BULLETIN 61

Lexicon of New Mexico Geologic Names: Precambrian Through Paleozoic

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Introduction

Acceleration of geologic work in New Mexico has emphasized the need for an up-to-date lexicon of published geologic names used in the State.

The preparation of such a lexicon was initiated in 1956 with the publication of names from the Precambrian through the Devonian eras (New Mexico Bureau of Mines and Mineral Resources Circular 40, by H. L. Jicha, Jr.). The listing is now extended to embrace the Mississippian, Pennsylvanian, and Permian periods. The material presented in Circular 50 has been incorporated in the new compilation. Thus, the present bulletin provides coverage of all geologic names used in publications on New Mexico geology from the Precambrian through the Permian.

The publication of this lexicon has been a cooperative undertaking. The basic compilation of listings and references was accomplished by H. L. Jicha, Jr. Christina Lochman-Balk critically evaluated this material and provided numerous additions and emendations. The checking of references, preparation of the manuscript for the printer, and final proofreading were performed by Joann E. Kellogg. G. V. Cohee, chairman of the Geologic Names Committee of the U. S. Geological Survey, was helpful in checking the list of names and indicating the designations in current usage by the Survey.

In general, the pattern adopted by Wilmarth (1938) has been followed. Names printed in boldface are those currently used by the U. S. Geological Survey. Names in boldface preceded by an asterisk (*) are accepted by the U. S. Geological Survey but have not been extended into New Mexico by Survey geologists. Names preceded by a dagger (†) have either been abandoned by their authors or rejected by the U. S. Geological Survey. The New Mexico Bureau of Mines and Mineral Resources recommends (see p. 3) the suppression of those names which are preceded by a double dagger (‡).

County names and other locality designations mentioned in the line below the captions seldom indicate the exact geographic distribution of the unit described; they serve, however, as clues to the part of the State in which the unit occurs.

ABBREVIATIONS

The following abbreviations have been used:

AAPG Bull., American Association of Petroleum Geologists Bulletin
AIME Bull., American Institute of Mining [, Metallurgical, and Petroleum] Engineers Bulletin (also Contribution; Transactions)
Am. Geol., American Geologist

Am. Jour. Sci., American Journal of Science
Calif. Inst. Tech., California Institute of Technology
Colo. Sci. Soc. Proc., Colorado Scientific Society Proceedings
Eng. and Mining Jour., Engineering and Mining Journal
GSA Bull., Geological Society of America Bulletin
Iowa Acad. Sci. Proc., Iowa Academy of Science Proceedings
Jour. Geol., Journal of Geology
Jour. Pal., Journal of Paleontology
Kans. Univ. Paleont. Contr., University of Kansas Paleontological Contributions
N. Mex. Bur. Mines Bull., New Mexico Bureau of Mines and Mineral Resources Bulletin (also Circular; Memoir)
N. Mex. State Eng. Bien. Rpt., New Mexico State Engineer Biennial Report
N. Mex. Univ. Pub., geol. ser., University of New Mexico Publication, geological series (also Hadley Laboratory Bulletin)
NMGS Guidebook, New Mexico Geological Society Guidebook
Okla. Acad. Sci. Proc., Oklahoma Academy of Science Proceedings
Okla. Geol. Surv. Bull., Oklahoma Geological Survey Bulletin
Okla. Univ. Bull., University of Oklahoma Bulletin
Ores and Met., Ores and Metals
Pan-Am. Geol., Pan-American Geologist
Rpt. Gov. N. Mex. to U. S. Sec. Interior, Report of the Governor of New Mexico to the United States Secretary of Interior
Strat. Problems Comm., Stratigraphic Problems Commission
Tex. Univ. Bull., University of Texas Bulletin (also Publication)
Tex. Univ. Bur. of Econ. Geol. Rpt. Inv., University of Texas, Bureau of Economic Geology, Report of Investigation
Tex. Univ. Min. Surv. Bull., University of Texas, Mineral Survey Bulletin
Univ. of Calif., University of California
USGS Bull., United States Geological Survey Bulletin (also Professional Paper; Annual Report; Oil and Gas Investigations)
U. S. Nat. Mus. Proc., United States National Museum Proceedings
W. Tex. Geol. Soc., West Texas Geological Society

abs., abstract
abund., abundant(ly)
anhyd., anhydrite; anhyds., anhydrites
appar., apparent(ly)
appear., appearance
approx., approximate(ly)
aren., arenaceous
argil., argillaceous
art., article
A.T.&S.F.Ry., Atchison, Topeka & Santa Fe Railway
aver., average
blk., block
btw., between
calc., calcareous
carb., carbonaceous
carbf., Carboniferous
cgl., conglomerate, conglomeratic; cgls., conglomerates
Co., County, Company
Colo., Colorado
conf., conformable, conformably
contemp., contemporaneous
Cret., Cretaceous
Dev., Devonian
diam., diameter
disconf., disconformably, disconformable, disconformity
dist., district
distrib., distributed
div., division
dol., dolomite; dols., dolomites
dolo., dolomitic
E., east
ed., edition
est., estimated
equiv., equivalent
fm., formation; fms., formations
fossilif., fossiliferous
ft, foot, feet
geol., geologic(al)
gp., group; gps., groups
gyp., gypsum
gypsif., gypsiferous
Ill., Illinois
in., inch(es)

Kans., Kansas
ls., limestone; lss., limestones
loc., locality
mag., magnesian
max., maximum
med., medium
memb., member; membs., members
mi, mile(s)
min., minimum
Miss., Mississippian
Mo., Missouri
mm, millimeter(s)
ms., manuscript
mtn., mountain; mtns., mountains
N. Mex., New Mexico
N., north
n., new, number
nonmag., nonmagnesian
Okla., Oklahoma
Penn., Pennsylvanian
petrolif., petroliferous
Precamb., Precambrian
predom., predominant(ly)
prom., prominent
quad., quadrangle; quads., quadrangles
qtz, quartz
qtzite, quartzite; qtzites, quartzites
qtzitic, quartzitic
qtzose, quartzose
rpt., report
S., south
sed., sedimentary
ser., series
sh., shale; shs., shales
Sil., Silurian
silic., siliceous, silicified, silicification
sim., similar
ss., sandstone; sss., sandstones
strat., stratigraphy, stratigraphic, stratigraphically
sublith., sublithologic
subsurf., subsurface
Tert., Tertiary
Tex., Texas
unconf., unconformity, unconformably, unconformable
undet., undetermined
undiff., undifferentiated
unpub., unpublished
W., west

RECOMMENDED SUPPRESSION OF ABANDONED STRATIGRAPHIC NAMES

In the early decades of this century, C. R. Keyes wrote many short papers on New Mexico geology in which he employed a number of local geographic names to refer to the various stratigraphic units within the State, which he was discussing. All these articles were brief, and Keyes never designated either a type section or type locality for any of his stratigraphic units. Only rarely can a probable location be surmised from the derivation of the place name. Subsequent workers have been unable to recognize these units; with a few exceptions, the names have neither been used locally nor appeared in print since Keyes' original publication.

The New Mexico Bureau of Mines and Mineral Resources recommends official suppression of these long-abandoned stratigraphic names in order that the place names thus preoccupied may again be available for use. The names marked by a dagger (†) have already been abandoned by the Geologic Names Committee of the U. S. Geological Survey.

Alamito shale
Albuquerquan Series
Antonio slate
Antonito limestone
Armendaris limestone
Bella shale

†Bernalillan (Bernallian) series
Bernalillo shale
Burro quartzites
Carrasco limestone
Ceja Glorieta sandstone
Chaves shale
Chiricahuan series
Chloride formation
Chloridian series
Cibola limestone
†Cimarron formation
Cimarronian series
Cristobal limestone
Dragoonan series
Eddy sandstone
El Pasan series
Frondosa limestone
Gallegos sandstone
Garnuan series
Graphic lavas
Hawkins limestone
Ladronesian series
Lone quartzite
Lunasan (Lunasian) series
Maderan series
Mangas quartzite
Manzanan series
Martinian series
Mimbresian (Mimbresan) series
Mimbres series
Moencopie shales
Montosa limestone
Mosca limestone
Naiad limestone
Ninos schist
Oscuro limestone
Otero limestone
Pecos shale
Penasco quartzite
Perchan series
Picurisan (Pecurisan) series
†Pinos Altos limestones
Placitos limestone
Rican series
†Rio Grande series
Rociada (Rociado) limestone
Sandia quartzite
†Sandia series
Sandoval granite
Santa Rita limestone
Santa Ritan series
Sapello quartzite
Serna schist
Silver shales
Socorroan series
Solitario slate
Taosan series
Tellera (Tellara) limestone
Tijeras quartzite
Torrance shale
Truchas slate
Valencian series
Ysidro shale

The New Mexico Bureau of Mines and Mineral Resources recognizes as suppressed the following additional stratigraphic names. Those marked by a dagger (†) have been officially abandoned by the Geologic Names Committee of the U. S. Geological Survey. Others have been suppressed by the original author, are preoccupied, or have lapsed from usage.

