm in Sandias & Nacimientos by Armstrong & Mamet (1974).

DILCO COAL MEMBER (of Crevasse Canyon Formation)-Upper Cretaceous

(1) Near village of Dilco, McKinley Co. (Sears, 1925); (2) Rio Puerco area W to Seboyeta, Grants, and Ambrosia Lake areas; (3) Interbedded orange, brown, & gray ss, siltst, & sh with coal beds; (4) Originally defined as mbr in Mesaverde Fm; reallocated as a mbr in Crevasse Canyon (Allen & Balk, 1954); (5) Hunt (1936), Sabins (1964), Santos (1966a, b), Thaden, Santos, & Raup (1967), Beaumont (1971), Shomaker (1971b, c), Kottlowski *et al.* (1971), Kottlowski & Parkhill (1971), Molenaar (1973).

DOCKUM GROUP-Upper Triassic

(1) Near Dockum, Texas (Cummins, 1890); (2) E side of Sandia Mtns, Manzano Mtns (?); (3) Lower gray to red-brown ss & mudst; upper mainly variegated to red-brown mudst with minor ss; (4) Read *et al.* (1944) first applied the name Dockum Fm to Triassic beds in the Sandia Mtns that Darton (1928) had referred to either the Moenkopi or Chinle or both; Kelley (1963) and Kelley & Northrop (1975) divided the Dockum in this area into the lower Santa Rosa Fm & upper Chinle Fm. Myers & McKay (1972) noted questionable presence of Dockum in Capilla Peak quad.

EDITH FORMATION-Pleistocene

(1) S1/2, sec. 2, T11N, R3E (Lambert, 1968); (2) Albuquerque area; (3) Sandy pebble & cobble gravel.

ENTRADA SANDSTONE (in San Rafael Group)-Upper Jurassic

(1) Entrada Point, N part of San Rafael Swell, Utah (Gilluly & Reeside, 1928); (2) E side of Sandia Mtns, Placitas, Hagan basin, Mesa Gigante, San Ysidro-White Mesa area, and W side of Nacimiento uplift, Laguna, Grants, & Bluewater areas; (3) Upper massive white to tan crossbedded ss & lower tan to red-brown siltst or silty ss with local basal brown thin-bedded to massive crossbedded ss; (4) The upper massive ss unit of Wingate Ss at Ft. Wingate & E through Albuquerque area (*e.g.*, Dutton, 1885; Darton, 1928; Renick, 1931; Baker *et al.*, 1936; Read *et al.*, 1944; Wood & Northrop, 1946) was found by Baker *et al.* (1947) to be the Entrada Ss, and the name has been used by later workers even though Wingate Ss has priority; Wingate was retained for Triassic units below Entrada. Silver (1948) divided "old" Wingate into an "upper cliff-forming mbr" (=Entrada), and a "middle slope-forming" and "lower cliff-forming" mbr, both assigned to Glen Canyon Gr; the "middle slope-forming mbr" was later assigned to Entrada as "medial silty mbr" (Harshbarger *et al.*, 1957; Hilpert, 1963; Schlee & Moench, 1963b; Moench & Puffett, 1963b; Moench, 1964a; Thaden & Ostling, 1967; Thaden, Santos, & Raup, 1967), with a restricted "lower sandy mbr" recognized locally in Laguna and Acoma areas

(Moench & Schlee, 1967; Maxwell, 1976, 1979) at base of "medial silty mbr." The "lower cliff-forming mbr" of "old" Wingate was retained as Lukachukai Mbr of Wingate by Harshbarger *et al.* (1957) and some later workers; Hilpert (1963) suggested that the Lukachukai might actually be equivalent to "lower sandy mbr" of Entrada, and this unit was reassigned as basal Iyanbito Mbr of Entrada by Green (1974), with Wingate Ss being completely abandoned in Gallup-Grants area.

ESPINASO FORMATION (Volcanics)-Oligocene

(1) Espinaso Ridge along Arroyo del Tuerdo (= "Arroyo Pinovetito"), Hagan basin (name credited to an unpublished manuscript by Bryan & Upson); (2) Hagan basin; (3) Water-laid breccia, cgl, & tuff; (5) Stearns (1943, 1953a, b), Disbrow & Stoll (1957), Sun & Baldwin (1958), Kelley & Northrop (1975), Kautz *et al.* (1981).

ESPIRITU SANTO FORMATION (in Arroyo Pefiasco Group)-Mississippian

(1) Quarry W of Pecos River at Tererro, near Holy Ghost (formerly Espiritu Santo) Creek, San Miguel Co. (Baltz & Read, 1960); (2) S Nacimiento Mtns, Placitas; (3) Bioclastic dolomite, dedolomite, & coarse-grained ls with algal mat laminations; (4) Established as basal fm of Arroyo Pefiasco Gr, consisting of lower Del Padre Ss Mbr and unnamed upper ls mbr (Armstrong & Mamet, 1974); (5) Armstrong & Mamet (1979), Armstrong *et al.* (1979).

[Fresnal Group]

(4) Name used for Virgilian (Upper Pennsylvanian) strata in central New Mexico, including Nacimiento & Manzano Mtns, by Thompson (1942); part of the Madera Fm of modern usage.

GALISTEO FORMATION (formerly Sandstone, sand group)-Eocene

(1) N bank of Galisteo Creek, E of Cerrillos, secs. 14-16, 21-23, T14N, R8E; (2) Hagan basin, N of Placitas, S of San Ysidro; (3) Ss, cgl, & variegated (mostly red) mudst & siltst; (4) Early workers disagreed over whether Galisteo was Cretaceous or Tertiary; since Lee (1917), it has been considered lower Tertiary. Exposures S of San Ysidro assigned to San Jose Fm (*e.g.*, Renick, 1931; Slack, 1975) are now included in Galisteo; (5) Stearns (1943, 1953a), Robinson (1957), Galusha (1966), Kelley & Northrop (1975), Gorham & Ingersoll (1979), Lucas & Kues (1979), Gawne (1981), Lucas (1982).

GALLEGO SANDSTONE MEMBER (of Gallup Sandstone)-Upper Cretaceous

(1) Gallego Creek, Socorro Co. (Winchester, 1920); type section-sec. 17, T4N, R7W (Lochman-Balk, 1959); (2) Cebolleta Mesa to Mt. Taylor & Ambrosia Lake areas (?); (3) Massive gray to yellow ss; (4) Originally defined as Gallego Ss Mbr of Miguel Fm (Winchester, 1920); name retained as upper mbr of Gallup Ss (Dane, Wanek, & Reeside, 1957; Dane, Bachman, & Reeside, 1957) and traced to Mt. Taylor and Ambrosia Lake areas (see also Molenaar, 1973, 1974); however, mapped in Grants, San Mateo, & Ambrosia Lake areas as "Main body" of Gallup (Santos, 1966a, b; Santos & Thaden, 1966; Thaden *et al.*, 1966; Thaden, Santos, & Raup, 1967).

[Gallegos Sandstone]

(4) Name used by Keyes (1915a, b) for thick ss beds in middle of Madera ls in Sandia Mtns; Jicha & Lochman-Balk (1958) recommend suppression of this name.

GALLUP SANDSTONE (in Mesaverde Group)-Upper Cretaceous

(1) Town of Gallup (Sears, 1925); no type section designated; (2) Laguna, Marquez, Seboyeta, Mt. Taylor, Grants, San Mateo, and Ambrosia Lake areas, & W side of Cebolleta Mesa; (3) One to three gray, tan to orange ss units interbedded with gray sh & minor coal beds and separated by tongues of Mancos Sh; (4) Originally defined as a mbr in Mesaverde Fm; raised to fm status in Mesaverde Gr (Beaumont *et al.*, 1956); (5) Hunt (1936), Sears *et al.* (1941), Pike (1947), Dane, Wanek, & Reeside (1957), Dane, Bachman, & Reeside (1957), Gadway (1959), Santos (1966a, b), Santos & Thaden (1966), Thaden, Santos, & Ostling (1966), Thaden, Merrin, & Raup (1967), Thaden, Santos, & Raup (1967), Moench & Schlee (1967), Beaumont (1971), Molenaar (1973, 1974).

GIBSON COAL MEMBER (of Crevasse Canyon Formation)-Upper Cretaceous

(1) Near village of Gibson, McKinley Co. (Sears, 1925); (2) Rio Puerco area, Laguna, Mt. Taylor, Seboyeta, San Mateo, Ambrosia Lake areas & N of Grants; (3) Gray to yellow massive crossbedded ss interbedded with dark gray sh & coal beds; (4) Originally defined as a mbr of Mesaverde Fm; lower part assigned as a mbr to Crevasse Canyon Fm (Allen & Balk, 1954), upper part as the Cleary Coal Mbr of Menefee (Beaumont *et al.*, 1956); (5) Hunt (1936), Sears *et al.* (1941), Sabins (1964), Santos (1966a, b), Santos & Thaden (1966), Thaden *et al.* (1966), Moench & Schlee (1967), Beaumont (1971), Shomaker (1971b, c), Kottlowski *et al.* (1971), Kottlowski & Parkhill (1971).

GLEN CANYON GROUP-Upper Triassic

(4) Group originally defined by Baker *et al.* (1927); the basal Wingate Ss was long considered to be the only part of the Glen Canyon present in the Albuquerque area. As various parts of the Wingate were assigned to Jurassic formations (see Entrada Ss for summary), it appeared, after 1974, that the Glen Canyon Gr was absent in the Ft. Wingate area and eastward. However, Maxwell (1979) reported very restricted exposures of the Rock Point Mbr of Wingate S of Acoma; this minute part of the Glen Canyon Gr is apparently present along the S flank of the Zuni uplift (O'Sullivan, 1977).

GLORIETA SANDSTONE (or Sandstone Member of San Andres Formation)-Permian

(1) Glorieta Mesa (Keyes, 1915a, b); type section-S-central part of T15N, R12E, 1.6 km (1 mi) W of Rowe, San Miguel Co. (Needham & Bates, 1943); (2) E side of Sandia Mtns, Placitas area, Hagan basin, Lucero uplift, S & W sides of Nacimiento Mtns, SW of Grants on Zuni uplift; (3) White to tan locally eolian & crossbedded ss with local thin ls & gypsum beds; (4) Keyes (1915a, b) used name for "main body of Dakotan series"; Rich (1921) recognized as Permian unit between Yeso & San Andres; Wilmarth (1938) considered it upper mbr of Yeso; Needham & Bates (1943) established as a separate fm, a convention followed by most subsequent workers except in Sandia Mtns area where it is considered the basal mbr of San Andres Fm (Kelley & Northrop, 1975); (5) Kelley & Wood (1946), Wood & Northrop (1946), Baars (1961a, b; 1962), Kelley (1963a, 1972), Woodward & Martinez (1974), Woodward & Ruetschilling (1976).

Graneros Shale

(4) A widespread Midcontinent unit, the Graneros was reported by Rankin (1944) in Rio Puerco area and is present in N New Mexico; workers in the Albuquerque area have included Graneros-equivalent beds in Mancos Shale.

GRAY MESA MEMBER (of Madera Ls)-Middle Pennsylvanian

(1) E face of Gray Mesa, T5N, R3W, Valencia Co. (Kelley & Wood, 1946); (2) Lucero uplift, from Ladron Mtns to Lucero Mesa; (3) Gray massive ls, locally cherty, with tan thin-bedded ls at top; (4) Read & Wood (1947) reported a late Atokan-Desmoinesian age.

Greenhorn Limestone

(4) A widespread Midcontinent unit, the Greenhorn was reported by Rankin (1944) in Rio Puerco area and is present in N New Mexico; workers in the Albuquerque area have included Greenhorn-equivalent beds in Mancos Shales.

HOSTA SANDSTONE TONGUE (Member) (of Point Lookout Sandstone)-Upper Cretaceous

(1) Hosta Butte, W side of S end of Dalton Pass, McKinley Co. (Sears, 1934); (2) Seboyeta, Marquez, Cabezon, Mt. Taylor, and Ambrosia Lake areas; Hagan basin (?); (3) Olive to orange massive ss, interbedded with sh locally toward top; (4) First defined as Hosta Mbr of Mesaverde Fm; restricted to lower part of Point Lookout Ss where Point Lookout is split by Satan Tongue of Mancos Sh (Beaumont *et al.*, 1956). Black (1979) considered Cano Ss Mbr of Mesaverde in Hagan basin as part of Hosta-Dalton "turnaround"; (5) Hunt (1936), Sears *et al.* (1941), Pike (1947), Sabins (1964), Santos (1966a), Santos & Thaden (1966), Moench & Schlee (1967), Beaumont (1971), Shomaker (1971b), Kottowski *et al.* (1971).

IYANBITO MEMBER (of Entrada Sandstone)-Upper Jurassic

(1) Near village of Iyanbito, NW1/4, sec. 15 (unsurveyed), T15N, R16W, McKinley Co. (Green, 1974); (2) Grants area; (3) Mainly red-orange crossbedded ss with basal cgl layer; (4) Previously recognized as Lukachukai Mbr of Wingate Ss (Harshbarger *et al.*, 1957; Thaden, Santos, & Raup, 1967); that name is abandoned in Gallup-Grants area.

JACKPILE SANDSTONE UNIT (Member) (of Morrison Formation)-Upper Jurassic

(1) Near Laguna, sec. 28, TION, R5W, Cibola Co. (Freeman & Hilpert, 1956); (2) Marquez, Mesa Gigante, and Laguna areas & W of San Ysidro; (3) Yellow to gray to white ss, with minor cgl seams and interbedded gray-green clays; (4) Considered a "ss unit of economic usage" by most workers; Flesch (1974) recommended mbr status; (5) Schlee & Moench (1961), Hilpert (1963), Moench (1963b), papers in Kelley (1963b), Schlee & Moench (1963a, b), Moench & Puffett (1963a, b), Moench *et al.*, (1965), Moench & Schlee (1967), papers in Rautman (1980).

[Jemez marl(s)]

(4) Term first used by Reagan (1903) for the "marls" in the Rio Grande embayment in the Jemez region, and considered to represent a continuation of the "Santa Fe marls" and a lateral equivalent of the "Albuquerque marls."

JEMEZ SPRINGS SHALE MEMBER (of Madera Formation)-Upper Pennsylvanian

(1) Immediately N of church ruins on N side of town of Jemez Springs (Sutherland & Harlow, 1967); (2) Jemez Springs area; (3) Gray to maroon calcareous sh & marlst, highly fossiliferous, with thin nodular ls beds.