Aqua Torres formation
Augur limestone member
†Badito quartzite member (of Hopewell series)
†Bone Canyon limestone (member)
†Bone Springs limestone
†Brazos series
Dixon granite
†Dog Canyon limestone
Don limestone
†El Capitan limestone
†Fierro limestone

†Frijole limestone member (of Delaware Mountain formation)
†Graphic-Kelly limestone
†Hanover limestone
Hondo slate
†Hot Springs formation
†Humboldt formation
Incarnacion granite
†Mimbres limestone
†Nogal formation
†Pecos formation
†Pecos Valley red beds
Picacho limestone
†Pueblo quartzite

Lexicon

Abo formation (sandstone, red beds). (Of Manzano group.)

Permian (Wolfcampian-Leonardian): New Mexico (widespread) and subsurface of western Texas.

W. T. Lee, 1909 (USGS Bull. 389). *Abo ss.*—Coarse-grained ss., dark-red to purple, usually conglomeratic at base; with subordinate amount of sh., which attains prominence in some places. Thickness 300 to 800 ft. Upper limit is drawn below the gyp., for obvious reason that in many places the overlying or Yeso fm. contains beds of gyp. and gypsif. sh. at several horizons, through a thickness in some places of 1,000 ft or more. Is basal memb. of Manzano gp. and rests unconf. upon Magdalena gp. Named for Abo Canyon, at S. end of Manzano Range.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). The *Abo ss.*, at the base of the Manzano gp., lies on beds of Wolfcamp age, and apparently extends southward into beds of late Wolfcamp or early Leonard age in Hueco Mtns. [Deer Mountain red sh. memb. of Hueco fm.].

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, pl. 2). The *Abo fm.* grades southward into Hueco ls. (Wolfcampian).

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1668). *Abo fm.*—In its type sec. the Abo consists of about 40 percent ss., arkose, and cgl., and about 60 percent red sh. This ratio holds approximately true for most exposures in central N. Mex. The Abo contains no lss. nor marine fossils. Its continental origin is indicated by red color and clastic character; casts of halite crystals; mud cracks; ripplemarks, both wave and current; very extensive crossbedding; bones and tracks of land vertebrates; and plant remains. Max. thickness 915 ft at type sec. The Abo is a part of the Wolfcamp series of early Permian age.

R. E. King, 1945 (N. Mex. Bur. Mines Bull. 23, 16-17). In SE. N. Mex., *Abo* grades into marine facies which are considered to be Clear Fork (Leonardian) age.

R. L. Bates et al., 1947 (N. Mex. Bur. Mines Bull. 26, 26-28). The uppermost unit of the type *Abo* of Needham and Bates (1943) is a 6-ft white massive ss. Further field work has shown the presence just above this ss. of a thin ls. that is identical with the lowest unit of the Yeso as redefined by the same authors. However, as pointed out by C. B. Read (personal communication, 1945), the "basal Yeso ls." cannot be found in the northern part of the State—in Glorieta Mesa and the Zuni Mtns., for example; consequently it cannot serve as a universally recognizable "base of Yeso." Read further states that a 100- to 300-ft section of sss. and shales, heretofore considered uppermost Abo, can be recognized and mapped regionally. As most of these beds are apparently of marine origin and in many places, including Abo Canyon, have a pink color more similar to that of the Yeso than to the dark red of the Abo, Read and his coworkers have included the beds in the Yeso and have mapped the Abo-Yeso contact some distance below the basal Yeso ls. of Needham and Bates. Applied to the Abo type section, this revision lowers the Abo-Yeso contact 104 ft, to top of interval 32 in the Needham and Bates section. Exclusion of this top 104 ft of Abo gives the fm. a thickness of 810 ft at the type sec. The Abo is here assigned tentatively in part to the Wolfcamp series of Permian(?) age and in part to the Leonard series of Permian age.

E. R. Lloyd, 1949 (N. Mex. Bur. Mines Bull. 29, 31). By lithologic correlation, the continental red beds of the typical Abo have been traced into a marine lower Leonard section in Lea Co. Most of the Abo of the southern Sacramento Mtns. is equiv. to a part of the Hueco fm. of Wolfcamp age.

L. C. Pray and C. Otte, Jr., 1954 (GSA Bull., v. 65, 1296). Field investigations have clarified the relationship of the terrestrial *Abo fm.* with other lower Permian

fms. in south central N. Mex. and western Tex. The Abo is transitional with the underlying latest early Wolfcampian marine strata (Bursum fm.) in the northernmost Sacramento Mtns. Southward to beyond the Hueco Mtns., early Wolfcampian strata are absent, and Abo or equiv. marine strata of later Wolfcampian age unconf. overlie Penn. or older rocks. The Abo, 1,400 ft thick in the northernmost Sacramento Mtns., thins abruptly to 250 ft in the central Sacramento Mtns. It extends southward as two major tongues of red beds separated by, but transitional with, a southward-thickening sequence of brackish to marine carbonates, fine clastics, and minor gyp. of the Hueco fm. The basal tongue of the Abo correlates with the Powwow cgl., and the upper tongue (considered the entire Abo by Darton) forms the Deer Mountain red sh. in the Hueco fm. The Abo of the Sacramento Mtns. is the lateral equiv. of the lower 1,200 ft of the Hueco fm., at Hueco Canyon, Tex., and probably correlates with both the Abo (Leonardian) and Hueco (Wolfcampian) as identified in the Permian Basin subsurf.

In summary, the Abo fm. of central N. Mex. is probably Wolfcampian, but beds that have been correlated with the Abo in the subsurf. of the Permian Basin are also basal Leonardian.

Type locality and section: From the base of the formation in sec. 32, T. 3 N., R. 5 E., Valencia County, just N. of U. S. Highway 60, through sec. 33, into sec. 2, T. 2 N., R. 5 E., Torrance County; thence to secs. 35 and 36, T. 3 N., R. 5 E., to the upper limit of the formation at the top of the hill just E. of the road to Abo Ruins in sec. 25, T. 3 N., R. 5 E., Torrance County. The base of the formation lies about 1 mi NW. of the village of Scholle, and its top about 2 mi WNW. of the village of Abo.

Name: From Abo Canyon, S. end of Manzano Mtns., Socorro Co., New Mexico.

Adobe formation. (Of Veredas group.)

Pennsylvanian (Missourian): Central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 59-62). *Adobe fm.*—At type loc. 47 ft of noncherty to highly cherty gray lss., gray shs., and arkosic sss. Type section (ascending): (1) ss., green, medium- to fine-grained, crossbedded in lower part, weathers brown, 4 ft; (2) ls., gray, thinly and irregularly bedded, interbedded with calc. sh. and nodular lime, 5 ft; (3) ls., bluish-gray, dense, hard, massively bedded, algal at top, 10 ft; (4) irregular nodular lime and calc. sh., poorly exposed, 3 ft; (5) ls., medium-gray, thinly bedded, crinoidal at top, 4 ft; (6) ss., green, weathers brown, arkosic and micaceous, medium-grained, conglomeratic at base, 7 ft; (7) ls., light-gray, thinly and irregularly bedded, chert common, 5 ft; (8) ls., algal, 5 ft; (9) calc. sh. with few thin beds of ls., 4 ft. In most of central N. Mex., Adobe fm. has arkosic ss. or granule cgl. at base, calc. shs. at top. In Ladron Mtns. area, Adobe fm. is 200 ft thick. Locally contains thick gray shs. Conf. overlain by Council Springs ls.; lies conf. on Coane fm. Fusulinid fossils (*Triticites*) abundant.

Type locality and section: NW. side of Oscura Mtns., on W. slope of range, in SE¼ sec. 36, T. 5 S., R. 5 E.

Name: From village of Adobe, 3 mi NE. of N. end of Oscura Mtns.

Agua Caliente gabbro.

Precambrian: Central northern New Mexico (Picuris Range).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 25). *Agua Caliente gabbro.*—An exposure of gabbro was found on one of the southern tributaries of Agua Caliente

Creek. No definite evidence of an intrusive origin or Precamb. age was discovered. A diorite just NW. of the top of Picuris Peak is also of doubtful age and origin. It is suggested that these rocks may be intrusive and of Keweenawan age. They are not schistose and were not mapped separately.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 35), describes a "bytownite-hornblende meta-intrusive" [a quartz gabbro] which occurs as a widespread sill. It is associated with the schist member of the Vadito fm. of Precamb. age.

Type locality: Along Agua Caliente Creek, according, however, to the map by Montgomery, the Agua Caliente gabbro does not crop out along Agua Caliente Creek.

Name: From Agua Caliente Creek.

‡Alamito shale.

Pennsylvanian: New Mexico.

C. R. Keyes, 1906 (Jour. Geol., v. 14, 147-154), applied *Alamito shs.* to beds said to unconf. overlie Lake Valley ls.

Type locality: Not designated.

Name: Derivation not indicated.

Alamogordo member (of Lake Valley formation).

Mississipian (Osagian): Southern New Mexico.

L. R. Laudon and A. L. Bowsher, 1941 (AAPG Bull., v. 25, 2114-2116, 2125-2133). *Alamogordo memb.*—Normal development of Alamogordo memb. contains a thin soft siltstone facies overlain by an almost vertical cliff of hard, black, resistant, very cherty ls., followed by a thin, soft marly zone, and capped with hard gray crinoidal ls. Biohermal facies in upper part. In columnar section the Alamogordo was broken into four facies (from bottom to top): The *Taonurus* siltstone facies, the black cherty ls. facies, the blue-gray shaly marl facies, and the upper gray crinoidal facies. The upper two units may be locally missing in Sacramento Mtns. Lies unconf. on Caballero fm. (Miss.); disconf. overlain by Arcente memb. of Lake Valley fm.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 13). *Alamogordo memb.* as originally defined included beds designated in this report as Andrecito, Alamogordo, Nunn, and Tierra Blanca. The name Alamogordo is here restricted to the massive black very cherty poorly fossilif. cliff-forming ls. beds above the thinbedded Andrecito memb. and below the soft blue-gray crinoidal marls of the Nunn memb. The Alamogordo memb. (restricted) makes a conspicuous scarp along the front of the Sacramento Mtns. and is the most widely distributed memb. of the Lake Valley fm. Thickness averages from 30 to 50 ft and is fairly constant. Variation in thickness occurs particularly where bioherms are developed. It forms the base from which the central structures arise, and in many places it is part of the central biohermal structure. The memb. is thinnest in Cooks Range.

Type locality and section: Upper end of Deadman Canyon, S. center sec. 3, T. 17 S., R. 10 E., Sacramento Mtns.

Name: From town of Alamogordo, just W. of Sacramento Mtns.

‡Albuquerquan series.

Precambrian: New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4). *Albuquerquan series.*—The great sequence of argil. beds, with some qtzites, exposed to the extent of more than 2,000 ft in the Tijeras Canyon, E. of Albuquerque.

Type locality: Not designated.

Name: From city of Albuquerque.

Aleman formation (of Montoya group).

Upper Ordovician (Richmond): Southern New Mexico.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 60-62). *Aleman fm.*—Alternations of chert and dol. beds which form a strikingly banded outcrop. The chert occurs as irregular bands 1 to 3 in. thick, alternating with 1- to 6-in. bands of dol. Chert weathers white, brown, and black; dol. weathers light gray to medium gray. Dol. is medium to dark gray, brownish gray, or pinkish gray on fresh exposures, and microcrystalline to granular. Fossils occur irregularly as 1- to 2-in. streaks and lenses of silicified shells. Characteristic fossil is *Zygospira recurvirostris*. Lies conf. on Upham dol.; apparently conf. overlain by Cutter fm. Thickness in Caballo Mtns. 120 to 170 ft.

Type locality and section: Cable Canyon, Caballo Mtns., NW¼ sec. 10, T. 16 S., R. 4 W.

Name: From Aleman station of A.T.&S.F. Ry., E. of Caballo Mtns.

Andrecito member (of Lake Valley formation).

Mississippian (Osagian): Southern New Mexico.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 12-13). *Andrecito memb.*—At type section, 35 ft of thin-bedded gray fossilif. ls., grading upward into thin-bedded dark-gray somewhat cherty ls. The surfaces of the ls. beds throughout the memb. commonly are covered with fenestelloid bryozoans. Rests conf. on the soft, nodular Caballero fm. (Miss.) and is differentiated easily from the massive black cherty cliff-forming ls. beds of the overlying Alamogordo memb. Max. development in Cooks Range, where about 270 ft of thin-bedded ls. belongs to this memb.

Type locality and section: S. wall Andrecito Canyon, Sacramento Mtns., NW¼ sec. 8, T. 18 S., R. 4 E.

Name: From Andrecito Canyon.

Aneth formation.

Upper Devonian: Subsurface, northwestern New Mexico, northeastern Arizona, southwestern Colorado, and southeastern Utah (Four Corners area).

R. L. Knight and J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 56-58). *Aneth fm.*—Eleven wells in the Four Corners region have penetrated a dark dol. interval interbedded with varying amounts of gray, brown, and black sh., gray siltstone, and lighter dols. This distinctive lithologic unit is believed to meet all the requirements of a fm. It is easily distinguishable from other Dev. units in the region and is traceable over a sizable area.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 59-65). *Aneth fm.*—The Aneth fm., ranging from 0 to 170 ft, underlies an irregular ellipsoidal area of approx. 2,600 sq mi which straddles the four-State intersection. The type section at the Shell well lies near the center and is the max. thickness known. This facies wedges out in all directions from the Shell test. The Aneth fm. consists predom. of dark-brown to black resinous dense dol., ls., and sh., locally slightly anhydritic, with some associated glauconite. In the Continental South Ute Mtn. test, located in the extreme NW. corner of N. Mex., some carb. sh. and associated minor coal were logged. The Aneth fm. unconf. overlies the Camb. Ophir fm.; where the Ophir is absent, it lies on the Tintic ss. In the Phillips

Navajo No. 1, at Chimney Rock, the Aneth fm. is underlain by a probable intrusive. The Aneth fm. (probably unconf.) underlies the McCracken ss. memb. of the Elbert fm. (Dev.) The Jefferson ls. of northern Utah is believed to be the approx. equiv. of the Aneth fm.

Type section: Shell Oil Co. Bluff Unit No. 1, sec. 32, T. 39 S., R. 23 E., near Blanding, Utah.

Name: From town of Aneth, San Juan Co., Utah.

‡Antonio slate.

Precambrian: Central New Mexico (Manzano Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 5). *Antonio slates.*—Somewhat metamorphosed argil. beds, 2,000 ft thick, which lie beneath Tijeras qtzite and are well displayed at N. end of Manzano Mtns. Underlain by other, as yet undet., sediments.

Type locality: Not designated.

Name: Derivation not indicated.

‡Antonito limestone.

Pennsylvanian(?): Central New Mexico (Sandia Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 3, 5). *Antonito lss.*—Lowermost of heavy gray lss. exposed in fine sections at S. extremity of Sandia Range. Thickness 200 ft. Basal part of Maderan series and overlies Mosca ls.

Type locality: Designated as approximately the S. end of Sandia Range.

Name: Derivation not indicated.

Apodaca formation. (Of Green Canyon group.)

Pennsylvanian (Derryan): Central and southern New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 34, 36). *Apodaca fm.*— At type loc. 65 ft of dense gray lss., with common masses and lenses of chert, nodular lss., calc. shales, black to dark-gray calc. siltstones, and greenish- to bluish-gray shs. Type section (ascending): (1) sh., dark-gray, silty, alternating with gray nodular to platy ls., 10 ft.; (2) covered, 10 ft; (3) ls., medium- to dark-gray, laminated, silty and micaceous, cherty, fossilif., dark-brown chert weathers out on surface, 10 ft; (4) sh., silty, alternating with gray ls., 12 ft; (5) ls., gray, large algal reefs, cherty throughout, surface very rough, 6 ft; (6) covered, 13 ft; (7) ls., extremely cherty, dense, surface of chert has wavy bands, immediately overlain by 1 ft greenish-gray argil. siltstone or sh., underlain by 1 ft greenish-gray hard sh., 4 ft. Northward from Derry becomes more highly clastic. In Ladron Mtns. region is predom. clastic, of shs., highly argil. lss., and sss. Fusulinid fauna: *Millerella, Ozawainella(?), Eoschubertella, Pseudostaffella, Profusulinella.* Conf. underlain by Arrey fm.; overlain by Fra Cristobal fm. of Mud Springs gp.