JOYITA SANDSTONE MEMBER (of Yeso Formation)-Lower Permian

(1) Joyita Hills, near Mesa del Yeso, sec. 33, T1S, R2E, Socorro Co. (Needham & Bates, 1943); (2) Interfingers with San Ysidro Mbr of Yeso N of Albuquerque (Hunter & Ingersoll, 1981); (3) Pink, tan, orange, & yellow thin- to medium-bedded ss with local carbonate beds.

KERES GROUP-Miocene

(1) Keresan Range (old name for part of Jemez Mtns); type area in S Jemez Mtns, Sandoval Co. (Bailey *et al.*, 1969); (2) Jemez Mtns; (3) Basaltic, andesitic, dacitic, & rhyolitic rocks; (4) Includes Basalt of Chamisa Mesa, Canovas Canyon Rhyolite, Paliza Canyon Formation, & Bearhead Rhyolite; (5) Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

LA CASA MEMBER (of Wild Cow Formation)-Upper Pennsylvanian

(1) La Casa Spring; type section-W side of Priest Canyon, sec. 7, T3N, R5E, Valencia Co. (Myers, 1973); (2) Manzano Mtns; (3) Basal siltst & sh, with arkose & cgl locally, overlain by alternating sequence of ls, siltst, ss, & sh; (4) Is Unit D of upper part of upper Madera Fm of Myers (1966, 1967, 1969) and Myers & McKay (1970, 1971, 1972); (5) Myers & McKay (1976), Myers (1977).

LAGUNA BASALT FLOW-Pleistocene

(1 & 2) San Jose valley, Cibola Co. (Nichols, 1936); (3) Olivine basalt; (5) Nichols (1939, 1946), Laughlin *et al.* (1972).

LOG SPRINGS FORMATION-Upper Mississippian

(1) Log Springs, Pefiasco Canyon, Nacimiento Mtns, NW 1/4, SE1/4, sec. 5, T16N, R1E (Armstrong, 1955); (2) Sandia, Jemez, S Nacimiento Mtns; (3) Red, silty, oolitic or pisolitic hematitic sh; (4) First believed to be Lower Pennsylvanian (Armstrong, 1955); questionable occurrence in Tijeras Canyon included in Sandia Fm (Kelley & Northrop, 1975); (5) Armstrong (1967), Armstrong & Mamet (1974), DuChene (1974).

LOS DURANES FORMATION-Pleistocene

(1) NE1/4, NEB/, sec. 11, TION, R2E, Bernalillo Co. (Lambert, 1968); (2) Albuquerque area; (3) Clay, mud, sand, & gravel; (4) Equivalent to upper part of Bryan's (1909) Rio Grande beds.

LOS MOYOS LIMESTONE (in Madera Group)-Middle-Upper Pennsylvanian

(1) Los Moyos Canyon, Manzano Mtns; type section-walls of a ravine that drains into Priest Canyon, sec. 7, T3N, R5E (Myers, 1973); (2) Manzano Mtns; (3) Cherty olive to gray calcarenites, with minor lenticular ss & cgl, and thin beds of orange siltst & dark sh; (4) Desmoinesian-lower Missourian. Is the "lower gray ls mbr" of Read *et al.* (1944) and "lower part of Madera Ls" of Myers (1966, 1967, 1969) & Myers & McKay (1970, 1971, 1972); is probably equivalent to Gray Mesa Mbr of Kelley & Wood (1946); (5) Myers & McKay (1976).

LOS VALLOS MEMBER (of Yeso Formation)-Lower Permian

(1) Los Vallos, Lucero uplift; no type section designated (Kelley & Wood, 1946); (2) Lucero uplift; (3) Lower yellow, pink, & gray sh, a few thin ls & thicker gypsums; upper thin ss, dark ls, silty sh & thick gypsums; (4) Apparently equivalent to Tones Mbr of Yeso (Hunter & Ingersoll, 1981).

[Loup Fork beds]

(4) Name used by Cope (e.g., 1884) to refer to rocks in north-central New Mexico now referred to Santa Fe Group.

Lukachukai Member of Wingate Sandstone

(4) Considered by Harshbarger *et al.* (1957) to be only part of Wingate present in Ft. Wingate to Laguna area after upper part of old Wingate was assigned to Entrada (Baker *et al.*, 1947); mapped in Grants area by Thaden, Santos, & Raup (1967), but name abandoned in Gallup-Grants area by Green (1974), who named the unit Iyanbito Mbr of Entrada.

MADERA FORMATION (Group, Limestone)-Pennsylvanian-Lower Permian

(1) Village of La Madera, Sandia Mtns; no type section designated (Keyes, 1903a); (2) Sandia, Manzanita, Manzano, S Nacimiento Mtns, & Lucero uplift; (3) Thick massive gray ls, locally cherty, with dark gray, red-brown & green sh; gray, green, & tan ss, and minor arkosic cgl; (4) Divided into "lower gray ls" & "upper arkosic ls" members in Nacimiento, Manzano, Manzanita, & Sandia Mtns (Read *et al.*, 1944; Wood & Northrop, 1946; Read & Wood, 1947; Bates *et al.*, 1947); into Gray Mesa, Atrasado, & Red Tanks mbrs in Lucero uplift (Kelley & Wood, 1946); raised to group status consisting of Los Moyos Ls, Wild Cow Fm, & Bursum Fm in Manzano-Manzanita Mtns (Myers, 1973); Sutherland & Harlow (1967) established Jemez Springs Sh Mbr for uppermost beds in Jemez Springs area; Thompson (1942) recommended abandoning Madera in favor of several other units he proposed; (5) Keyes (1904), Gordon (1907), Needham (1937), Henbest & Read (1944), Wenger (1959), Kottowski (1960, 1961), Northrop (1961), Kelley (1963a), Myers (1966, 1967, 1969), Myers & McKay (1970, 1971, 1972, 1976), DuChene (1974), Woodward & Martinez

(1974), Kelley & Northrop (1975), Woodward & Ruetschilling (1976), Armstrong *et al.* (1979).

[Madrid Formation (Coal Group)]

(4) Name used by Johnson (1902-1903) for combined Mesaverde Fm and Galisteo Fm in Cerrillos-Hagan basin area.

Magdalena Group

(4) Name established by Gordon (1907) to include Sandia and Madera Fms, and used extensively in descriptions of the Pennsylvanian sequence in the Sandia, Manzano, & Nacimiento Mtns and Lucero uplift (e.g., Darton, 1928; Renick, 1931; Needham, 1940; Wood & Northrop, 1946; Kelley & Wood, 1946; Read & Wood, 1947, Kelley & Northrop, 1975). Thompson (1942) rejected use of Magdalena because the group was essentially equivalent to the Pennsylvanian Series in New Mexico, and Myers (1973) rejected use of name in Manzano Mtns while raising the Madera Fm to group status. The present authors believe that the Madera elsewhere in the Albuquerque area also deserves group status and that the term Magdalena Gr should not be retained.

MANCOS SHALE (Formation)-Upper Cretaceous

(1) Mancos valley, near town of Mancos, SW Colorado (Cross, 1899); (2) N Lucero uplift, E side of Sandia Mtns, Placitas, Hagan basin, S & E of San Ysidro, W side of Nacimiento uplift, Rio Puerco area, Mesa Gigante, Seboyeta, Laguna, San Mateo, Marquez, Mt. Taylor, Grants, Acoma, Bluewater, Ambrosia Lake, & Cebolleta Mesa areas; (3) Dark gray sh & sandy sh, with ss & thin ls beds, some units with brown limy concretions; (4) Units now assigned to Mancos in Albuquerque area have been studied since mid-1800s (see Lee, 1912, 1917 for summary); divided into "lower part" containing several ss units, "main body," Mulatto & Satan tongues (Hunt, 1936); this terminology used throughout W part of Albuquerque area by USGS in 1960s (e.g., Moench, 1963a, b; Schlee & Moench, 1963a, b; Moench & Puffett, 1963a; Moench *et al.*, 1965; Santos & Thaden, 1966; Santos, 1966a, b; Moench & Schlee, 1967); "lower part" intertongues complexly with Dakota Ss (see Clay Mesa and Whitewater Arroyo Sh tongues of Mancos, Landis *et al.*, 1973); intertongues to SW with Gallup Ss (see D-Cross & Pescado tongues); locally includes various mbrs (e.g., Juana Lopez, Semilla Ss mbrs); to N & E of Albuquerque area Mancos is divided into or replaced by Midcontinent terminology (e.g., Graneros, Greenhorn, Carlite); (5) Herrick (1900b), Herrick & Johnson (1900), Shimer & Blodgett (1908), Darton (1910, 1928), Renick (1931), Rankin (1944), Kelley & Wood (1946), Wood & Northrop (1946), Pike (1947), Stearns (1953b), Dane (1960), Kelley & Northrop (1975), Maxwell (1976), Cobban (1977), Molenaar (1977); see also citations for individual tongues and mbrs.

MANUELITAS MEMBER (of Tererro Formation)-Upper Mississippian

(1) W end of the gap 2.6 km (1.6 mi) E of Lower Rociada, near Manuelitas Creek, San Miguel Co. (Baltz & Read, 1960); (2) S Nacimiento Mtns; (3) Arenaceous lime mudst, pelletoid-oid wackestone & packstone with abundant microfossils; (4) Only mbr of Tererro Fm (assigned to Arroyo Pefiasco Gr) present in Albuquerque area (Armstrong & Mamet, 1974).

[Manzano Group]

(4) Name, first used as "Manzano series" by Herrick (1900b) for redbed sequence of Permian age above Madera Ls and subdivided into several unnamed units (Gordon, 1907); Lee (1909) named Abo Ss, Yeso Fm, & San Andreas [sic] Ls divisions of Manzano Gr; name has fallen out of usage and should be abandoned (Jicha & Lochman-Balk, 1958).

McCARTYS BASALT FLOW-Holocene

(1) Around McCarty's in San Jose valley SE of Grants, Cibola Co. (Nichols, 1934); (2) San Jose valley from W of McCarty's S to Point of Malpais; (3) Basalt of a pahoehoe flow; (4) Erroneously called "San Rafael Basalt" by Manton & Leeman (1969); (5) Nichols (1939, 1946), Leeman (1970), Laughlin *et al.* (1972), Carden & Laughlin (1974), Brookins *et al.* (1975).

MENAU FORMATION-Pleistocene

(1) Secs. 3, 10, T ION, R3E, Albuquerque (Lambert, 1968); (2) Albuquerque area; (3) Sandy pebble axial gravel.

MENEFEE FORMATION (of Mesaverde Group)-Upper Cretaceous

(1) Menefee Mtn, Mesa Verde National Park, Colorado (Collier, 1919); (2) N of Ambrosia Lake & in a large area NE of San Mateo to W of Cabezon area; (3) Interbedded gray to tan massive to thin-bedded ss with gray sh and coal beds; (4) Name Menefee extended from N to include "upper Gibson Coal Mbr" (now Cleary Coal Mbr) & Allison Barren Mbr of Mesaverde of Sears (1925) by Allen & Balk (1954) & Beaumont *et al.* (1956), who established Menefee as middle fm of Mesaverde Gr in W part of Albuquerque area. Represents strata that had much earlier been termed "lignite division" (Herrick & Johnson, 1900; Darton, 1910) and "Mesaverde coal beds" (Gardner, 1909, 1910) in Rio Puerco and San Mateo-Cabezon areas. Generally not recognized in Hagan basin except by Black (1979); (5) Sabins (1964), Santos & Thaden (1966), Santos (1966a, b), Beaumont (1971), Pierce & Shomaker (1971), Shomaker (1971a), Siemers *et al.* (1975), Tschudy (1976), Siemers & Wadell (1977).

MESA PRIETA FLOW-Pleistocene

(1, 2) Mesa Prieta, Sandoval Co. (Weber, 1963); (3) Dark-gray to nearly black, fine-grained, massive, subcolumnar to platy olivine basalt to basaltic andesites separated by rubbly flow breccia.

MESAVERDE GROUP (Formation)-Upper Cretaceous

(1) Mesa Verde, SW Colorado (Holmes, 1877); (2) Widely distributed; see individual formations; (3) See individual formations; (4) Name extended as a fm from Colorado to Albuquerque area (Gardner, 1909); divided into Gallup, Dilco, Bartlett, Gibson, & Allison mbrs (Sears, 1925); divided in Cabezon area into "lower ss mbr," "middle coal-bearing mbr," & "upper ss mbr (destined to become Point Lookout, Menefee, & Cliff House fms) by Renick (1931); Dalton Mbr added above Dilco & Hosta Mbr between upper & lower Gibson in Mt. Taylor area (Hunt, 1936); raised to group status in W part of Albuquerque area and mbrs reassigned to Gallup, Crevasse Canyon, Point Lookout, & Menefee fms (Allen & Balk, 1954; Beaumont *et al.*, 1956); still considered a fm in Hagan basin and around Sandia Mtns (Stearns, 1953b; Kelley & Northrop, 1975); (5) Herrick (1900b), Herrick & Johnson (1900), Shimer & Blodgett (1908), Lee (1912, 1917), Darton (1928), Sears *et al.* (1941), Pike (1947); see also citations for individual fms & mbrs.

MESETA BLANCA SANDSTONE MEMBER (of Yeso Formation)-Lower Permian

(1) Meseta Blanca, Nacimiento Mtns; type section-sec. 3, T16N, R2E (Wood & Northrop, 1946); (2) S Nacimiento Mtns, E side of Sandia Mtns, S Manzano Mtns, Lucero uplift; (3) Light-orange to red, tan & white crossbedded ss; (4) Upper part of Abo Fm of Needham & Bates (1943) assigned to Meseta Blanca in Abo Pass area (Bates *et al.*, 1947); Baars (1962) recommended replacement of name by De Chelly Ss; (5) Kelley & Wood (1946), Kelley & Northrop (1975), Myers (1977), Hunter & Ingersoll (1981).

[Mesita Alta Gravel]

(4) The Mesita Alta Gravel of Soister (1952) along SE flank of Jemez Mtns probably is equivalent to Ortiz or Tuerto Gravel (Kelley, 1977).

MOENKOPI(?) FORMATION-Lower-Middle? Triassic

(1) Moenkopi Wash, Grand Canyon, Arizona (Ward, 1901); (2) Bluewater, Grants, and Correo areas, & Mesa Gallina; (3) Pale red-brown & gray-red arkosic & micaceous ss, interbedded with lenticular pebble cgl; crossbedded near top; (4) As tentatively recognized, the Moenkopi(?) was included by Kelley & Wood (1946) in their Shinarump Cgl (Stewart *et al.*, 1972b); Darton's (1928) Moenkopi in Bluewater area was that part of Chinle below Sonsela Ss bed with present Moenkopi(?) at base (Stewart *et al.*, 1972c); (5) Cooley (1959), Thaden & Ostling (1967), Thaden, Merrin, & Raup (1967), Repenning *et al.* (1969), O'Sullivan (1977).