Type locality and section: ¾ mi E. of Derry.

Name: From Apodaca Creek, about 3 mi N. of Derry.

‡Aqua Torres formation.

Permian (Wolfcampian): Central New Mexico (Los Pinos and Manzano Mountains).

J. T. Stark and E. C. Dapples, 1946 (GSA Bull., v. 57, 1121-1172). *Aqua Torres fm.* —Thin cgl. at base, above which lies a sequence of arkoses, red sss., red shs.,

nodular lss., and at top a gray massive ls. The basal cgl., everywhere less than 5 ft thick, forms base of the red sediments in nearly all localities. It is characteristically brown and contains pebbles, 1 to 2 in. in longest dimension, of qtz, gray ls., and occasional red ls., in a fine-grained calc. and well-cemented matrix. The cgl. is overlain by 40 to 50 ft of coarse prominently crossbedded arkose or red-brown medium-grained sss. These are locally overlain by about 5 ft of purplish nodular lss. and gray shs. Alternating red and gray nonfossilif. sss., ranging from 15 to 40 ft thick, lie upon the nodular lss. The uppermost memb. is 0 to 30 ft of light-gray to medium-gray finely crystalline or dense thick-bedded ls., which weathers dark gray. Thickness approx. 100 ft. Lies unconf. on Penn. (Virgilian) strata; unconf. overlain by Abo fm.

E. R. Lloyd, 1949 (N. Mex. Bur. Mines Bull. 29, 32). *Aqua Torres fm.* is same as *Bursum fm.* The name Aqua Torres has been discarded by the N. Mex. Bur. Mines. These beds are called *Bursum fm.*

Type locality: Arroyo Aqua Torres, Manzano Mtns. No type section given.

Name: From Arroyo Aqua Torres.

Arcente member (of Lake Valley formation).

Mississippian (Osagian): South central New Mexico (Sacramento Mountains).

L. R. Laudon and A. L. Bowsher, 1941 (AAPG Bull., v. 25, 2116, 2133-2136). *Arcente memb.*—Consists of soft dove-gray relatively thin-bedded calc. siltstone interbedded with an equal amount of soft, dark silty shs. Weathers to blocky, rubbly, retreating slopes; it is mostly free from chert, although it does carry some black chert. In lower part of section the more resistant siltstone beds average about 3 in. thick; toward top of the fm. they are more massive, averaging about 9 in. thick. Lower portion of section is over 50 percent sh. The interbedded shs. are progressively less conspicuous toward the top. The Arcente memb. is everywhere evenly bedded. Thickness 0 to 230 ft. Disconf.(?) on Tierra Blanca memb.; gradational with overlying Dona Ana memb.

Type locality and section: Upper end Deadman Canyon, Sacramento Mtns., S. center sec. 3, T. 17 S., R. 10 E.

Name: From Arcente Canyon, Sacramento Mtns.

Ardian.

A term proposed by R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302) to cover the epoch during which their Ardian series (Lower Penn.) was deposited.

Ardian series.

A term proposed by R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302) as a substitute for Lower Penn. (Springeran and Morrowan), based on outcrops in the Ardmore Basin of southern Oklahoma. Springeran and Morrowan are designated as stages in the Ardian series.

Armendaris group.

Pennsylvanian (Desmoinesian): New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 41-51). *Armendaris gp.*—Name proposed for all strata btw. the top of the Derry series below and the base of the Bolander gp. above. Composed very largely of gray to light-gray cherty ls., with a few thin sh. and ss. beds scattered throughout. Divided into 3 fms. (ascending): Elephant Butte fm. (includes Warmington ls. memb.),

Whiskey Canyon ls., and Garcia fm. Lies unconf.(?) on Derry series; conf. overlain by Bolander gp.

Type locality and section: N. end Mud Springs Mtns., in W. end of Whiskey Canyon, SW¼ sec. 1, T. 13 S., R. 5 W.

Name: From Armendaris Grant, E. and NE. of Truth or Consequences (Hot Springs).

‡Armendaris limestone.

Ordovician: New Mexico.

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 259, 260). *Armendaris lss.*—Lss., 300 ft thick, underlying Montoyan series and unconf. overlying late Camb. qtzites (Lone terrane) in N. Mex. The main body of Early Ord. lss. well displayed in Sierra de los Caballos.

Type locality: Not designated.

Name: Derivation not indicated.

Arrey formation. (Of Green Canyon group).

Pennsylvanian (Derryan): Central and southern New Mexico and western Texas.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 32-36). *Arrey fm.*—At type loc. 32 ft of dense massive lss., highly nodular lss. with irregularly interbedded highly calc. shales, and very common irregular masses and lenses of chert. To the N. the fm. is more clastic; to the S. it is essentially pure ls. In Mud Springs Mtns. 50 ft thick, in Hueco Mtns. 300 ft thick. Type section (ascending): (1) ls., gray, in beds 1 ft thick, upper and lower 1 ft highly nodular, fossilif. throughout, 5.5 ft; (2) ls., bluish-gray, fine-grained, dense and hard, cherty, forms cliff, 9 ft; (3) irrregularly bedded ls. and calc. sh., 2 ft; (4) ls., gray, fine-grained, dense and hard, massive, upper and lower 1 ft highly nodular, 4.5 ft; (5) sh., highly calc., interbedded with argil. ls., fossilif., 2.5 ft; (6) ls., bluish-gray to light-gray, massive, abund. chert as concentric masses and irregular beds, 3.5 ft; (7) ls., crinoidal, in irregular beds up to 1 ft thick, interbedded with highly calc. fossilif. sh., 5 ft. Lies unconf. on Dev. sh.; conf. overlain by Apodaca fm. Fauna: *Millerella, Ozawainella*(?), *Eoschubertella, Profusulinella.*

Type locality and section: ¾ mi E. of Derry, New Mexico.

Name: From town of Arrey, 4½ mi NW. of Derry, New Mexico.

Arroyo Penasco formation.

Mississippian (Meramecian): Northern and central New Mexico.

A. K. Armstrong, 1955 (N. Mex. Bur. Mines Circ. 39, 3, 6). *Arroyo Penasco fm.*—20 to 150 ft of gray dense fine-grained to oölitic massive to medium-bedded ls., which rests unconf. on Precamb. and is overlain unconf. by red shs. and sss. of the Penn. Log Springs fm. At type loc., base of fm. is 18 to 20 ft of clean calc. ss., with interbedded shs. and ls. beds as much as 3 ft thick in upper part. The intergrading ls. and clastic beds are overlain by 31 ft of fine- to coarse-grained gray to brown ledge-forming ls. The upper unit is some 70 ft of lithographic to oölitic light-gray medium-bedded ls., of which the uppermost 10 to 15 ft has been replaced by white chert. In certain zones the fm. contains a Meramec microfauna characterized by *Endothyra* sp. and *Plectogyra* sp.

Type locality and section: Pinos and Penasco Canyons, Nacimiento Mtns., SW¼ SE¼ sec. 5, T. 16 N., R. 1 E.

Name: From Arroyo Penasco, in Nacimiento Mtns.

"Artesia red sand."

Permian (Guadalupian): Southeastern New Mexico.

M. J. Davis, 1929 (Structure of Typical American Oil Fields, v. 1, 114-115). Above the top of the dol. measures is an anhyd. series broken here and there by beds of red ss. or red shs. This series is approx. 1,100 ft thick. About 400 ft above the top of the dol., in the anhyd. section, is a prom. bed of hard red ss. that occurs generally throughout the field. This bed ranges in thickness from 20 to 50 ft, and has been used extensively as a key bed for subsurf. mapping. In some wells this stratum carries showings of both oil and gas.

D. E. Winchester, 1933 (N. Mex. Bur. Mines Bull. 9, 153). A study of the logs of wells drilled in the area, shows the "Red Sand" occurs in the anhyd. zone some 300 ft above the main lime zone, which is probably the equiv. of the basal Carlsbad (White Lime)—Upper San Andres lime series of the Hobbs field.

M. G. Wilmarth, 1938 (USGS Bull. 896, 78). Subsurf. sand, of Perm. (probably Capitan) age, in Artesia field, Eddy Co., N. Mex.

R. L. Bates, 1942 (N. Mex. Bur. Mines Bull. 18, 181, 188). The topmost memb. of the Queen, the *"Artesia red sand,"* is 40 to 50 ft thick and serves as a local subsurf. marker. The "Artesia red sand," widespread top memb. of the Queen, is about 40 ft thick and carries frosted qtz grains.

Edgar Krauz, 1942 (N. Mex. Bur. Mines Bull. 18, 210). The "Artesia red sand" zone, used as a marker in the oil fields of Eddy Co. and easily traced into NW. Lea Co., is represented in the Eunice section by red and gray sands in the Queen, but it is neither uniform nor definite enough to serve as a marker.

J. A. Barnett, 1942 (N. Mex. Bur. Mines Bull. 18, 243). The upper memb. of the Queen fm. is the so-called "Red Sand," which varies from 20 to 45 ft in thickness. The sand is of reddish color, and is in part fairly well cemented with calcareous material; and in places it lies above, below, or between layers of gray sand a few ft thick. Nine oil wells in the southern part of the field and 2 gas wells along the northeastern edge have been completed in the "Red Sand" as commercial producers.

T. S. Jones, 1953 (Strat. of the Perm. Basin of W. Tex., 39). The upper part of the Queen fm. is in most places sand with numerous, large, frosted grains, known in Eddy Co. as the "Artesia red sand."

Type locality: Not designated.

Name: From Artesia oil field, Eddy Co.

Atokan.

A time term used by some geologists to cover the epoch during which the Atoka series (Middle Penn.) was deposited.

***Atoka series.**

Pennsylvanian (Middle): Midcontinent region only.

R. C. Spivey and T. G. Roberts, 1946 (AAPG Bull., v. 30, 181-186), proposed the use of the term *Atoka series* for Middle Penn. beds in central Tex., from the top of the Wapanucka ls., Morrow series, to the base of the Hartshorne ss., Des Moines series. The name is derived from the Atoka fm., Okla., which is raised to series rank. The Atoka series in central Tex. is made up of the Smithwick and Marble Falls fms. (Lampasas series of Cheney, 1940).

R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302), include *Atokan* stage in their Middle Penn. Oklan series. Sediments of Derry age included in Atoka fm. of Okla. (Thompson, 1942, p. 28).

Atrasado member (of Madera formation).

Pennsylvanian (Missourian-Virgilian): North central New Mexico (Lucero uplift area).

V. C. Kelley and G. H. Wood, 1946 (USGS Oil and Gas Inv. Prelim. Map 47). *Atrasado memb.*—500 to 750 ft of medium-gray thin-bedded shaly ls. with a few massive beds, interbedded with thick gray shs. Differs from Gray Mesa memb. in having greater proportion of sh., somewhat more ss. and red beds, and far less chert in the ls. Lies conf. on Gray Mesa memb.; conf. overlain by Red Tanks memb.

C. B. Read and G. H. Wood, 1947 (Jour. Geol., v. 55, 229-235). Fauna of *Atrasado memb.* of Madera fm. in Lucero uplift area includes *Fusulina, Prismopora,* and *Triticites.* The highest beds of this memb. are probably of Virgilian age, and the memb. is Missourian-Virgilian in age.

Type locality: Lucero uplift; no type section designated.

Name: From Atrasado Arroyo, Lucero uplift.

‡Augur limestone member (of Lake Valley formation).

A name applied by geologists of mining companies, in their company reports, to basal 100 ft of Lake Valley ls. (Miss.) in Santa Rita dist., SW. New Mexico.

Azotea tongue (of Carlsbad limestone).

Permian (Guadalupian): Southeastern New Mexico (Pecos Valley).

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). The part of Carlsbad ls. that caps western Azotea Mesa and overlies Seven Rivers gypsif. memb. of Chalk Bluff fm. is here named *Azotea tongue.*

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14), define *Carlsbad ls.* as the thin-bedded lagoonal facies of the massive Capitan reef ls.

R. K. DeFord, N. H. Wills, and G. D. Riggs, 1940 (W. Tex. Geol. Soc. 1940 Road-log, Eddy Co., N. Mex., mimeographed), state that on the above definition of *Carlsbad ls., Azotea tongue* of Lang must be included as upper ls. memb. of *Seven Rivers fm.* [In spite of this statement, Azotea tongue is still recognized as a separate unit by many geologists.]

Type locality: Not designated.

Name: From Azotea Mesa, Eddy Co.

‡†Badito quartzite member (of Hopewell series).

Precambrian: Central northern New Mexico (Picuris Range).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 21). *Badito qtzite memb.*—Bluish-gray qtzite, locally converted to qtz-muscovite schist. Thickness not given.

Cgl. memb. of Montgomery's (N. Mex. Bur. Mines Bull. 30, 21-24, 1953) *Vadito fm.* is the same lithic unit as Just's *Badito qtzite memb. of Hopewell series.*

Type locality: Not designated.

Name: Derivation not given; presumably from town of Badito (Vadito), Taos Co.

Bar B formation.

Pennsylvanian (upper Missourian-Virgilian): South central New Mexico (Caballo Mountains).

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 93-94). *Bar B fm.*—339 ft dominantly thin-bedded ls. and sh. in alternating thin intervals. About 80 percent sh. Both cherty and noncherty ls. present. The chert is weathered to tan or yellowish brown. Bryozoans very abund. Uppermost beds intercalated with reddish-brown siltstone, ls. cgl., and calc. ss. through an un-

even strat. interval of about 50 ft. Upper contact placed at top uppermost marine ls. in this transition zone. Part or all of this transition zone may be of Permian age. Lies conf. on Nakaye fm.; conf. overlain by Abo fm.

M. L. Thompson and F. E. Kottlowski, 1955 (NMGS Guidebook, 6th Field Conf., 73), state that uppermost beds of *Bar B fm.* may be an equiv. of Bursum fm. (Permian).

Type locality and section: South Ridge, Caballo Mtns., secs. 10, 11, 12, T. 15 S., R. 5 W.

Name: From Bar B Draw, Caballo Mtns.

Bat Cave formation. (Of El Paso group.)

Ordovician (Canadian): Southern New Mexico.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 45-52). *Bat Cave fm.*—Composed of two principal divisions of about equal thickness at the type section. The lower unit is slope forming and light colored, and contains many biostromes and bioherms distributed irregularly in thin- to medium-bedded ls. Surrounding and interspersed with the stromatolitic masses is much gray, bluish-gray, and tannish-gray detrital ls. The upper unit shows a typical banded outcrop. It consists of medium- to thick-bedded alternating dark-gray and medium-gray ls., dolo. ls., and some dol. Most of the beds are very fine grained and dense, and when broken, yield a faint fetid odor. Beds of calcarenite or calcirudite commonly are intercalated with the normal autochthonous ls. Cherty beds are occasionally present. The chert weathers light brown to dark brown and occurs as nodules or bands. The topmost beds locally may contain areas of collapse breccia. Thickness 216 to 305 ft in the Caballo Mtns. Lies conf. on Sierrite ls.; unconf. overlain by Cable Canyon ss.

Type locality and section: N. side of Cable Canyon, Caballo Mtns., sec. 10, T. 16 S., R. 4 W.

Name: From Bat Cave, in Cable Canyon.

Beeman formation.

Pennsylvanian (Missourian): Southeastern New Mexico (Sacramento Mountains).

L. C. Pray, 1952 (Calif. Inst. Tech., Ph. D. dissertation, 201-207). *Beeman fm.*—Largely thin-bedded argil. ls. and calc. sh. Green-gray feldspathic ss. locally abund. Weathers to gray-brown slope. Base marked by 3-ft bed finely crystalline dol. Sss. in Beeman fm. more feldspathic than in underlying Gobbler fm. (Penn.). In lower third of fm. sss. increase in thickness and number of beds to E. Lss. are brown gray to dark gray, very argil., in beds a few in. to 2 ft thick, alternating with beds of brown, gray, and green calc. sh. Some lss. are dolo. In upper two-thirds of fm., ls. beds thicken and become less argil. to E., and sh. beds decrease. Thin layers of red shs. and ls. cgls. commonly are interbedded with the massive ls. in strata in E., but are rare to W. Thickness 350 to 450 ft. Conf. on Gobbler fm.; conf. overlain by Holder fm. (Penn.) or unconf. overlain by Abo fm. (Perm.).