MONITOR BUTTE MEMBER (of Chinle Formation)-Upper Triassic

(1) N end of Monitor Butte, SE Utah (Kiersch, 1955); (2) Bluewater & Grants areas, not recognized E of Mt. Taylor; (3) Red to variegated mudst & siltst interbedded with white, yellow, & brown ss & cgl; (4) "Lower red mbr of Chinle" of Cooley (1959), Thaden & Ostling (1967) & Thaden, Santos, & Raup (1967) is Monitor Butte Mbr (Repenning *et al.*, 1969); (5) O'Sullivan (1977).

[Montana Group]

(4) Midcontinent name used by Schrader (1906) as "upper Montana Coal Group" for rocks now assigned to the Mesaverde Gr from Nacimiento Mtns to Mt. Taylor.

[Montosa Limestone]

(4) Name used by Keyes (1906) for ls below "Coyote Ss" and above Sandia Fm; part of Madera of modern usage. Name rejected by Gordon (1907) & Jicha & Lochman-Balk (1958).

MORRISON FORMATION-Upper Jurassic

(1) About 3.2 km (2 mi) N of Morrison, Colorado (Eldridge in Emmons *et al.*, 1896); (2) N Lucero uplift, E side of Sandia Mtns, Placitas, Hagan basin, W side of Nacimiento Mtns, San Ysidro-White Mesa area, Laguna, San Mateo, Grants, Acoma, and Bluewater areas; (3) Gray-red, green-gray, orange to variegated mudst, siltst, & interbedded ss & minor ls; (4) Undivided in Sandia-Hagan basin area (Kelley, 1963a; Kelley & Northrop, 1975); divided into lower & upper mbrs on W side of Nacimientos & San Ysidro area (Renick, 1931; Woodward & Martinez, 1974; Woodward & Ruetschilling, 1976); in S Nacimientos & Mesa Gigante area, Todilto considered basal mbr (Wood & Northrop, 1946; Kelley & Wood, 1946; Silver, 1948), but now is a separate fm; divided into 5 mbrs in Mesa Gigante to Laguna area by Kelley & Wood (1946) & Silver (1948): Todilto, "buff sh mbr" (equivalent to Summerville Fm, Freeman & Hilpert, 1956), "brown-buff ss mbr," "white ss mbr" (both brown-buff & white mbrs equivalent to Bluff Ss, Freeman & Hilpert, 1956), & "variegated sh mbr" (equivalent to entire Morrison as defined in W half of Albuquerque area); standard sequence in Grants uranium belt is Recapture, Westwater Canyon, and Brushy Basin mbrs & Jackpile unit (Freeman & Hilpert, 1956; Hilpert, 1963; Moench & Schlee, 1967; papers in Rautman, 1980); this terminology extended to Ca-

bezón-San Ysidro area by Flesch (1973); (5) Darton (1928), Hunt (1936), Smith (1961) papers in Kelley (1963b), Hilpert (1969), Siemers *et al.* (1975), Green & Pierson (1977).

[Mosca Limestone]

(4) Name used by Keyes (1906) for Is above "Coyote Ss" in central New Mexico; rejected by Gordon (1907) & Jicha & Lochman-Balk (1958); part of Madera Gr of modern usage.

[Moya Formation]

(4) Name used by Thompson (1942) for nodular fossiliferous Is near top of Pennsylvanian in Abo Pass area and elsewhere; part of Madera Gr of modern usage.

MULATTO TONGUE (of Mancos Shale)-Upper Cretaceous

(1) S end of Canyon Mulatto, 14.5 km (9 mi) NW of San Mateo, Cibola Co. (Sears, 1934; Hunt, 1936); (2) Seboyeta, Laguna, San Mateo, Grants, Mt. Taylor, & Ambrosia Lake areas; (3) Gray to yellow-brown sh & subordinate yellowish silty ss; (4) Tongue of Mancos between underlying Dilco Ss (or Borrego Pass Lentil) & overlying Dalton Ss; referred to as Mulatto Sh by Sabins (1964); (5) Sears *et al.* (1941), Santos (1966a, b), Santos & Thaden (1966), Thaden *et al.* (1966), Thaden, Santos, & Raup (1967), Thaden, Merrin, & Raup (1967), Moench & Schlee (1967), Molenaar (1977), Lipman *et al.* (1979). Nacimiento Formation (Group)

(4) Widely exposed Paleocene unit in San Juan Basin; a small exposure was reported by Renick (1931) in Rio Puerco area W of San Ysidro, underneath his "Wasatch Fm"; exposure was questionably assigned to Nacimiento by Galusha (1966); now considered to be parts of Galisteo and Mesaverde formations.

Navajo Sandstone

(4) Name used by Darton (1928) for a massive gray ss between Todilto & Dakota in Grants-Laguna area; is Summerville, Bluff, & Zuni fms of modern usage. True Navajo Ss is restricted to NW corner of N.M. (Harshbarger *et al.*, 1957).

Niobrara Formation

(4) Widespread Midcontinent unit reported present in Rio Puerco area (Rankin, 1944) and in Hagan basin (Black, 1979). Units equivalent to Niobrara have been assigned to upper part of Mancos in Albuquerque area by most workers.

OAK CANYON MEMBER (of Dakota Formation)-Upper Cretaceous

(1) Oak Canyon, 6.4-8 km (4-5 mi) NE of Laguna; type section-NE1/4, SEA/, sec. 20 & SW1/4, NWT, sec. 21, T10N, R5W, Cibola Co. (Landis *et al.*, 1973); (2) Laguna, Grants, & Acoma areas; (3) Lower ss, locally cgl or silty, and upper clay-sh & silty sh with bentonites & local fossiliferous Is; (4) Lower part considered part of Dakota and upper part as lowest Mancos by previous authors (e.g., Hunt, 1936; Thaden *et al.*, 1966; Thaden, Merrin, & Raup, 1967; Moench & Schlee, 1967); (5) Maxwell (1976, 1979), Cobban (1977).

Ortiz Gravel (Pediment Gravel)

(4) The term Ortiz Gravel has been used as a synonym of Tuerco Gravel (e.g., Galusha, 1966; Kelley, 1977).

[Oscuro Limestone]

(4) Name applied by Keyes (1909) to Pennsylvanian Is overlying "Mosca Ls" in Rio Grande area; Jicha & Lochman-Balk (1958) recommended suppression of this name.

OSHA CANYON FORMATION-Lower Pennsylvanian

(1) Osha Canyon, near Guadalupe Box, S Nacimiento Mtns (DuChene *et al.*, 1977); (2) S Nacimiento Mtns; (3) Lower gray to white bioclastic Is & calcareous sh & upper gray to tan sh with Is nodules; (4) Included in lower Sandia Fm (Northrop & Wood, 1945) & in lowest part of "upper elastic ss mbr of Sandia Fm" (Wood & Northrop, 1946; Read & Wood, 1947); as "unnamed Morrowan Ls" (Armstrong, 1955, 1967; Armstrong & Mamet, 1974); as "Sandia Fm-Morrowan" (Armstrong & Mamet, 1977, 1979); named informally by DuChene (1974).

OTOWI MEMBER (of Bandelier Tuff)-Pleistocene

(1) Otowi section of Bandelier National Monument near Otowi ruins, NE V4, NEB/, sec. 18, T19N, R7E (Griggs, 1964); (2) Jemez Mtns; (3) Tan massive aggregate of poorly sorted rhyolitic pumice fragments and fine pumiceous glass; (4) Includes Guaje Pumice Bed; (5) Bailey *et al.* (1969), Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

Owl Rock Member (of Chinle Formation)

(4) Variegated clayst, siltst, & Is unit overlying Petrified Forest Mbr; O'Sullivan (1977) reported that it thinned E-ward to a featheredge at Thoreau, W of Albuquerque area, but it was included on a stratigraphic section for the Ambrosia Lake area in Rautman (1980).

PAGUATE SANDSTONE TONGUE (of Dakota Sandstone)-Upper Cretaceous

(1) Paguate, 11 km (7 mi) N of Laguna; type section-NE1/4, SEA/, sec. 20 & SW1/4, NW1/4, sec. 21, T10N, R5W, Cibola Co. (Landis *et al.*, 1973); (2) Grants & Laguna areas; (3) Fine-grained locally silty ss with interbedded siltst & minor concretionary Is; (4) Merges with upper part of "main body" of Dakota W of Grants; referred to as "middle ss" in lower Mancos (Hunt, 1936; Moench & Schlee, 1967), and part of middle unit of lower Mancos (Thaden *et al.*, 1966; Thaden, Merrin, & Raup, 1967); (5) Cobban (1977), Maxwell (1979).

PALIZA CANYON FORMATION (in Keres Group)-Miocene

(1) Paliza Canyon, Jemez Mtns (Bailey *et al.*, 1969); (2) S Jemez Mtns; (3) Basaltic, andesitic, & dacitic flows, tuffs & breccias; (5) Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

PERALTA TUFF MEMBER (of Bearhead Rhyolite, formerly of Santa Fe Group)-Middle Pliocene

(1) Peralta Canyon, near its junction with Colle Canyon, Sandoval Co. (Stearns, 1953a); (2) S of Valles Caldera; (3) Bedded air-fall tuffs, hot-avalanche deposits, & reworked tuffs; (4) Is a tuffaceous facies of Bearhead Rhyolite; (5) Bailey *et al.* (1969), Smith *et al.* (1970), Kudo (1974).

Pescado Tongue (of Mancos Shale)

(4) Reported as present along E & S side of Cebolleta Mesa (Pike, 1947), but this unit reinterpreted by Dane, Wanek, & Reeside (1957) as D-Cross Tongue; shown as questionably present into Rio Puerco & Mt. Taylor areas in a diagram in Dane (1960); true Pescado absent in Albuquerque area (Molenaar, 1973, 1977), but shown in stratigraphic section between upper and lower parts of Gallup in Ambrosia Lake area (Rautman, 1980). Questionably present in Albuquerque country.

PETRIFIED FOREST MEMBER (of Chinle Formation)-Upper Triassic

(1) Named for shales in Zion National Park, Utah "closely resembling the dominant rocks in the Petrified Forest of Arizona" (Gregory, 1950; first described by Gregory & Williams, 1947); (2) Lucero uplift, San Ysidro-White Mesa area, W side of Nacimiento Mtns, Correo, Laguna, Grants, and Bluewater areas; (3) gray-green, red, to brown-maroon and variegated sh, with subordinate red ss, siltst, & brown Is; (4) Is "lower red sh mbr" of Kelley & Wood (1946) and Silver (1948); includes "middle mbr" & "upper mbr" of Thaden & Ostling (1967) & Thaden, Santos, & Raup (1967); includes "upper mbr" of Thaden, Santos, & Ostling (1967) and Woodward & Martinez (1974); (5) Cooley (1959), Moench & Schlee (1967), Stewart *et al.* (1972a, c); Woodward & Ruetschilling (1976), O'Sullivan (1977).

PIEDRA PARADA MEMBER (of Zia Sand Formation)-Miocene

(1) Canada Piedra Parada, SW of Zuni Pueblo; type section-secs. 11, 14 & 23, T14N, R1E, Sandoval Co. (Galusha, 1966); (2) N part of Albuquerque basin; (3) Red, green, pink, & gray ss, siltst & clayst; (5) Galusha & Blick (1971), Gawne (1975, 1976, 1981), Kelley (1977), Manley (1978).

PINE SHADOW MEMBER (of Wild Cow Formation)-Upper Pennsylvanian

(1) Pine Shadow Spring, near head of Priest Canyon, Manzano Mtns; type section-W side of Priest Canyon, sec. 7, T3N, R5E, Valencia Co. (Myers, 1973); (2) Manzano Mtns; (3) Basal red-brown arkosic cgl or yellow to brown siltst/ss overlain by siltst & sh, & topped by thick-bedded gray calc arenitic Is; (4) Is "Unit C" of upper part of upper Madera of Myers (1966, 1967, 1969) and Myers & McKay (1970, 1971, 1972); (5) Myers & McKay (1976), Myers (1977).

[Placita marl]

(4) Term introduced by Cope (1875) for strata now assigned to the Santa Fe Group from the Sandia Mtns to Placitas and beyond; used also by Cope (1877) and Reagan (1903).

[Placitos Limestone]

(4) Name proposed by Keyes (1903a) for black Pennsylvanian Is overlying Sandia Fm in Sandia Mtns; part of Madera Gr of modern usage. Jicha & Lochman-Balk (1958) recommended suppression of this name.

POINT LOOKOUT SANDSTONE (in Mesaverde Group)-Upper Cretaceous

(1) Cliffs at Point Lookout, 12.1 km (7.5 mi) SW of Mancos, SW Colorado (Collier, 1919); (2) Seboyeta, Marquez, San Mateo, and Ambrosia Lake areas; Hagan basin (?); (3) Gray, red-brown, & orange ss; (4) Pike (1947) established equivalency of Point Lookout and "upper part of Hosta Mbr" of earlier workers; Hosta Mbr of Mesaverde Fm supplanted in W part of Albuquerque area and elsewhere by Point Lookout Ss, of which Hosta became lower tongue (Allen & Balk, 1954; Beaumont *et al.*, 1956); presence in Canoncito area (Dane & Bachman, 1965) disputed by Molenaar (1977); Black (1979) reported presence in Hagan basin Mesaverde sequence; (5) Sabins (1964), Santos (1966a, b), Santos & Thaden (1966), Thaden *et al.* (1966), Moench & Schlee (1967), Beaumont (1971).

POISON CANYON SANDSTONE LENS (of economic usage) (of Westwater Canyon Member of Morrison Formation)-Upper Jurassic

(1) Near Poison Canyon mine, sec. 19, TUN, R9W (Zitting *et al.*, 1957); (2) Grants uranium district; (3) Arkosic ss, upper part clayey & silty, much

carbonaceous material and petrified wood; (5) Santos (1963), Thaden *et al.* (1966), Thaden & Ostling (1967), Thaden, Santos, & Ostling (1967), Hilpert (1969).

Poleo Sandstone (Sandstone lentil)

(4) Mapped by Renick (1931) in S Nacimiento Mtns-White Mesa area but Wood & Northrop (1946) considered these exposures to be Agua Zarca Mbr of Chinle. Stewart *et al.* (1972a) stated that Poleo wedges out in Petrified Forest Mbr S of Cuba.

[Prieta Sandstones]

(4) Name used by Herrick & Johnson (1900) for thick sequence of "loose yellow ss & shaly phases" above Punta de la Mesa Ss in Rio Puerco area; upper Mancos and Mesaverde of modern usage.