L. C. Pray, 1954 (NMGS Guidebook, 5th Field Conf., 93), indicated *Beeman fm.* on a stratigraphic chart as a manuscript name. It was described as 0 to 500 ft of sh., argil. ls., and feldspathic ss.

Type section: NW¼NE¼NE¼ sec. 15, T. 17 S., R. 10 E., and NW¼NW¼ sec. 14, T. 17 S., R. 10 E., in Sacramento Mtns.

Name: From Beeman Canyon, secs. 3 and 4, T. 16 S., R. 10 E., in Sacramento Mtns.

‡Bella shale.

Upper Devonian: Southwestern New Mexico (Sierra County).

C. R. Keyes, 1908 (AIME Bull. 19, 7-21). *Bella shs.*—Green shs., 60 ft thick, underlying Berenda ls. and overlying Silver shs. No recognizable fossils. Assigned to Dev.

M. G. Wilmarth, 1938 (USGS Bull. 896, 151). Appears to be upper part of Percha sh.

Type locality: Not designated.

Name: From Bella mine, near Lake Valley.

Bell Canyon formation.

Permian (Guadalupian): Western Texas and southeastern New Mexico (Permian Basin).

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Bell Canyon fm.*—Fine-grained sss., thin-bedded and massive. Contains interbedded persistent lss., named, from base upward, Hegler, Pinery, Rader, and Lamar.

P. B. King, 1948 (USGS Prof. Paper 215, 53-59). *Bell Canyon fm.*—670 to 1050 ft of very fine-grained buff sss., with interlayered persistent ls. membs. Sss. may be thin bedded, platy, or massive. Each of the ls. membs. is underlain by 50 or 100 ft of very massive ss; most are overlain by platy ss. Four ls. membs. are distinguished in Bell Canyon fm. Hegler, Pinery, and Rader membs. are closely spaced in lower fourth of the unit and are separated by several hundred ft of ss. from Lamar memb., which lies near its top. In addition, a thin ls. bed about halfway btw. the Rader and Lamar membs. has been mapped but not named, being designated merely as "flaggy ls. bed." The ls. membs. are thinner but more persistent than those in the Cherry Canyon fm. and are separated by sss. containing few calc. beds. In the Delaware Mtns., the membs. are each 10 or 25 ft thick, dark gray to black, fine grained, and mostly thin bedded; they contain few fossils. Nearer the Capitan ls. reef, each ls. memb. thickens to 50 or 100 ft and becomes lighter gray, thicker bedded, and more fossilif. In the Guadalupe Mtns., the fm. intergrades with the reef mass of the Capitan ls., the change taking place farther SE. in the upper than in the lower part. Lies conf. on Cherry Canyon fm.

Type locality: Bell Canyon, Guadalupe Mtns., Texas.

Name: From Bell Canyon, Guadalupe Mtns.

*Bend group (Pennsylvanian).

Bend series.

(Pennsylvanian and Mississippian): Central Texas.

Term was used by many geologists in central and western Texas and southeastern New Mexico to indicate those strata which are of the same age as the Lower Penn. Bend series of central Texas.

Bendian.

A time term used by some geologists to cover the epoch during which the Lower Penn. Bend series was deposited.

Berenda limestone.

Mississippian: Southwestern New Mexico.

C. R. Keyes, 1906 (Jour. Geol., v. 14, 154), applied *Berenda lss.* to lss. said to underlie Lake Valley ls. in New Mexico.

C. R. Keyes, 1908 (AIME Bull. 19, 7-10). *Berenda ls.*—Nodular lss., 50 ft thick, consisting of (descending): (1) 10 ft of bluish thinly bedded cherty ls.; (2) 30 ft of gray thinly bedded ls.; (3) 10 ft of massive compact ls. Underlies Grande ls. and overlies Bella sh.

M. G. Wilmarth, 1938 (USGS Bull. 896, 165). In several subsequent reports, Keyes assigned his Berenda ls. to Dev. and correlated it with Martin ls. of Ariz.

Type locality: Not designated.

Name: Probably(?) from Berenda Valley.

Berino member (of Magdalena group).

Pennsylvanian (Lower?): Central southern New Mexico and extreme western Texas (Franklin Mountains).

L. A. Nelson, 1940 (AAPG Bull., v. 24, 116-171). *Berino memb.*—550 ft fine-grained drak-gray to black lss., thick- to thin-bedded, with 45 ft of sh. at top and a 42-ft massive cherty gray ls. unit at base. The top sh. and the basal ls. units form distinctive topographic breaks in the section of Penn. rocks in the Franklin Mtns. area. Conf. overlain by Bishop's Cap memb.; lies conf. on La Tuna memb.

Type locality and section: Franklin Mtns., opposite Vinton, Texas.

Name: From town of Berino, New Mexico, on A. T. & S. F. Ry.

Bernal formation.

Permian (Guadalupian?): Central northern New Mexico.

G. O. Bachman, 1953 (USGS Oil and Gas Inv. Map 137). *Bernal fm.*—In central N. Mex., the San Andres fm. has in the past been considered to contain 3 membs. (in ascending order): Glorieta ss. memb., ls. memb., and upper clastic memb. However, the upper clastic memb. is recognized now as a separate fm. and is here named *Bernal fm.* Bernal fm., as here defined, consists of brownish-red siltstone and fine-grained ss. Many of the pods and irregularly shaped bodies within the fm. are leached to gray. In southern part of area, contains 1-ft ss. bed, which is reworked Glorieta. Aver. thickness 100 ft; overall thickness 0 to 126 ft. Lies disconf. on Glorieta memb. of San Andres fm.; disconf. overlain by Triassic. Believed to correlate with Chalk Bluff fm. (Guadalupian).

Type locality: Not designated.

Name: From village of Bernal, Mora Co.

‡†Bernalillan (Bernallian) series.

Permian: New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 3, 5). *Bernalillan series.*—A term originally proposed for the Mid Carbonic red beds below the Cimarronian series.

Type locality: Not designated.

Name: From Bernalillo Co.

‡Bernalillo shale.

Permian: Central northern New Mexico.

C. R. Keyes, 1903 (Ores and Met., v. 12, 48). The Permo-Carbf. of N. Mex. consists of a series of red shs. and sss. called *Bernalillo shs.* in Sandia Mtns. Younger than Coyote ss.

C. R. Keyes, 1903 (Rpt. Gov. N. Mex. to U. S. Sec. Interior, 337-341), gave thickness of Bernalillo terrane as 1,000 ft.

C. R. Keyes, 1922 (Pan-Am. Geol., v. 37, 426). The so-called Bernalillo shs. comprise Abo red beds and Yeso pink beds.

Type locality: Not designated.

Name: From Bernalillo Co.

Bishop's Cap member (of Magdalena group).

Pennsylvanian (Middle): Central-southern New Mexico and extreme western Texas (Franklin Mtns.).

L. A. Nelson, 1940 (AAPG Bull., v. 24, 116-171). *Bishop's Cap memb.*—Lss., gray to dark-gray, fine- to coarse-grained, thick-bedded, with minor sh., cgl., and ss. near the base. Base placed at top of 45-ft sh. interval in underlying Berino memb. Lies conf. on Berino memb.; unconf. overlain by alluvium. Thickness 600 to 650 ft.

Type locality and section: Franklin Mtns., opposite Vinton, Texas.

Name: From Bishop's Cap Peak, opposite Fillmore, New Mexico.

Bliss sandstone (formation).

Upper Cambrian and Lower Ordovician: Western Texas and southern New Mexico.

G. B. Richardson, 1904 (Tex. Univ. Min. Surv. Bull. 9, 27). *Bliss ss.*—Massive compact fine-textured fossilif. gray ss., about 300 ft thick, varying from almost white to brown; toward top locally crossbedded, and some of beds hard. Overlies coarse red granite; unconf. underlies El Paso ls. (Ord.)