[Puertecito Formation]

(4) Name used by Wells (1919) to designate strata between Permian and Cretaceous units in Puertecito to Laguna area; now assigned to Chinle Fm (Stewart *et al.*, 1972c).

[Punta de la Mesa Sandstone]

(4) Name used by Herrick (1900b) and Herrick & Johnson (1900) for a ss above Tres Hermanos Ss in Rio Puerco valley; considered a basal unit of Mesaverde (Lee, 1912), then as an upper mbr of Mancos (Lee, 1917); name discarded by USGS as the unit was determined to be an E extension of Gallup Ss (Wilmarth, 1938; Sears *et al.*, 1941).

Purgatoire Formation

(4) Unit present in NE N.M.; name used by Darton (1928) for a ss-sh sequence below Dakota in Sandia Mtns.

RECAPTURE MEMBER (of Morrison Formation)-Upper Jurassic

(1) Near mouth of Recapture Creek, 9.7 km (6 mi) E of Bluff, Utah (Gregory, 1938); (2) Mesa Gigante, Laguna, Acoma, Grants, & Bluewater areas, and E of Cabezon; (3) Gray-red & green-gray to variegated mudst, siltst, & ss with thin ls beds; (5) Craig *et al.* (1955), Freeman & Hilpert (1956), Harshbarger *et al.* (1957), Hilpert (1963), Moench (1963b, 1964b), Moench & Puffett (1963a, b), Schlee & Moench (1963b), Thaden & Ostling (1967), Thaden, Santos, & Raup (1967), Moench & Schlee (1967), Flesch (1974), papers in Rautman (1980).

RED TANKS MEMBER (of Madera Formation)-Upper Pennsylvanian-Lower Permian?

(1) W side of Red Tanks Arroyo, Lucero uplift (Kelley & Wood, 1946); type section-NW1/4, sec. 4 & NE1/4, sec. 5, T3N, R3W, Valencia Co. (Jicha & Lochman-Balk, 1958); (2) Lucero uplift; (3) Lower dark red-brown siltst, ss, & sh with local tan ss & ls cgl; also gray-green nodular ls and sh; (4) Approximately equivalent to Bursum Fm (Bates *et al.*, 1947), (5) Read & Wood (1947), Kottowski (1960), Kues & Kietzke (1976, 1981).

[Rio Grande gravels (beds)]

(4) Term used by Herrick (1898) to refer to a thin sequence of gravel & sands in the Albuquerque area. Bryan (1909) included it in his "Santa Fe marl" and Bryan & McCann (1937) recommended rejection of the name.

[Rio Grande loess]

(4) Term used by Herrick (1898) for "sandy loess passing into clay" in the Albuquerque area; Bryan (1909) rejected use of term because "these stratified silts and sands can hardly be called loess."

ROCK POINT MEMBER (of Wingate Sandstone)-Upper Triassic

(1) Little Round Rock butte, 24 km (15 mi) S of Rock Point, Arizona (Kiersch, 1955; Harshbarger *et al.*, 1957); (2) East Mesa & Broom Mountain quads, S of Acoma; (3) Red to red-purple thick-bedded to massive siltst & shaly mudst with local ls cgl lenses near base; (5) Maxwell (1979).

SAN ANDRES FORMATION-Upper Permian

(1) San Andres Mtns (Lee, 1909); type section-Rhodes Canyon, sec. 29, T12S, R2E (Needham & Bates, 1943); (2) Lucero uplift, E side of Sandia Mtns, Placitas, Hagan basin, S Nacimiento Mtns, Grants & Bluewater areas; (3) Mainly gray dense ls, locally cherty or dolomitic, with variable amounts of red to yellow ss, and clean white ss at base (Glorieta Mbr); (4) Divided into Glorieta, "limestone," & "upper" mbrs ("upper" now called Bernal Fm) by Read *et al.* (1944); into Glorieta & upper "fine-grained red ss" mbrs in S Nacimientos (Wood & Northrop, 1946); into Glorieta, "middle evaporite," & "upper ls" mbrs in Lucero uplift (Kelley & Wood, 1946); Glorieta considered separate fm by Needham & Bates (1943) & most later workers, except in Sandia Mtns area (Kelley & Northrop, 1975); San Andres (excluding Glorieta) is Bonney Canyon Mbr only in most of central N.M. E of Rio Grande (Kelley, 1972; Kelley & Northrop, 1975); (5) Baars (1961a, b; 1962), Thaden & Ostling (1967), Thaden, Santos, & Raup (1967), Kottowski (1969).

[Sandia (Zandia) clay]

(4) Term used by Cope (1875) to refer to a "lacustrine deposit" of "indurated clay" of Quaternary age in the Sandia Mtns.

SANDIA FORMATION (series, quartzites)-Middle Pennsylvanian

(1) S end of Sandia Mtns; no type section designated (Herrick, 1900a); (2) Lucero uplift, Sandia, Manzanita, Manzano, & S Nacimiento Mtns; (3) Gray, green-gray, & brown ss, local cgl, & minor siltst, gray calcarenites, and coal; (4) Herrick (1900a) used as "Sandia series"; Keyes (1904) & Gordon (1907) established as fm; divided by Read *et al.* (1947) into "lower limestone mbr" & "upper clastic mbr"; "lower limestone mbr" early recognized as possibly Mississippian and detached from Sandia as Arroyo Penasco Fm (Armstrong, 1955); lowest part of remaining Sandia separated as Osha Canyon Fm (DuChene, 1974; DuChene *et al.*, 1977); (5) Thompson (1942), Bates *et al.* (1947), Kelley (1963a), Myers (1969, 1977), Myers & McKay (1970, 1971, 1972), DuChene (1974), Kelley & Northrop (1975), Armstrong *et al.* (1979).

San Jose Formation

(4) Widely exposed in NW N.M., the San Jose was also reported in Rio Puerco fault zone W of San Ysidro by Renick (1931, as Wasatch Fm) & Slack (1975). These exposures are considered by most workers to belong to the Galisteo Fm (Galusha, 1966; Lucas, 1982).

[San Rafael Basalt]

(4) Manton & Leeman (1969) erroneously used this name for the McCarty Basalt; Leeman (1970) corrected the error.

SAN RAFAEL GROUP-Upper Jurassic

(1) San Rafael swell of SE Utah (Gilluly & Reeside, 1928); (2-5) San Rafael Gr in Albuquerque area consists of Entrada, Todilto, Summerville, & Bluff fms; see those citations for detailed information.

SANTA ANA MESA, BASALT OF-Pliocene

(1, 2) Santa Ana Mesa, Sandoval Co. (Bryan, 1938); (5) Bachman & Mehnert (1978), Baldrige *et al.* (1980), Tedford (1981).

SANTA FE GROUP (Formation, marls)-Oligocene(?)-Miocene-Pleistocene

(1) Rio Grande Valley in vicinity of Santa Fe (Hayden, 1869); (2) Valley of the Rio Grande; (3) Tan to red ss, cgl, siltst, mudst, & marly beds; (4) The definition and use of the term Santa Fe Gr has not been agreed upon by all workers; the nomenclature history of the unit and its subdivisions is lengthy and complex (see Tedford, this guidebook). Briefly, Darton (1922) replaced "Santa Fe marls" (Hayden, 1869) with term Santa Fe Formation; Bryan & McCann (1937) divided into "lower gray" (subsequently removed from Santa Fe as Zia Sand by Galusha, 1966), "middle red," & "upper buff" mbrs in Ceja del Rio Puerco area N & NW of Albuquerque; Bryan (1938) extended definition to include any slightly or unconsolidated Neogene Rio Grande depression deposits; Spiegel & Baldwin (1963) formally raised to group status, but Galusha & Blick (1971) confined Santa Fe Gr to type area around Santa Fe & Espanola and recommended that new formation names be defined for rocks previously assigned to Santa Fe Gr in Albuquerque area and elsewhere; most workers in Albuquerque area have chosen to use Santa Fe Formation (e.g., Kelley & Northrop, 1975); Kelley (1977) divided into Zia (= "lower gray"), "middle red" (or "main body"), & Ceja (= "upper buff") mbrs in Albuquerque basin; (5) Hawley (1978), Riecker (1979), Tedford (1981).

SANTA ROSA FORMATION (in Dockum Group)-Upper Triassic

(1) Santa Rosa, Guadalupe Co. (Rich, 1921; Darton, 1922); (2) E side of Sandia Mtns, Placitas, and Hagan basin; (3) White, gray, tan, & red-brown locally crossbedded ss, with basal cgl; (5) Kelley (1963a), Kelley & Northrop (1975).

SAN YSIDRO MEMBER (of Yeso Formation)-Lower Permian

(1) Near Cation, sec. 3, T16N, R2E, Sandoval Co. (Wood & Northrop, 1946); (2) Jemez Pueblo area, E side of Sandia Mtns; (3) Orange-red to red ss & siltst with thin ls & gypsiferous ss; (4) Interfingers with Joyita Mbr to S of Abo Pass (Hunter & Ingersoll, 1981); (5) Kelley (1963a), Kelley & Northrop (1975).

SATAN TONGUE (of Mancos Shale)-Upper Cretaceous

(1) Satan Pass, 19 km (12 mi) W of Mt. Taylor coal field, Cibola Co. (Sears, 1934); (2) Seboyeta, Mt. Taylor, and Ambrosia Lake areas; (3) Black to light-gray & brown-gray sh & siltst; (4) Tongue of Mancos between Hosta tongue and Point Lookout Ss; called Satan Sh by Sabins (1964); (5) Hunt (1936), Sears *et al.* (1941), Santos (1966a), Santos & Thaden (1966), Moench & Schlee (1967), Molenaar (1977).

SEMILLA SANDSTONE MEMBER (of Mancos Shale)-Upper Cretaceous

(1) Arroyo Semilla; type section-about 650 m (2,130 ft) N of Holy Ghost Springs & about 1.5 km (0.9 mi) E of N.M. 44, Sandoval Co. (Dane *et al.*, 1968); (2) Holy Ghost Springs area and W of San Ysidro; Hagan basin (?); (3) Lower silty yellow-brown ss with several concretion zones & upper darker & coarser-grained massive ss; (5) Black (1979), LaFon (1981).

SHINARUMP MEMBER (of Chinle Formation)-Upper Triassic

(1) Shinarump cliffs, Kane Co., Utah (Gilbert, 1875); (2) Lucero uplift, E of Mt. Taylor; (3) Gray, tan, yellow-white coarse-grained ss, cgl, & sh; (4) "Shinarump Cgl" reported by Darton (1928) in Bluewater & Grants area is actually Sonsela Ss Bed of Chinle (Stewart, 1957); Kelley & Wood's (1946) Shinarump

in Lucero uplift includes Moenkopi? Fm (Stewart *et al.*, 1972b); (5) Stewart *et al.* (1972a), O'Sullivan (1977).

SOL SE METE MEMBER (of Wild Cow Formation)-Upper Pennsylvanian

(1) Sol se Mete Hill, Manzano Mtns; type section-W side of Priest Canyon, sec. 7, T3N, R5E (Myers, 1973); (2) Manzano Mtns; (3) Basal ss or cgl, locally arkosic, overlain by calcareous gray sh, topped by locally cherty gray, massive ls; (4) Basal clastics = "Coyote Ss" of Herrick (1900a); is unit B of upper part of Madera Ls of Myers (1966, 1967, 1969) and Myers & McKay (1970, 1971, 1972); (5) Myers & McKay (1976), Myers (1977).

SONSELA SANDSTONE BED (of Petrified Forest Member of Chinle Formation)-Upper Triassic

(1) 5.6 km (3.5 mi) N of W Sonsela Butte, E flank of Defiance uplift, Arizona (Kiersch, 1955); (2) Bluewater & Grants areas; (3) White, yellow, & brown conglomeratic ss interbedded with white, blue, purple, & brown clayst; (5) Cooley (1959), Thaden & Ostling (1967), Thaden, Santos, & Ostling (1967), Thaden, Santos, & Raup (1967), Stewart *et al.* (1972a), O'Sullivan (1977). ["Stray Sandstone Member"]

(4) See Borrego Pass Lentil.

SUMMERVILLE FORMATION (in San Rafael Group)-Upper Jurassic

(1) Summerville Point, San Rafael Swell, SE Utah (Gilluly & Reeside, 1928); (2) Mesa Gigante, Laguna, Acoma, Grants, Bluewater, and Ambrosia Lake areas; (3) Interbedded variegated or red-brown, gray, & white mudst, siltst, & ss; (4) Rapaport *et al.* (1952) extended E-ward to Laguna area from Ft. Wingate; Harshbarger *et al.* (1957) divided into "lower silty mbr" & "upper sandy mbr"; Hilpert (1963) noted equivalence of Summerville with "buff sh mbr" of Morrison of Kelley & Wood (1946) & Silver (1948); Moench & Schlee (1967) confined Summerville to "lower silty mbr" of Harshbarger *et al.* (1957), assigning "upper sandy mbr" to Bluff Ss; (5) Moench & Puffett (1963b), Moench (1963b, 1964b), Schlee & Moench (1963b), Thaden & Ostling (1967), Thaden, Santos, & Raup (1967), Maxwell (1976, 1979), Green & Pierson (1977).

SUWANEE BASALT FLOW-Pleistocene

(1, 2) San Jose valley, Cibola Co. (Nichols, 1934); (3) Olivine basalt; (5) Nichols (1936, 1939, 1946).

[Tellera (Tellara) Limestone]

(4) Name used by Keyes (1915a, b) for uppermost gray ls mbr of "Maderan series" in Sandia Mtns; Jicha & Lochman-Balk (1958) recommended suppression of this name.

TERERRO FORMATION (in Arroyo Pefiasco Group)-Upper Mississippian

(1) W of Pecos River at Tererro, San Miguel Co. (Baltz & Read, 1960); (2) S Nacimiento Mtns; (3) Lower thick-bedded oolitic-bothrolitic grainstone & upper silty pelletoidal fine-grained grainstone-packstone; (4) Extended into Nacimiento Mtns from Sangre de Cristo Mtns and assigned as upper fm of Arroyo Pefiasco Gr by Armstrong & Mamet (1974); (5) Armstrong & Mamet (1979), Armstrong *et al.* (1979).

TOWA GROUP-Pleistocene

(1, 2) Jemez Mtns (Griggs, 1964); (3) Rhyolite tuffs and lavas; (4) Includes Bandelier Tuff, Cerro Toledo Rhyolite, Cerro Rubio Quartz Latite, & Valles Rhyolite; only the Bandelier Tuff is cited separately in this lexicon; (5) Bailey *et al.* (1969), Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

TODILTO FORMATION (Limestone) (in San Rafael Group)-Upper Jurassic

(1) Todilto Park, McKinley Co. (Gregory, 1916, 1917); (2) N Lucero uplift, Mesa Gigante, E side of Sandia Mtns, Placitas, Hagan basin, San Ysidro-White Mesa area, W side of Nacimiento Mtns, Laguna, Grants, Acoma, & Bluewater areas; (3) Brown to black & fetid, or gray, olive or yellow laminated to massive ls, overlain in Laguna area and eastward by massive gray to white gypsum with local clay laminations & interbedded ls; (4) Considered mbr of Morrison Fm (Baker *et al.*, 1936; Wood & Northrop, 1946; Kelley & Wood, 1946); assigned by Baker *et al.* (1947) as mbr of Wanakah Fm; considered a fm (as originally defined) by Northrop (1950), Harshbarger *et al.* (1951), and subsequent workers; divided into lower ls & upper gypsum units or informal mbrs in Laguna area and eastward (Hilpert, 1963; Schlee & Moench, 1963b; Moench & Puffett, 1963b; Moench, 1964a, b; Moench & Schlee, 1967; Kelley & Northrop, 1975); (5) Darton (1928), Renick (1931), Silver (1948), Harshbarger *et al.* (1957), Smith (1961), Thaden & Ostling (1967), Thaden, Santos, & Raup (1967), Maxwell (1976, 1979), Green & Pierson (1977).

[Torrance Shale]

(4) Name used by Keyes (1915a, b) for upper part of "Bernalillian series" redbeds in Manzano Mtns; Jicha & Lochman-Balk (1958) recommended suppression of this name.

TORRES MEMBER (of Yeso Formation)-Lower Permian

(1) Tributaries of Aqua Torres Canyon, 11 km (7 mi) S of Black Butte, Socorro Co. (Wilpolt *et al.*, 1946); (2) Abo Pass area, S Manzano Mtns; (3) Alternating beds of orange-red and tan ss & siltst, gray ls, & gypsum; (4) Apparently

equivalent to Los Vallos Mbr of Yeso (Hunter & Ingersoll, 1981); (5) Bates *et al.* (1947), Myers (1977).

TRES HERMANOS SANDSTONE MEMBER (of Mancos Shale)-Upper Cretaceous

(1) 1.6 km (1 mi) E of Tres Hermanos Buttes, sec. 26, T3N, R7W, Socorro Co. (Herrick, 1900b; Pike, 1947); (2) Cebolleta Mesa area; (3) Massive yellow ss with large concretions; (4) Early attempts to recognize the Tres Hermanos of type area led to one or more different ss units in the lower Mancos (or tongue[s] of upper Dakota) being identified as Tres Hermanos (Lee, 1912, 1917; Hunt, 1936; Pike, 1947; Dane, 1959), including the Twowells Ss Tongue (Dane, 1960; Owen, 1966; Marvin, 1967); Dane *et al.* (1971) established that Tres Hermanos of Herrick (1900b) is a ss unit above the Twowells; it is now recognized as a mbr of Mancos below D-Cross tongue (Hook & Cobban, 1979; Cobban & Hook, 1979).

TSHIREGE MEMBER (of Bandelier Tuff)-Pleistocene

(1) Vicinity of Tshirege ruins, NWT/, sec. 5, T18N, R7E, Los Alamos Co. (Griggs, 1964); (2) Along Callon de San Diego N of Jemez Pueblo, and Pajarito Plateau; (3) Welded rhyolitic tuff composed of small fragments of crystallized pumice and crystals, & crystal fragments of sanidine & quartz in a welded-tuff matrix; (4) Includes Tsankawi Pumice Bed; (5) Bailey *et al.* (1969), Smith *et al.* (1970), Kudo (1974), Bailey & Smith (1978).

TUERTO GRAVEL-Pleistocene

(1) Arroyo del Tuerto, Hagan basin (Steams, 1953a); (2) Arroyo del Tuerto, Ceja del Rio Puerco, Sandoval Co.; (3) Gravel interbedded with basalt flows; (4) Ortiz Gravel is a synonym; (5) Baldwin (1956), Disbrow & Stoll (1957), Sun & Baldwin (1958), Galusha (1966), Kelley (1977).

TWOWELLS SANDSTONE TONGUE (Member, Lentil) (of Dakota Sandstone)-Upper Cretaceous

(1) Near Two Wells, NE/, sec. 17, T12N, R19W, McKinley Co. (Pike, 1947); (2) Laguna, Acoma, and Grants areas; (3) Gray to orange, silty ss; (4) Originally defined as a "ss lentil of Mancos"; equivalent to upper ss of "lower part of Mancos" of Hunt (1936), Moench & Schlee (1967), and others; has been confused with Tres Hermanos Ss of Herrick (1900b) (see Dane *et al.*, 1971, for discussion); (5) Owen (1966), Marvin (1967), Landis *et al.* (1973), Maxwell (1976, 1979), Cobban (1977).

[University beds]

(4) Term used by Bryan (1909) to refer to "side-wash deposits" of reddish sandy clay in side canyons of the Rio Grande around Albuquerque.

[Veredas Group]

(4) Term used by Thompson (1942) for an Upper Pennsylvanian sequence of ls & ss in Manzano Mtns and elsewhere; part of Madera Gr of modern usage.

Wanakah Formation

(4) Baker *et al.* (1947) assigned Todilto as mbr of Wanakah, a fm beneath Morrison in SW Colorado; assignment rejected by Northrop (1950) & later workers.

[Wasatch Formation]

(4) Reported by Renick (1931) in area W of San Ysidro; these exposures called San Jose Fm by Slack (1975); considered to be Galisteo by most workers (e.g., Galusha, 1966; Lucas, 1982).

WESTWATER CANYON MEMBER (of Morrison Formation)-Upper Jurassic

(1) Canyon of Westwater Creek, 24 km (15 mi) SW of Blanding, Utah (Gregory, 1938); (2) W side of Nacimiento Mtns, San Ysidro area, E of Cabezon, Laguna, San Mateo, Grants, Bluewater, and Ambrosia Lake areas; (3) Gray, yellow, & red-gray ss with green-gray lenticular mudst; (4) Locally includes Poison Canyon Ss of economic usage; (5) Craig *et al.* (1955), Freeman & Hilpert (1956), Harshbarger *et al.* (1957), Hilpert (1963, 1969), Santos (1963), Hazlett & Krech (1963), Moench (1963b), Moench Puffett (1963a, b), Santos (1966b), Thaden *et al.* (1966), Thaden & Ostling (1967), Thaden, Santos, & Raup (1967), Moench & Schlee (1967), Woodward & Martinez (1974), Flesch (1974), Woodward & Ruetschilling (1976), papers in Rautman (1980).

[Whiskey Canyon Limestone]

(4) Term used by Thompson (1942) for Middle Pennsylvanian ls sequence in Nacimiento Mtns and elsewhere; part of Madera Gr of modern usage.

WHITWATER ARROYO SHALE TONGUE (of Mancos Shale)-Upper Cretaceous

(1) Near Two Wells, NE/4, sec. 17, T12N, R19W, McKinley Co. (Owen, 1966); (2) Grants, Laguna, & Acoma areas; (3) Soft gray to tan sh & siltst with bentonite layers & is concretions; (4) Originally defined as Whitewater Shale Mbr of Dakota Ss (Owen, 1966); equivalent to uppermost sh of "lower part of Mancos" of Hunt (1936) & Moench & Schlee (1967); assigned as a tongue of Mancos by Dane *et al.* (1971); (5) Marvin (1969), Landis *et al.* (1973), Maxwell (1976, 1979), Cobban (1977).

WILD COW FORMATION (in Madera Group)-Upper Pennsylvanian-Lower Permian?

(1) Wild Cow Spring, Manzano Mtns; type section on W side of Priest Canyon, sec. 7, T3N, R5E, Valencia Co. (Myers, 1973); (2) Manzano Mtns; (3) Rhythmic sequences of arkosic ss & cgl, gray to yellow siltst & sh, & thin to thick bedded gray ls; (4) Equivalent to "arkosic ls mbr" of Read *et al.* (1944); probably equivalent to Atrasado Mbr of Kelley & Wood (1946); is units B, C, & D in upper part of Madera of Myers (1966, 1967, 1969) and Myers & McKay (1970, 1971, 1972); includes Sol se Mete, Pine Shadow, and La Casa Mbrs (Myers, 1973).

WINGATE SANDSTONE (in Glen Canyon Group)-Upper Triassic

(4) Wingate Ss of Dutton (1885), originally defined at type section along cliffs N of Ft. Wingate, has been completely transferred to Entrada Ss by Baker *et al.* (1947) and later workers (see Entrada Ss for summary); however, Maxwell (1979) reported Rock Point Mbr of Wingate present in area S of Acoma, apparently the only occurrence of redefined Triassic Wingate Ss in Albuquerque area.

YESO FORMATION-Lower Permian

(1) Mesa del Yeso; type section-3.6 km (2.2 mi) SE of Mesa del Yeso, secs. 4, 5, T2S, R2E & sec. 33, T1S, R2E, Socorro Co. (Lee, 1909; Needham & Bates, 1943); (2) Lucero uplift, Manzano Mtns, E side of Sandia Mtns, Placitas, S Nacimiento Mtns-San Ysidro area; (3) Brown, tan, orange, & red ss & sh, interbedded with gray ls & dolomitic ls with local thick gypsum beds; (4) Divided into "general zone of clastic material," "middle evaporites," Callas Gypsum Mbr, & Joyita Ss Mbr in Abo Pass area by Needham & Bates (1943), who also detached upper ls and underlying ss from Lee's (1909) Yeso and assigned to basal San Andres and Glorieta Ss, respectively; divided into Meseta Blanca & San Ysidro mbrs in Nacimiento Mtns by Wood & Northrop (1946), a practice also followed in the Sandia Mtns (Kelley, 1963a; Kelley & Northrop, 1975); divided into Meseta Blanca & Los Vallos mbrs in Lucero uplift by Kelley & Wood (1946); divided into Meseta Blanca & Torres mbrs in Abo Pass area by Bates *et al.* (1947), who also assigned upper part of Needham & Bates' (1943) Abo to Meseta Blanca Mbr; Baars (1961b, 1962) recommended replacing term Meseta Blanca Mbr with DeChelly Ss; Hunter & Ingersoll (1981) noted equivalence of Los Vallos & Torres mbrs and interfingering of Joyita with San Ysidro mbrs.

[Zandia clay]

(4) See Sandia clay.

[Zia marl(s)]

(4) Term used by Reagan (1903) to refer to 12 m (40 ft) of bluish-yellow "marls" of "Eocene" age that form the cap rock on the W side of the Rio Grande near Zia Pueblo.

ZIA SAND FORMATION (Member of Santa Fe Formation)-Miocene

(1) Zia Pueblo; type section-NWT/4, sec. 11 & secs. 14, 23, T14N, R1E, Sandoval Co. (Galusha, 1966); (2) Zia Pueblo and to N, W, & SW; (3) Friable, primarily quartzose & volcanoclastic ss, with a few beds of siltst & a few calcareous ledges; (4) Essentially equivalent to "lower gray" and part of "middle red" mbrs of Santa Fe Fm of Bryan & McCann (1937); considered a mbr of Santa Fe Fm by Kelley (1977); includes Piedra Parada, Chamisa Mesa, & Canada Pilares mbrs; (5) Galusha & Blick (1971), Gawne (1975, 1976, 1981), Manley (1978), Tedford (1981), DuChene *et al.* (1981).

ZUNI CANYON BASALT FLOW-Holocene

(1, 2) Zuni Canyon and Rio San Jose valley near Grants, Cibola Co. (Gordon, 1961); (3) Black basalt.

ZUNI SANDSTONE (in San Rafael Group)-Upper Jurassic

(1) Zuni Mtns to Mt. Taylor area (Dutton, 1885); (2) Acoma, Grants areas; (3) White, yellowish, or gray-green quartzose crossbedded eolian ss; (4) Established by Dutton (1885), but parts later assigned into various units of San Rafael Gr (from Todilto to Bluff) & Morrison Fm and name was abandoned; reinstated by USGS for use in Gallup-Zuni & Acoma basins (Keroher *et al.*, 1966); interfingers with and is partially equivalent to Bluff Ss of some earlier workers; mapped as "Yellow Ss" in Grants area by Thaden, Santos, & Ostling (1967), Thaden, Santos & Raup (1967), & Thaden, Merrin, & Raup (1967); (5) Maxwell (1976, 1979).