V. C. Kelley, 1949 (N. Mex. Univ. Pub., geol. ser., n. 2), reports the presence of beds of oölitic iron ore in the Bliss ss. of New Mexico.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4), propose changing the name *Bliss ss.* to *Bliss fm.*, because of the diverse lithology of the unit.

R. H. Flower, 1953 (AAPG Bull. 3, v. 37, 2054-2055). In central N. Mex. the Bliss ss. is Upper Camb. and Lower Ord. The base of the Bliss ss. is middle Franconian (U. Camb.), and its top extends into basal Ord. It may be either Camb. or Ord., or both, at any given locality. It represents a period of slow, intermittent deposition of sandy material.

R. H. Flower, 1955 (NMGS Guidebook, 6th Field Conf., 65-66). Trempealeauan (latest Upper Camb.) is absent in N. Mex. or adjacent parts of western Tex. Ord. deposition begins with a characteristic and easily recognizable crossbedded coarse-grained ss. The beds above are thinly laminated and essentially the same type of deposition as in the lower El Paso beds. The Bliss-El Paso contact in central N. Mex. is gradational, marked by a decrease, and finally the disappearance, of sand and glauconite in the sediments. There is probably some slight local variation in the exact horizon at which the transition occurs. The 225 ft of the type section of the Bliss ss. (Franklin Mtns.) appears to be completely Ord. and is separated from the overlying dolomites of the El Paso by a zone with large, sparsely scattered foreign pebbles.

Type locality: S. end of Franklin Mtns., El Paso, Texas.

Name: From Fort Bliss, El Paso Co., Texas.

Blue Springs schist.

Precambrian: Central New Mexico (Los Pinos and Manzano Mountains).

J. T. Stark and E. C. Dapples, 1946 (GSA Bull. v. 57, 1121-1172). *Blue Springs schist.*—A thick series of siltstones, slates, and sericitic schists, which are parallel with the enclosing fms. and appear to rest conf. upon the Sais qtzite and below

the White Ridge qtzite. Thickness ranges from about 300 ft, in N., to nearly 4,000 ft, in S. Massive beds of brittle red and gray slates and siltstones characterize the basal part of the fm. The central part is largely green sericitic schists in which some zones are prominently contorted and crenulated. The schistose beds are intercalated with the more massive slates and aren. siltstones. Many of the beds are spotted with biotite and blobs of granulated white qtz. Near the top of the fm. are beds of dense red and gray aren. slates, which become increasingly schistose as the overlying White Ridge qtzite is approached.

Type locality: A belt extending 10 mi S. from Abo Pass.

Name: From Blue Springs, N. of U. S. Highway 60, on W. side of Los Pinos Mtns.

Bolander group.

Pennsylvanian (Desmoinesian): Central and southern New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 51-55). *Bolander gp.*—Rocks of upper portion of Des Moines series btw. top of Armendaris gp., below and base of Missouri series above. Type section, 233 ft thick, is composed largely of gray to light-gray ls., several beds of fossilif. gray sh., and one well-developed bed of cgl. to highly cgl. ss. about 70 ft below the top of the gp. This cgl. bed marks a distinct unconf. Lies conf. on Armendaris gp.; unconf. overlain by Veredas gp. Fusulinid fauna: *Fusulina, Eoschubertella, Ozawainella(?),* and *Millerella.*

Type locality and section: Whiskey Canyon, Mud Spring Mtns., in S. center sec. 1, T. 13 S., R. 5 W.

Name: From deserted village of Bolander, 8 mi NE. of Mud Springs Mtns.

‡†Bone Canyon limestone (member).

Permian (Leonardian): Western Texas and southeastern New Mexico.

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 921, 922, 925). *Bone Canyon memb.*—Black ls. containing fossils of Leonard age, unconf. underlying Delaware Mtn. ss. (restriction of name) in Bone Canyon, on W. side of Guadalupe Mtns. A short distance N. of Bone Canyon, a wedge of gray ls. (here named *Victorio Peak memb. of Leonard fm.*) appears beneath the unconf. at base of Delaware Mtn. ss. and separates Bone Canyon memb. from that ss. Thickness 500 to 1,000 ft. Conf. overlies 500 ft of massive ls. containing rich Hess fauna.

See *Bone Spring ls.*, the approved name.

Bone Spring limestone.

Permian (Leonardian): Western Texas and southeastern New Mexico.

W. G. Blanchard, Jr. and M. J. Davis, 1929 (AAPG Bull., v. 13, 962, pl. 10, 11). The basal dark ls. series in the Guadalupe and Delaware Mtns. is here designated *Bone Spring ls.*, although its correlatives elsewhere will continue to be called *Leonard fm.* The series will not be included here in Delaware Mtn. fm., because of faunal difference, lithologic dissimilarities, and angular unconf. that separates the two. Upper part is gray ls., lower part is black ls. Crossbedding is noticeable at many points in both black and gray phases along Guadalupe scarp. North of Bone Springs Canyon, a mass of hard gray hackly ls., which evidently has been removed at Bone Springs Canyon, comes into the series. It lies conf. on top of the black ls. The gray and black phases seem to grade into each other from point to point. Total thickness exposed in Guadalupe Mtns. 1,600± ft. From Guadalupe Point the Bone Springs ls. has been traced S. along

W. base of Delaware Mtns. for approx. 25 mi. Correlated with Leonard fm. of Glass Mtns., on similarity of fossils and lithology.

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 921-922, 924, 925), treated this ls. as basal memb. of Delaware Mtn. fm. and named it *Bone Canyon memb.* (See under *Delaware Mtn. fm.*)

P. B. King, 1934 (GSA Bull., v. 45, 731, 755-768), redefined *Bone Springs ls.* by including, at top, Victorio Peak massive memb., and changed name to *Bone Spring ls.*, because there is only one spring present in Bone Canyon, although the place is locally called Bone Springs. (This is present approved usage of USGS.) The Bone Spring ls. was included by Richardson as a memb. in Delaware Mtn. fm., but the unit has a greater extent and thickness than was originally supposed, and the faunas, as first pointed out by Girty, are not entirely like those of the beds above, so that it is now generally recognized as a distinct fm.; in present paper the name is given the broader usage of Blanchard and Davis and applied to lss. of various sorts, of same general age and strat. position.

M. G. Wilmarth, 1938 (USGS Bull. 896, 233-234). These beds were included in Delaware Mtn. fm. as originally defined and subsequently used, but they are now treated as a distinct fm., underlying (in places unconf.) Delaware Mtn. fm. and equiv. to Leonard fm.

P. B. King, 1948 (USGS Prof. Paper 215, 13-27). *Bone Spring ls.* is composed almost entirely of ls. beds, as contrasted with the dominantly sandy strata of Delaware Mtn. gp., which overlies it. In Delaware Mtns., and extending as far N. as Bone Canyon, the exposed parts of the fm. are black cherty ls. in thin beds, with partings and a few membs. of shaly ls. and silic. sh. N. of Bone Canyon, in the Guadalupe Mtns., upper part of black ls. is replaced by a thick-bedded gray ls., the *Victorio Peak gray memb.*, which also forms the capping stratum of the Sierra Diablo. Btw. the main mass of lss. and the sss. of the Delaware Mtn. gp. is a small thickness of interbedded ls. and sh., which forms the *Cutoff shaly memb.* and its probable equivalents. Thickness several thousand ft; thicker to S., where it may be 4,500 ft thick.

Type locality: Bone Springs Canyon, sec. 2, Blk. 66, NW. part of Culberson Co., Texas.

Name: Renamed Bone Spring Canyon, as there is only one spring in the canyon.

‡†Bone Springs limestone.

See *Bone Spring ls.*, the approved name.

Box member (of Percha shale).

Upper Devonian: Southwestern New Mexico (Mimbres Mountains).

F. V. Stevenson, 1945 (Jour. Geol., v. 53, 217-245). *Box memb.*—The Percha is divided into Ready Pay memb. (lower) and Box memb. (upper). The Box memb. is composed of green to gray calc. shs., with intercalated lenses and nodules of ls. The unit becomes progressively more calc. to the west of Hillsboro; on Bear Mtn., NW. of Silver City, interbedded in the sh. are many massive beds of ls., one attaining a max. of 16 ft. This contrasts strongly with the scattered ls. nodules found in the Box memb. in the region of Hillsboro and Lake Valley. The memb., which has not been recognized outside of the Mimbres region, carries the entire Percha fauna. The lower contact grades without marked break into the Ready Pay memb.; upper contact unconf. with overlying Miss. fms. Equiv. to Ouray ls. of Colo. Thickness at type loc. 46.6 ft.