REFERENCES

- Allen, J. E. and Balk, R., 1954, Mineral resources of Fort Defiance and Tohatchi quadrangles, Arizona and New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 36, 192 p.
- Armstrong, A. K., 1955, Preliminary observations on the Mississippian System of northern New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 39, 42 p.
- _____, 1958a, Meramecian (Mississippian) endothyrid fauna from the Arroyo Penasco Formation, northern and central New Mexico: Journal of Paleontology, v. 32, p. 970-976.
- _____, 1958b, The Mississippian of west-central New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 5, 32 p.
- _____, 1963, Biostratigraphy and paleoecology of the Mississippian System, west-central New Mexico: New Mexico Geological Society Guidebook 14, p. 112-122.
- _____, 1967, Biostratigraphy and carbonate facies of the Mississippian Arroyo Penasco Formation, north-central New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 20, 79 p.
- Armstrong, A. K. and Holcomb, L. D., 1967, Interim report on Mississippian Arroyo Penasco Formation of north-central New Mexico: American Association of Petroleum Geologists Bulletin, v. 51, p. 417-433.
- Armstrong, A. K. and Mamet, B. L., 1974, Biostratigraphy of the Arroyo Penasco Group, Lower Carboniferous (Mississippian), north-central New Mexico: New Mexico Geological Society Guidebook 25, p. 145-158.
- _____, 1977, Biostratigraphy and paleogeography of the Mississippian System in northern New Mexico and adjacent San Juan Mountains of southwestern Colorado: New Mexico Geological Society Guidebook 28, p. 111-127.
- _____, 1979, The Mississippian System of north-central New Mexico: New Mexico Geological Society Guidebook 30, p. 201-210.
- Armstrong, A. K. and others, 1979, The Mississippian and Pennsylvanian (Carboniferous) systems in the United States-New Mexico: U.S. Geological Survey Professional Paper 1110-W, 27 p.
- Baars, D. L., 1961a, Permian blanket sandstones of Colorado Plateau, in Geometry of sandstone bodies: American Association of Petroleum Geologists, p. 179-207.
- _____, 1961b, Permian strata of central New Mexico: New Mexico Geological Society Guidebook 12, p. 113-120.
- _____, 1962, Permian System of Colorado Plateau: American Association of Petroleum Geologists Bulletin, v. 46, p. 149-218.
- Bachman, G. O., 1953, Geology of a part of northwestern Mora County, New Mexico: U.S. Geological Survey Oil and Gas Investigations Map OM-137.
- Bachman, G. O. and Mehnert, H. H., 1978, New K-Ar dates and the late Pliocene to Holocene geomorphic history of the central Rio Grande region, New Mexico: Geological Society of America Bulletin, v. 89, p. 283-292.
- Bailey, R. A. and Smith, R. L., 1978, Volcanic geology of the Jemez Mountains, New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 163, p. 184-196.
- Bailey, R. A., Smith, R. L., and Ross, C. S., 1969, Stratigraphic nomenclature of volcanic rocks in the Jemez Mountains, New Mexico: U.S. Geological Survey Bulletin 1274-P, 19 p.
- Baker, A. A., Dane, C. H., and Reeside, J. B., Jr., 1936, Correlation of the Jurassic formations of parts of Utah, Arizona, New Mexico and Colorado: U.S. Geological Survey Professional Paper 183, 66 p.
- _____, 1947, Revised correlation of Jurassic formations of parts of Utah, Arizona, New Mexico, and Colorado: American Association of Petroleum Geologists Bulletin, v. 31, p. 1664-1668.
- Baker, A. A., Dobbin, C. E., McKnight, E. T., and Reeside, J. B., Jr., 1927, Notes on the stratigraphy of the Moab region, Utah: American Association of Petroleum Geologists Bulletin, v. 11, p. 785-808.
- Baldrige, W. S., Damon, P. E., Shafiqullah, M., and Bridwell, R. J., 1980, Evolution of the central Rio Grande rift, New Mexico: new potassium-argon ages: Earth and Planetary Science Letters, v. 51, p. 309-321.
- Baldwin, B., 1956, The Santa Fe Group of north-central New Mexico: New Mexico Geological Society Guidebook 7, p. 115-121.
- Baltz, E. H., Jr., Dixon, G. H., Griggs, R. L., Johnson, R. B., Spiegel, Z., and Wood, G. H., 1952, First day's road log: New Mexico Geological Society Guidebook 3, p. 12-33.
- Baltz, E. H., Jr. and Read, C. B., 1960, Rocks of Mississippian and probable Devonian age in Sangre de Cristo Mountains, New Mexico: American Association of Petroleum Geologists Bulletin, v. 44, p. 1749-1774.
- Bates, R. L., Wilpolt, R. H., MacAlpin, A. J., and Vorbe, G., 1947, Geology of the Gran Quivira quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 26, 57 p.
- Beaumont, E. C., 1971, Stratigraphic distribution of coal in San Juan Basin: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 15-30.
- Beaumont, E. C., Dane, C. H., and Sears, J. D., 1956, Revised nomenclature of Mesaverde Group in San Juan Basin, New Mexico: American Association of Petroleum Geologists Bulletin, v. 40, p. 2149-2162.
- Black, B. A., 1979, Structure and stratigraphy of the Hagan embayment: a new look: New Mexico Geological Society Guidebook 30, p. 101-105.
- Brookins, D. G., Carden, J. R., and Laughlin, A. W., 1975, Additional note on the isotopic composition of strontium in McCarty flow, Valencia County, New Mexico: Earth and Planetary Science Letters, v. 25, p. 327-330.
- Bryan, K., 1909, Geology of the vicinity of Albuquerque, New Mexico: Bulletin of the University of New Mexico, Geological Series, v. 3, p. 1-24.

- , 1938, Geology and ground-water conditions of the Rio Grande depression in Colorado and New Mexico, in U.S. Natural Resources Planning Board, the Rio Grande Joint Investigations in the upper Rio Grande basin: Washington, U.S. Government Printing Office, v. 1, pt. 2, p. 197-225.
- Bryan, K. and McCann, F. T., 1937, The Ceja del Rio Puerco: a border feature of the Basin and Range Province in New Mexico, part I, stratigraphy and structure: *Journal of Geology*, v. 45, p. 801-828.
- , 1938, The Ceja del Rio Puerco: a border feature of the Basin and Range Province in New Mexico, part II, geomorphology: *Journal of Geology*, v. 46, p. 1-16.
- Carden, J. R. and Laughlin, A. W., 1974, Petrochemical variations within the McCarty's basalt flow, New Mexico: *Geological Society of America Bulletin*, v. 85, p. 1479-1484.
- Cobban, W. A., 1977, Characteristic marine molluscan fossils from the Dakota Sandstone and intertongued Mancos Shale, west-central New Mexico: U.S. Geological Survey Professional Paper 1009, 30 p.
- Cobban, W. A. and Hook, S. C., 1979, *Collignoniceras woollgari woollgari* (Mantell) ammonite fauna from Upper Cretaceous of Western Interior: New Mexico Bureau of Mines and Mineral Resources Memoir 37, 51 p.
- Collier, A. J., 1919, Coal south of Mancos, Montezuma County, Colorado: U.S. Geological Survey Bulletin 691, p. 293-310.
- Cooley, M. E., 1959, Triassic stratigraphy in the state line region of west-central New Mexico and east-central Arizona: *New Mexico Geological Society Guidebook 10*, p. 66-73.
- Cope, E. D., 1875, Report upon the geology of that part of northwestern New Mexico examined during the field season of 1874: Annual Report upon the Geographical Explorations West of the One Hundredth Meridian [Wheeler Survey], Appendix LL, Annual Report of the Chief of Engineers for 1875, p. 981-1017.
- , 1877, Report upon the extinct Vertebrata obtained in New Mexico by parties of the expedition of 1874: Geographical Surveys West of the One Hundredth Meridian [Wheeler Survey], v. 4, Paleontology, part 2, p. 1-370.
- , 1884, On the distribution of the Loup Fork formation in New Mexico: *Proceedings of the American Philosophical Society*, v. 21, p. 308-309.
- Correa, A. C., 1970, Borrego Pass Lentil, a new member of the Crevasse Canyon Formation, southern San Juan Basin, New Mexico: *The Mountain Geologist*, v. 7, p. 99-102.
- Craig, L. C. and others, 1955, Stratigraphy of the Morrison and related formations, Colorado Plateau region. A preliminary report: U.S. Geological Survey Bulletin 1009-E, p. 125-168.
- Cross, W., 1899, Description of the Telluride quadrangle (Colorado): U.S. Geological Survey Atlas, Telluride Folio (No. 57).
- Cummins, W. F., 1890, The Permian of Texas and its overlying beds: *Texas Geological Survey Annual Report 1*, p. 183-197.
- Dane, C. H., 1959, Historical background of the type locality of the Tres Hermanos Sandstone Member of the Mancos Shale: *New Mexico Geological Society Guidebook 10*, p. 85-91.
- , 1960, The boundary between rocks of Carlile and Niobrara age in San Juan Basin, New Mexico and Colorado: *American Journal of Science*, v. 258-A, p. 46-56.
- Dane, C. H. and Bachman, G. O., 1965, Geologic map of New Mexico: U.S. Geological Survey, 1:500,000.
- Dane, C. H., Bachman, G. O., and Reeside, J. B., Jr., 1957, The Gallup Sandstone, its age and stratigraphic relationships south and east of the type locality: *Four Corners Geological Society Guidebook*, 2nd Field Conference, p. 99-113.
- Dane, C. H., Cobban, W. A., and Kauffman, E. G., 1966, Stratigraphy and regional relationships of a reference section for the Juana Lopez Member, Mancos Shale, in the San Juan Basin, New Mexico: U.S. Geological Survey Bulletin 1224-H, 15 p.
- Dane, C. H., Kauffman, E. G., and Cobban, W. A., 1968, Semilla Sandstone, a new member of the Mancos Shale in the southeastern part of the San Juan Basin, New Mexico: U.S. Geological Survey 1254-F, 21 p.
- Dane, C. H., Landis, E. R., and Cobban, W. A., 1971, The Twowells Sandstone tongue of the Dakota Sandstone and the Tres Hermanos Sandstone as used by Herrick (1900), western New Mexico: U.S. Geological Survey Professional Paper 750-B, p. B17-B22.
- Dane, C. H., Wanek, A. A., and Reeside, J. B., Jr., 1957, Reinterpretation of Cretaceous rocks in Alamosa Creek Valley area, Catron and Socorro counties, New Mexico: *American Association of Petroleum Geologists Bulletin*, v. 41, p. 181-196.
- Darton, N. H., 1910, A reconnaissance of parts of northern New Mexico and northern Arizona: U.S. Geological Survey Bulletin 435, 88 p.
- , 1922, Geologic structure of parts of New Mexico: U.S. Geological Survey Bulletin 726, p. 173-275.
- , 1928, "Red beds" and associated formations in New Mexico: U.S. Geological Survey Bulletin 794, 356 p.
- Disbrow, A. E. and Stoll, W. C., 1957, Geology of the Cerrillos area, Santa Fe County, New Mexico: *New Mexico Bureau of Mines and Mineral Resources Bulletin 48*, 73 p.
- DuChene, H. R., 1974, Pennsylvanian rocks of north-central New Mexico: *New Mexico Geological Society Guidebook 25*, p. 159-162.
- DuChene, H. R., Engelhardt, D. W., and Woodward, L. A., 1981, Palynologic evidence for the age of the Abiquiu Formation, north-central New Mexico: *Geological Society of America Bulletin*, v. 92, pt. I, p. 993-998.
- DuChene, H. R., Kues, B. S., and Woodward, L. A., 1977, Osha Canyon Formation (Pennsylvanian), new Morrowan unit in north-central New Mexico: *American Association of Petroleum Geologists Bulletin*, v. 61, p. 1513-1522.
- Dutton, C. E., 1885, Mount Taylor and the Zuni Plateau: U.S. Geological Survey 6th Annual Report, p. 113-202.
- Emmons, S. F., Cross, W., and Eldridge, G. H., 1896, Geology of the Denver basin in Colorado: U.S. Geological Survey Monograph 27.
- Fitzsimmons, J. P., Armstrong, A. K., and Gordon, M., Jr., 1956, Arroyo Pefiasco Formation, Mississippian, north-central New Mexico: *American Association of Petroleum Geologists Bulletin*, v. 40, p. 1935-1944.
- Flesch, G. A., 1974, Stratigraphy and sedimentology of the Morrison Formation (Jurassic), Ojito Spring quadrangle, Sandoval County, New Mexico: a preliminary discussion: *New Mexico Geological Society Guidebook 25*, p. 185-195.
- Freeman, V. L. and Hilpert, L. S., 1956, Stratigraphy of the Morrison Formation in part of northwestern New Mexico: U.S. Geological Survey Bulletin 1030J, p. 309-334.
- Gateway, K. L., 1959, Cretaceous sediments of the North Plains and adjacent areas, McKinley, Valencia, and Catron counties, New Mexico: *New Mexico Geological Society Guidebook 10*, p. 81-84.
- Galusha, T., 1966, The Zia Sand Formation, new early to medial Miocene beds in New Mexico: *American Museum Novitates 2271*, 12 p.
- Galusha, T. and Blick, J. C., 1971, Stratigraphy of the Santa Fe Group, New Mexico: *Bulletin of the American Museum of Natural History*, v. 144, art. 1, p. 1-127.
- Gardner, J. H., 1909, The coal field between Gallup and San Mateo, New Mexico: U.S. Geological Survey Bulletin 341, p. 364-378.
- , 1910, The coal field between San Mateo and Cuba, New Mexico: U.S. Geological Survey Bulletin 381, p. 461-473.
- Gawne, C. E., 1975, Rodents from the Zia Sand Miocene of New Mexico: *American Museum Novitates 2586*, 25 p.
- , 1976, Lagomorphs from the Zia Sand Miocene of New Mexico: *American Museum Novitates 2608*, 15 p.
- , 1981, Sedimentology and stratigraphy of the Miocene Zia Sand Formation of New Mexico: *Geological Society of America Bulletin*, v. 92, pt. I, p. 999-1007; pt. II, p. 2484-2552.
- Gilbert, G. K., 1875, Report on the geology of portions of Nevada, Utah, California and Arizona: U.S. Geographical and Geological Surveys West of the 100th Meridian [Wheeler Survey], v. 3, p. 1-187.
- Gilluly, J. and Reeside, J. B., Jr., 1928, Sedimentary rocks of the San Rafael Swell and some adjacent areas in southeastern Utah: U.S. Geological Survey Professional Paper 150-D, p. 61-110.
- Gordon, C. H., 1907, Notes on the Pennsylvanian formations in the Rio Grande Valley, New Mexico: *Journal of Geology*, v. 15, p. 805-816.
- Gorham, T. W. and Ingersoll, R. V., 1979, Evolution of the Eocene Galisteo basin, north-central New Mexico: *New Mexico Geological Society Guidebook 30*, p. 219-224.
- Green, M. W., 1974, The Iyanbito Member (a new stratigraphic unit) of the Jurassic Entrada Sandstone, Gallup-Grants area: U.S. Geological Survey Bulletin 1395-D, 12 p.
- Green, M. W. and Pierson, C. T., 1977, A summary of the stratigraphy and depositional environments of Jurassic and related rocks in the San Juan Basin, Arizona, Colorado, and New Mexico: *New Mexico Geological Society Guidebook 28*, p. 147-152.
- Gregory, H. E., 1915, The igneous origin of the "glacial" deposits on the Navajo reservation, Arizona and Utah: *American Journal of Science*, v. 4, p. 97-115.
- , 1916, The Navajo Country—a geographic and hydrographic reconnaissance of parts of Arizona, New Mexico, and Utah: U.S. Geological Survey Water-Supply Paper 380, 219 p.
- , 1917, Geology of the Navajo country: U.S. Geological Survey Professional Paper 93, 161 p.
- , 1938, The San Juan country: a geographic and geologic reconnaissance of southeastern Utah: U.S. Geological Survey Professional Paper 188, 123 p.
- , 1950, Geology and geography of the Zion Park region, Utah and Arizona: U.S. Geological Survey Professional Paper 220, 200 p.
- Gregory, H. E. and Williams, N. C., 1947, Zion National Monument, Utah: *Geological Society of America Bulletin*, v. 58, p. 211-244.

- Griggs, R. L., 1964, Geology and ground-water resources of the Los Alamos area, New Mexico: U.S. Geological Survey Water-Supply Paper 1753, 107 p.
- Harshbarger, J. W., Repenning, C. A., and Irwin, J. H., 1957, Stratigraphy of the uppermost Triassic and the Jurassic rocks of the Navajo country: U.S. Geological Survey Professional Paper 291, 74 p.
- Harshbarger, J. W., Repenning, C. A., and Jackson, R. L., 1951, Jurassic stratigraphy of the Navajo country: New Mexico Geological Society Guidebook 2, p. 95-99.
- Hawley, J. W. (compiler), 1978, Guidebook to Rio Grande rift in New Mexico and Colorado: New Mexico Bureau of Mines and Mineral Resources Circular 163, 241 p.
- Hayden, F. V., 1869, Preliminary field report of the U.S. Geological Survey of Colorado and New Mexico: U.S. Geological Survey Third Annual Report, 155 p.
- Hazlett, G. W. and Kreck, J., 1963, Geology and ore deposits of the southeastern part of the Ambrosia Lake area: New Mexico Bureau of Mines and Mineral Resources Memoir 15, p. 82-89.
- Henbest, L. G., 1946, Stratigraphy of the Pennsylvanian in the west half of Colorado and in adjacent parts of New Mexico and Utah: American Association of Petroleum Geologists Bulletin, v. 30, p. 750-751.
- Henbest, L. G. and Read, C. B., 1944, Stratigraphic distribution of the Pennsylvanian Fusulinidae in a part of the Sierra Nacimiento of Sandoval and Rio Arriba counties, New Mexico: U.S. Geological Survey Oil and Gas Investigations Preliminary Chart 2.
- Herrick, C. L., 1898, The geology of the environs of Albuquerque, New Mexico: The American Geologist, v. 22, p. 26-43.
- _____, 1900a, The geology of the White Sands, New Mexico: Journal of Geology, v. 8, p. 112-125.
- _____, 1900b, Report of a geological reconnaissance [sic] in western Socorro and Valencia counties, New Mexico: American Geologist, v. 25, p. 331-346.
- Herrick, C. L. and Johnson, D. W., 1900, The geology of the Albuquerque sheet: Bulletin of the Scientific Laboratories of Denison University, v. 11, p. 175-239.
- Hilpert, L. S., 1963, Regional and local stratigraphy of uranium-bearing rocks: New Mexico Bureau of Mines and Mineral Resources Memoir 15, p. 6-18.
- _____, 1969, Uranium resources of northwestern New Mexico: U.S. Geological Survey Professional Paper 603, 166 p.
- Holmes, W. H., 1877, Geological report on the San Juan district: U.S. Geological and Geographical Survey of the Territories, Ninth Annual Report, for 1875, p. 237-276.
- Hook, S. C. and Cobban, W. A., 1979, *Prionocyclus novimexicanus* (Marcou)--common Upper Cretaceous guide fossil in New Mexico: New Mexico Bureau of Mines and Mineral Resources Annual Report, July 1, 1977 to June 30, 1978, p. 34-42.
- Hunt, C. B., 1936, Geology and fuel resources of the southern part of the San Juan Basin, New Mexico. Part 2. The Mount Taylor coal field: U.S. Geological Survey Bulletin 860-B, p. 31-80.
- Hunter, J. C. and Ingersoll, R. V., 1981, Callas Gypsum Member of Yeso Formation (Permian) in New Mexico: New Mexico Geology, v. 3, p. 49-53.
- Jicha, H. L., Jr. and Lochman-Balk, C., 1958, Lexicon of New Mexico geologic names: Precambrian through Paleozoic: New Mexico Bureau of Mines and Mineral Resources Bulletin 61, 137 p.
- Johnson, D. W., 1902-03, The geology of the Cerrillos Hills, New Mexico: Columbia University School of Mines Quarterly, v. 24, p. 173-246 (1902); p. 303-350, 456-500 (1903); v. 25, p. 69-98 (1903).
- Kautz, P. F., Ingersoll, R. V., Baldrige, W. S., Damon, P. E., and Shafiqullah, M., 1981, Geology of the Espinazo Formation (Oligocene), north-central New Mexico: Geological Society of America Bulletin, v. 92, pt. I, p. 980-983; pt. II, p. 2318-2400.
- Kelley, V. C., 1963a, Geologic map of the Sandia Mountains and vicinity, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map 18.
- _____, (compiler), 1963b, Geology and technology of the Grants uranium region: New Mexico Bureau of Mines and Mineral Resources Memoir 15, 277 p.
- _____, 1971, Geology of the Pecos country, southeastern New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 24, 75 p.
- _____, 1972, Outcropping Permian shelf formations of eastern New Mexico: New Mexico Geological Society Guidebook 23, p. 72-78.
- _____, 1977, Geology of Albuquerque basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 33, 60 p.
- Kelley, V. C. and Kudo, A. M., 1978, Volcanoes and related basalts of Albuquerque basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 156, 30 p.
- Kelley, V. C. and Northrop, S. A., 1975, Geology of Sandia Mountains and vicinity, New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 29, 136 p.
- Kelley, V. C. and Wood, G. H., Jr., 1946, Lucero uplift, Valencia, Socorro and Bemalillo counties, New Mexico: U.S. Geological Survey Oil and Gas Investigations Preliminary Map 47.
- Keroher, G. C. and others, 1966, Lexicon of geologic names of the United States for 1936-1960: U.S. Geological Survey Bulletin 1200, 4341 p.
- Keyes, C. R., 1903a, Geological sketch of New Mexico: Ores and Metals, v. 12, p. 48.
- _____, 1903b, Geological formations of New Mexico: Report of the Governor of New Mexico to the Secretary of the Interior, 1903, p. 337-341.
- _____, 1904, Unconformity of the Cretaceous on older rocks in central New Mexico: American Journal of Science, v. 18, p. 360-362.
- _____, 1906, Carboniferous formations of New Mexico: Journal of Geology, v. 14, p. 147-154.
- _____, 1915a, Conspectus of the geologic formations of New Mexico: Des Moines, privately printed, 12 p.
- _____, 1915b, Foundation of exact geologic correlation: Iowa Academy of Science Proceedings, v. 22, p. 249-267.
- Kiersch, G. A., 1955, Mineral resources, Navajo-Hopi reservations, v. 2: Tucson, University of Arizona Press, 105 p.
- Kottlowski, F. E., 1960, Summary of Pennsylvanian sections in southwestern New Mexico and southeastern Arizona: New Mexico Bureau of Mines and Mineral Resources Bulletin 66, 187 p.
- _____, 1961, Pennsylvanian rocks in north-central New Mexico: New Mexico Geological Society Guidebook 12, p. 97-103.
- _____, 1969, San Andres Limestone west of the Sacramentos: New Mexico Geological Society Special Publication 3, p. 5-11.
- Kottlowski, F. E., Beaumont, E. C., and Parkhill, T. A., 1971, East Mount Taylor Crevasse Canyon area: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 89-92.
- Kottlowski, F. E. and Parkhill, T. A., 1971, South Mount Taylor Crevasse Canyon area: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 87-89.
- Kottlowski, F. E. and Stewart, W. J., 1970, The Wolfcampian Joyita uplift in central New Mexico: New Mexico Bureau of Mines and Mineral Resources Memoir 23, p. 1-31.
- Kudo, A. M., 1974, Outline of the igneous geology of the Jemez Mountains volcanic field: New Mexico Geological Society Guidebook 25, p. 109-110.
- Kues, B. S. and Kietzke, K. K., 1976, Paleontology and stratigraphy of the Red Tanks Member, Madera Formation (Pennsylvanian) near Lucero Mesa, New Mexico: New Mexico Geological Society Special Publication 6, p. 102-108.
- _____, 1981, A large assemblage of a new eurypterid from the Red Tanks member, Madera Formation (Late Pennsylvanian-Early Permian) of New Mexico: Journal of Paleontology, v. 55, p. 709-729.
- LaFon, N. A., 1981, Offshore bar deposits of Semilla Sandstone Member of Mancos Shale (Upper Cretaceous), San Juan Basin, New Mexico: American Association of Petroleum Geologists Bulletin, v. 65, p. 706-721.
- Lambert, P. W., 1968, Quaternary stratigraphy of the Albuquerque area, New Mexico (Ph.D. thesis): University of New Mexico, Albuquerque, 329 p.
- Landis, E. R., Dane, C. H., and Cobban, W. A., 1973, Stratigraphic terminology of the Dakota Sandstone and Mancos Shale, west-central New Mexico: U.S. Geological Survey Bulletin 1372-J, 44 p.
- Laughlin, A. W., Brookins, D. G., and Causey, J. D., 1972, Late Cenozoic basalts from the Bandera lava field, Valencia County, New Mexico: Geological Society of America Bulletin, v. 83, p. 1543-1552.
- Lee, W. T., 1909, Stratigraphy of the Manzano Group: U.S. Geological Survey Bulletin 389, p. 5-40.
- _____, 1912, Stratigraphy of the coal fields of northern central New Mexico: Geological Society of America Bulletin, v. 23, p. 571-686.
- _____, 1917, Geology of the Raton Mesa and other regions in Colorado and New Mexico: U.S. Geological Survey Professional Paper 101, p. 9-221.
- Leeman, W. P., 1970, The isotopic composition of strontium in late Cenozoic basalts from the Basin-Range province, western United States: Geochimica et Cosmochimica Acta, v. 34, p. 857-872.
- Lipman, P. W., Pallister, J. S., and Sargent, K. A., 1979, Geologic map of the Mount Taylor quadrangle, Valencia County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-1523.
- Lloyd, E. R., 1949, Pre-San Andres stratigraphy and oil-producing zones in southeastern New Mexico, a progress report: New Mexico Bureau of Mines and Mineral Resources Bulletin 29, 79 p.
- Lochman-Balk, C., 1959, List of stratigraphic names used in northwest and central New Mexico: New Mexico Geological Society Guidebook 10, p. 100-111.
- _____, 1967, Lexicon of stratigraphic names used in northwest New Mexico and adjacent states: New Mexico Geological Society Guidebook 18, p. 15-27.
- Lucas, S. G., 1982, Vertebrate paleontology, stratigraphy, and biostratigraphy

- of the Eocene Galisteo Formation, north-central New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 186 (in press).
- Lucas, S. G. and Ingersoll, R. V., 1981, Cenozoic continental deposits of New Mexico: an overview: Geological Society of America Bulletin, v. 92, pt. 1, p. 917-932, pt. II, p. 1807-1981.
- Lucas, S. G. and Kues, B. S., 1979, Vertebrate biostratigraphy of the Eocene Galisteo Formation, north-central New Mexico: New Mexico Geological Society Guidebook 30, p. 225-229.
- Manley, K., 1978, Geologic map of Bemalillo NW quadrangle, Sandoval County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-1446.
- Manton, W. I. and Leeman, W. P., 1969, Sr⁸⁷/Sr⁸⁶ ratios of late Cenozoic basalts from the western U.S.: American Geophysical Union Transactions, v. 50, p. 331.
- Marvin, R. G., 1967, Dakota Sandstone-Tres Hermanos relationship, southern San Juan Basin area: New Mexico Geological Society Guidebook 18, p. 170-172.
- Maxwell, C. H., 1976, Geologic map of the Acoma Pueblo quadrangle, Valencia County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-1298.
- _____, 1979, Geologic map of the East Mesa quadrangle, Valencia County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-1522.
- Meek, F. B. and Hayden, F. V., 1862, Descriptions of new Silurian (Primordial), Jurassic, Cretaceous, and Tertiary fossils, collected in Nebraska by the exploring expedition under the command of Capt. Wm. F. Reynolds, U.S. Topographical Engineers, with some remarks on the rocks from which they were obtained: Philadelphia Academy of Sciences Proceedings, v. 13, p. 415-447.
- Moench, R. H., 1963a, Geologic map of the Seboyeta quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-207.
- 1963b, Geologic map of the Laguna quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-208.
- _____, 1964a, Geology of the Dough Mountain quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-354.
- _____, 1964b, Geology of the South Butte quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-355.
- Moench, R. H. and Puffett, W. P., 1963a, Geologic map of the Arch Mesa quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-211.
- _____, 1963b, Geologic map of the Mesa Gigante quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-212.
- Moench, R. H. and Schlee, J. S., 1967, Geology and uranium deposits of the Laguna district, New Mexico: U.S. Geological Survey Professional Paper 519, 117 p.
- Moench, R. H., Schlee, J. S., and Bryan, W. B., 1965, Geologic map of the La Gotera quadrangle, Sandoval and Valencia counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-371.
- Molenaar, C. M., 1973, Sedimentary facies and correlation of the Gallup Sandstone and associated formations, northwestern New Mexico: Four Corners Geological Society Memoir, 1973, p. 85-110.
- _____, 1974, Correlation of the Gallup Sandstone and associated formations, Upper Cretaceous, eastern San Juan and Acoma basins, New Mexico: New Mexico Geological Society Guidebook 25, p. 251-258.
- _____, 1977, Stratigraphy and depositional history of Upper Cretaceous rocks of the San Juan Basin area, New Mexico and Colorado, with a note on economic resources: New Mexico Geological Society Guidebook 28, p. 159-166.
- Myers, D. A., 1966, Geologic map of the Tajiue quadrangle, Torrance and Bemalillo counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-551.
- _____, 1967, Geologic map of the Torreon quadrangle, Torrance County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-639.
- _____, 1969, Geologic map of the Escabosa quadrangle, Bemalillo County, New Mexico: U.S. Geological Survey Quadrangle Map GQ-795.
- _____, 1973, The upper Paleozoic Madera Group in the Manzano Mountains, New Mexico: U.S. Geological Survey Bulletin 1372-F, 13 p.
- _____, 1977, Geologic map of the Scholle quadrangle, Socorro, Valencia, and Torrance counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-1412.
- Myers, D. A. and McKay, E. J., 1970, Geologic map of the Mount Washington quadrangle, Bemalillo and Valencia counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-886.
- _____, 1971, Geologic map of the Bosque Peak quadrangle, Torrance, Valencia and Bemalillo counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-948.
- _____, 1972, Geologic map of the Capilla Peak quadrangle, Torrance and Valencia counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-1008.
- _____, 1976, Geologic map of the north end of the Manzano Mountains, Tijeras and Sedillo quadrangles, Bernalillo County, New Mexico: U.S. Geological Survey Miscellaneous Geologic Investigations Map 1-968.
- Needham, C. E., 1937, Some New Mexico Fusulinidae: New Mexico School of Mines, State Bureau of Mines and Mineral Resources Bulletin 14, 88 p.
- _____, 1940, Correlation of Pennsylvanian rocks of New Mexico: American Association of Petroleum Geologists Bulletin, v. 24, p. 173-179.
- Needham, C. E. and Bates, R. L., 1943, Permian type sections in central New Mexico: Geological Society of America Bulletin, v. 54, p. 1653-1668.
- Nichols, R. L., 1934, Quaternary geology of the San Jose valley, New Mexico: Geological Society of America Proceedings for 1933, p. 453.
- _____, 1936, Flow units in basalt: Journal of Geology, v. 44, p. 617-630.
- _____, 1939, Pressure-ridges and collapse-depressions on the McCarty's basalt flow, New Mexico: Transactions of the American Geophysical Union 20th Annual Meeting, pt. 3, p. 432-433.
- _____, 1946, McCarty's basalt flow, Valencia County, New Mexico: Geological Society of America Bulletin, v. 57, p. 1049-1086.
- Northrop, S. A., 1950, General geology of northern New Mexico, in Colbert, E. H. and Northrop, S. A. (ed.), Guidebook for the Fourth Field Conference of the Society of Vertebrate Paleontology in northwestern New Mexico: American Museum of Natural History and University of New Mexico, p. 26-46.
- _____, 1961, Mississippian and Pennsylvanian fossils of the Albuquerque country: New Mexico Geological Society Guidebook 12, p. 105-112.
- _____, 1973, Lexicon of stratigraphic names of the Monument Valley-Four Corners region: New Mexico Geological Society Guidebook 24, p. 157-176.
- Northrop, S. A. and Wood, G. H., Jr., 1945, Large *Schizophoria* in basal Pennsylvanian of New Mexico: Geological Society of America Bulletin, v. 56, p. 1185.
- O'Sullivan, R. B., 1977, Triassic rocks in the San Juan Basin of New Mexico and adjacent areas: New Mexico Geological Society Guidebook 28, p. 139-146.
- O'Sullivan, R. B., Repenning, C. A., Beaumont, E. C., and Page, H. G., 1972, Stratigraphy of the Cretaceous rocks and the Tertiary Ojo Alamo Sandstone, Navajo and Hopi Indian reservations, Arizona, New Mexico and Utah: U.S. Geological Survey Professional Paper 521-E, 65 p.
- Owen, D. E., 1966, Nomenclature of Dakota Sandstone (Cretaceous) in San Juan Basin, New Mexico and Colorado: American Association of Petroleum Geologists Bulletin, v. 50, p. 1023-1028.
- _____, 1973, Depositional history of the Dakota Sandstone, San Juan Basin area, New Mexico: Four Corners Geological Society Memoir, 1973, p. 3751.
- Owen, D. E. and Siemers, C. T., 1977, Lithologic correlation of the Dakota Sandstone and adjacent units along the eastern flank of the San Juan Basin, New Mexico: New Mexico Geological Society Guidebook 28, p. 179-183.
- Pierce, W. H. and Shomaker, J. W., 1971, San Mateo Menefee area: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 64-69.
- Pike, W. S., Jr., 1947, Intertonguing marine and nonmarine Upper Cretaceous deposits of New Mexico, Arizona and southwestern Colorado: Geological Society of America Memoir 24, 103 p.
- Rankin, C. H., 1944, Stratigraphy of the Colorado Group, Upper Cretaceous, in northern New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 20, 27 p.
- Rapaport, I., Hadfield, J. P., and Olson, R. H., 1952, Jurassic rocks of the Zuni uplift, New Mexico: U.S. Atomic Energy Commission, RMO-642, Technical Information Service, Oak Ridge, Tennessee.
- Rautman, C. A. (compiler), 1980, Geology and mineral technology of the Grants uranium region, 1979: New Mexico Bureau of Mines and Mineral Resources Memoir 38, 400 p.
- Read, C. B. and others, 1944, Geologic map and stratigraphic sections of Permian and Pennsylvanian rocks of parts of San Miguel, Santa Fe, Sandoval, Bemalillo, Torrance, and Valencia counties, north central New Mexico: U.S. Geological Survey Oil and Gas Investigations Preliminary Map 21.
- Read, C. B. and Wood, G. H., Jr., 1947, Distribution and correlation of Pennsylvanian rocks in late Paleozoic sedimentary basins of northern New Mexico: Journal of Geology, v. 55, p. 220-236.
- Reagan, A. B., 1903, Geology of the Jemez-Albuquerque region, New Mexico: The American Geologist, v. 31, p. 67-111.
- Renick, B. C., 1931, Geology and ground-water resources of western Sandoval County, New Mexico: U.S. Geological Survey Water-Supply Paper 620, 117 p.
- Repenning, C. A., Cooley, M. E., and Akers, J. P., 1969, Stratigraphy of the Chinle and Moenkopi formations, Navajo and Hopi Indian reservations, Arizona, New Mexico, and Utah: U.S. Geological Survey Professional Paper 521-B, 34 p.
- Rich, J. L., 1921, The stratigraphy of eastern New Mexico—a correction: American Journal of Science (5), v. 2, p. 295-298.
- Riecker, R. E. (ed.), 1979, Rio Grande rift: tectonics and magmatism: American Geophysical Union, Washington, D.C., 438 p.
- Robinson, P., 1957, Age of the Galisteo Formation, Santa Fe County, New

- Mexico: American Association of Petroleum Geologists Bulletin, v. 41, p. 757.
- Sabins, F. F., Jr., 1964, Symmetry, stratigraphy, and petrography of cyclic Cretaceous deposits in San Juan Basin: American Association of Petroleum Geologists Bulletin, v. 48, p. 292-316.
- Santos, E. S., 1963, Relation of ore deposits to the stratigraphy of host rocks in the Ambrosia Lake area: New Mexico Bureau of Mines and Mineral Resources Memoir 15, p. 53-59.
- _____, 1966a, Geologic map of the San Lucas Dam quadrangle, McKinley County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-516.
- _____, 1966b, Geologic map of the San Mateo quadrangle, McKinley and Valencia counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-517.
- Santos, E. S. and Thaden, R. E., 1966, Geologic map of the Ambrosia Lake quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-515.
- Schlee, J. S. and Moench, R. H., 1961, Properties and genesis of "Jackpile Sandstone," Laguna, New Mexico, in Peterson, J. A. and Osmond, J. C. (eds.), Geometry of Sandstone Bodies: American Association of Petroleum Geologists, p. 134-150.
- _____, 1963a, Geologic map of the Moquino quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-209.
- _____, 1963b, Geologic map of the Mesita quadrangle, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-210.
- Schrader, F. C., 1906, The Durango-Gallup coal field of Colorado and New Mexico: U.S. Geological Survey Bulletin 285, p. 241-258.
- Sears, J. D., 1925, Geology and coal resources of the Gallup-Zuni basin, New Mexico: U.S. Geological Survey Bulletin 767, 53 p.
- _____, 1934, Geology and fuel resources of the southern part of the San Juan Basin, New Mexico. Part 1. The coal field from Gallup eastward toward Mount Taylor, with a measured section of pre-Dakota(?) rocks near Navajo Church: U.S. Geological Survey Bulletin 860-A, 29 p.
- Sears, J. D., Hunt, C. B., and Hendricks, T. A., 1941, Transgressive and regressive Cretaceous deposits in southern San Juan Basin, New Mexico: U.S. Geological Survey Professional Paper 193-F, p. 101-121.
- Shimer, H. W. and Blodgett, M. E., 1908, The stratigraphy of the Mt. Taylor region, New Mexico: American Journal of Science (4), v. 25, p. 53-67.
- Shomaker, J. W., 1971a, Standing Rock Cleary area: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 69-75.
- _____, 1971b, Crownpoint Crevasse Canyon area: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 81-87.
- _____, 1971c, Rio Puerco Mesaverde area: New Mexico Bureau of Mines and Mineral Resources Memoir 25, p. 92-94.
- Siemers, C. T. and Wadell, J. S., 1977, Humate deposits of the Menefee Formation (Upper Cretaceous), northwestern New Mexico: New Mexico Geological Society Guidebook 28 (supplement), p. 1-21.
- Siemers, C. T. and others, 1975, Upper Jurassic and Upper Cretaceous stratigraphy and sedimentology--eastern San Juan Basin, New Mexico: Rocky Mountain Section American Association of Petroleum Geologists--Society of Economic Paleontology and Mineralogy Annual Meeting Guidebook, Field Trips to Central New Mexico, 1975, p. 1-98.
- Silver, C., 1948, Jurassic overlap in western New Mexico: American Association of Petroleum Geologists Bulletin, v. 32, p. 68-81.
- Slack, P. B., 1975, Tectonic development of the northeast part of the Rio Puerco fault zone, New Mexico: Geology, v. 3, p. 665-668.
- Smith, C. T., 1961, Triassic and Jurassic rocks of the Albuquerque area: New Mexico Geological Society Guidebook 12, p. 121-128.
- Smith, H. T. U., 1938, Tertiary geology of the Abiquiu quadrangle, New Mexico: Journal of Geology, v. 46, p. 933-965.
- Smith, R. L. and Bailey, R. A., 1966, The Bandelier Tuff—a study of ash-flow eruption cycles from zoned magma chambers: Bulletin Volcanologique, v. 29, p. 83-104.
- Smith, R. L., Bailey, R. A., and Ross, C. S., 1970, Geologic map of the Jemez Mountains, New Mexico: U.S. Geological Survey Miscellaneous Investigations Map I-571.
- Soister, P. E., 1952, Geology of Santa Ana Mesa and adjoining area, New Mexico (M.S. thesis): Albuquerque, University of New Mexico, 126 p.
- Stark, J. T. and Dapples, E. C., 1946, Geology of the Los Pinos Mountains, New Mexico: Geological Society of America Bulletin, v. 57, p. 1121-1172.
- Stearns, C. E., 1943, The Galisteo Formation of north-central New Mexico: Journal of Geology, v. 51, p. 301-319.
- _____, 1953a, Tertiary geology of the Galisteo-Tonque area, New Mexico: Geological Society of America Bulletin, v. 64, p. 459-508.
- _____, 1953b, Upper Cretaceous rocks of the Galisteo-Tonque area, north-central New Mexico: American Association of Petroleum Geologists Bulletin, v. 37, p. 961-974.
- Stewart, J. H., 1957, Proposed nomenclature of part of Upper Triassic strata in southeastern Utah: American Association of Petroleum Geologists Bulletin, v. 41, p. 441-465.
- Stewart, J. H., Poole, F. G., and Wilson, R. F., 1972a, Stratigraphy and origin of the Chinle Formation and related Upper Triassic strata in the Colorado Plateau region: U.S. Geological Survey Professional Paper 690, 336 p.
- _____, 1972b, Stratigraphy and origin of the Triassic Moenkopi Formation and related strata in the Colorado Plateau region: U.S. Geological Survey Professional Paper 691, 195 p.
- _____, 1972c, Changes in nomenclature of the Chinle Formation on the southern part of the Colorado Plateau, 1850's-1950's: Museum of Northern Arizona Bulletin, v. 47, p. 75-103.
- Sun, M.-S. and Baldwin, B., 1958, Volcanic rocks of the Cienega area, Santa Fe County, New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 54, 80 p.
- Sutherland, P. K., 1963, Paleozoic rocks: New Mexico Bureau of Mines and Mineral Resources Memoir II, p. 22-46.
- Sutherland, P. K. and Harlow, F. H., 1967, Late Pennsylvanian brachiopods from north-central New Mexico: Journal of Paleontology, v. 41, p. 1065-1089.
- Tedford, R. H., 1981, Mammalian biochronology of the late Cenozoic basins of New Mexico: Geological Society of America Bulletin, v. 92, pt. I, p. 1008-1022.
- Thaden, R. E., Merrin, S., and Raup, O. B., 1967, Geologic map of the Grants SE quadrangle, Valencia County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-682.
- Thaden, R. E. and Ostling, E. J., 1967, Geologic map of the Bluewater quadrangle, Valencia and McKinley counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-679.
- Thaden, R. E., Santos, E. S., and Ostling, E. J., 1966, Geologic map of the Goat Mountain quadrangle, McKinley County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-518.
- _____, 1967, Geologic map of the Dos Lomas quadrangle, Valencia and McKinley counties, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-680.
- Thaden, R. E., Santos, E. S., and Raup, O. B., 1967, Geologic map of the Grants quadrangle, Valencia County, New Mexico: U.S. Geological Survey Geologic Quadrangle Map GQ-681.
- Thompson, M. L., 1942, Pennsylvanian System in New Mexico: New Mexico School of Mines, State Bureau of Mines and Mineral Resources Bulletin 17, 92 p.
- Tschudy, R. H., 1976, Palynology of Crevasse Canyon and Menefee Formation of San Juan Basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 154, p. 48-55.
- Ward, L. F., 1901, Geology of the Little Colorado Valley: American Journal of Science, v. 12, p. 401-413.
- Weber, R. H., 1963, Cenozoic volcanic rocks of Socorro County: New Mexico Geological Society Guidebook 14, p. 132-143.
- Wells, E. H., 1919, Oil and gas possibilities in the Puertecito district, Socorro and Valencia counties, New Mexico: New Mexico School of Mines Mineral Resource Survey Bulletin 3, 47 p.
- Wengerd, S. A., 1959, Regional geology as related to the petroleum potential of the Lucero region, west-central New Mexico: New Mexico Geological Society Guidebook 10, p. 121-134.
- Wilmarth, M. G. (compiler), 1938, Lexicon of geologic names of the United States: U.S. Geological Survey Bulletin 896, 2396 p.
- Wilpolt, R. H. and others, 1946, Geologic map and stratigraphic sections of Paleozoic rocks of Joyita Hills, Los Pinos Mountains, and northern Chupadera Mesa, Valencia, Torrance, and Socorro counties, New Mexico: U.S. Geological Survey Oil and Gas Investigations Preliminary Map 61.
- Winchester, D. E., 1920, Geology of Alamosa Creek Valley, Socorro County, New Mexico, with special reference to the occurrence of oil and gas: U.S. Geological Survey Bulletin 716-A, 15 p.
- Wood, G. H., Jr. and Northrop, S. A., 1946, Geology of Nacimiento Mountains, San Pedro Mountain, and adjacent plateaus in parts of Sandoval and Rio Arriba counties, New Mexico: U.S. Geological Survey Oil and Gas Investigations Preliminary Map 57.
- Woodward, L. A. and Martinez, R., 1974, Geologic map and sections of Holy Ghost Spring quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map 33.
- Woodward, L. A. and Ruetschilling, R. L., 1976, Geology of San Ysidro quadrangle, New Mexico: New Mexico Bureau of Mines and Mineral Resources Geologic Map 37.
- Wright, H. E., Jr., 1946, Tertiary and Quaternary geology of the lower Rio Puerco area, New Mexico: Geological Society of America Bulletin, v. 57, p. 383-456.
- Zitting, R. T., Masters, J. A., Groth, F. A., and Webb, M. D., 1957, Geology of the Ambrosia Lake area uranium deposits, McKinley County, New Mexico: Mines Magazine, v. 47, p. 53-58.