Type locality and section: SW¼SW¼SE¼ sec. 14, T. 16 S., R. 7 W., Sierra Co., New Mexico.

Name: From "The Box," 2½ mi SE. of Hillsboro, on Percha Creek.

‡†Brazos series.

Late Permian and Triassic: Texas, Oklahoma, southern Kansas, and eastern New Mexico.

R. T. Hill, 1901 (USGS 21st Ann. Rpt., pt. 7, 100-103). *Brazos series.*—All rocks of Tex., Okla., Kans., and eastern N. Mex. btw. top of conformable Coleman div. (now known to be approx. same as Wichita) of Permo-Carbf. beds below the base of Cret. above. Consists of red clays, sss., occasional impure ls., some cgl., and great beds of gyp. (Also called "Red Beds" and "Permo-Triassic Red Beds.") Includes Wichita (then supposed to be older than Coleman div.), Clear Fork, Double Mtn., and Dockum fms.

Name: From Brazos River, central northern Texas.

*Bromide formation. (Of Simpson group.)

Middle Ordovician: Central and southern Oklahoma (Arbuckle Mountains); subsurface of western Texas and southeastern New Mexico (Permian Basin).

E. O. Ulrich, 1911 (GSA Bull., v. 22, pl. 27), showed a new fm., called *Bromide*, of Black River and uppermost Chazy age, as overlying, in places unconf., the Simpson fm. and unconf. underlying Viola ls., in Arbuckle Mtns., Okla., the type region of the Simpson and the Viola. As originally defined and used up to this time, the Viola rested on the Simpson.

E. O. Ulrich, 1927 (Okla. Geol. Surv. Bull. 45, 21-32). Simpson fm. of Taff comprises at least 3 faunas of exceedingly diverse origin and geographic distribution. None of these faunas, nor any beds that might contain them, are found in southern Mo. or Ark. The closing stage, provisionally added to top of *Bromide div.* of Simpson, contains a good representative of Decorah and Prosser faunas of Minn. (Black River and lower Trenton). *Typical Bromide* is of late Chazy age (and is shown as constituting topmost part of Simpson fm.).

F. C. Edson, 1927 (AAPG Bull., v. 11, 967-975). Simpson fm. divided into *Bromide group* (above) and "Wilcox" sand (below). The Bromide is a series of mag. limes and sands, in places interbedded with small amounts of green sh. Thickness 315 to 495 ft, in Arbuckle Mtns.; 0 to 600 ft, in Midcontinent field. The descriptive term "post-Wilcox" was applied to these beds by Luther White to indicate that part of Simpson fm. which is younger than "Wilcox" sand. Ulrich (1911) classified Bromide fm., as occurring btw. Simpson fm. and Viola ls. Taff mapped type loc. of Bromide fm., near Bromide, sec. 19, T. 1 S., R. 8 E., as *lower Viola ls.* This outcrop is made up of sediments that in every way resemble the "post-Wilcox" well cuttings. It is suggested that the term "post-Wilcox" be dropped and that *Bromide* be retained to designate the group of sediments that occur btw. "Wilcox" sand and Viola lime.

E. O. Ulrich, 1929 (letter dated Nov. 11, 1929, published by C. E. Decker in Okla. Geol. Surv. Bull. 55, 40, 1931). As used by Ulrich in past 2 yr, the Bromide includes all beds of Black River and Trenton ages that were deposited in Arbuckle region.

F. C. Edson, July 1930 (AAPG Bull., v. 14, 947). *Bromide fm.* is overlain, with angular unconf., by Viola ls.; underlain, with angular unconf., by Tulip Creek fm.

C. E. Decker, Dec. 1930 (AAPG Bull., v. 14, 1948-1505). *Bromide fm.*—Chiefly lss. and some sh.; some ss., with a ss. of variable thickness at base. Thickness of fm. 171 to 600± ft. Of Trenton and Black River age. Overlies Tulip Creek fm. and underlies Viola ls. As *Bromide* has been used more extensively in connection with Simpson, it seems best to retain it for the upper fm. and drop Criner.

C. E. Decker and C. A. Merrit, 1931 (Okla. Geol. Surv. Bull. 55, 11-12, 98). The *Simpson* is here raised to a gp., divided into 5 fms. (ascending): Joins, Oil Creek,

McLish, Tulip Creek, and Bromide. Heretofore *Bromide*, in various tables, has been used to represent a number of different horizons, but its last use limits it to the upper part of the section exposed in hill just W. of the hotel at Bromide, and it was thought that the fauna represented in this section was younger than that found in upper part of Simpson elsewhere. Further studies of a section above the 3 artesian wells at NE. edge of Bromide, and of sections on Robertson ranch about 3 mi S. of Bromide, have contributed evidence to show that certain parts of fauna, and the physical characteristics of upper part of the Simpson at E. end of mtns., are almost identical with those of upper part of Simpson in most of its outcrops.

E. O. Ulrich, 1933 (GSA Bull., v. 44, 105). *Bromide fm.* included in Simpson gp. Typical Bromide correlates with Lowville.

C. E. Decker, 1941 (AAPG Bull., v. 25, 650-667), presents new sections of the Simpson gp. The *Bromide fm.* is described as consisting of lss., shs., and sss. Lss. occur at the top, shs. alternate with lss. in the middle, and shs. separate the sss. at the base. The lss. are brown, gray, and yellowish; shs., green; and sss., brown and white. Thickness in Okla. 128-675 ft. Correlated by graptolites with Plateville of Wis.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038). Since, on paleontological grounds, all the formational units of the Okla.-type Simpson can be shown to be represented in the subsurf. of western Tex., and since the gp. in western Tex. can also be subdivided on lithologic grounds, not in conflict with the former, it is proposed that the Okla. formational names be applied to the recognized subdivs. of the subsurf. Simpson.

Type locality and section: Near Bromide, Johnston Co., Oklahoma, sec. 19, T. 1 S., R. 8 E.

Name: From the town of Bromide, Johnston Co., Oklahoma, where type section is on a hill NW of Galbraith Hotel.

Brushy Canyon formation. (Of Delaware Mountain group.)

Permian (Guadalupian): Western Texas and southeastern New Mexico.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Brushy Canyon fm.*—Basal memb. of Delaware Mtn. gp. Consists of fine- to coarse-grained sss., many ripple-marked. 0 to 1000 ft thick. Locally cgl. at base. Lies conf. on Bone Spring ls.; conf. overlain by Bell Canyon fm. Laps out to the N.

P. B. King, 1948 (USGS Prof. Paper 215). *Brushy Canyon fm.* rests on Cutoff shaly memb. of Bone Spring ls. Its top is formed by a persistent, massive ss. ledge that is nearly continuous throughout the area. Thickness 1,000 to 1,152 ft. Consists largely of ss., a part of which, coarser grained than the rest, stands out in massive yellow or brown ledges or forms the caps of flat-topped mesas. Btw. the massive sss. are fine-grained, thin-bedded, or even shaly sss., which crop out on slopes. Almost every bedding plane is ripple marked. Locally unconf. on Bone Spring ls.

Type locality: The total thickness of the fm. is exposed along Brushy Canyon, which drains W. across the Delaware Mtn. escarpment a short distance S. of U. S. Highway 62.

Name: From Brushy Canyon, Delaware Mtns., Culberson Co., Texas.

Bruton formation. (Of Fresnal group.)

Pennsylvanian (Virgilian): Central and southern New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 79-82). *Bruton fm.*—Red shs., arkosic sss. and conglomerates, with light-gray to greenish-gray interbedded nodular to irregularly bedded lss. Thickness 113 ft at type loc. Fm. is basal

member of Fresnal gp., which is otherwise undiff. At type loc. lies conf. on Moya fm. (Penn.); unconf.(?) overlain by Perm. lss. (Bursum fm.).

Type locality and section: NE. side of Oscura Mtns., in SE¼ sec. 32, T. 5 S., R. 6 E., Socorro Co.

Name: From Bruton tank, on NE. side of Oscura Mtns.

Bug Scuffle limestone member (of Gobbler formation).

Pennsylvanian (Atokan, Desmoinesian, and lower Missourian): Southeastern New Mexico (Sacramento Mountains).

L. C. Pray, 1952 (Calif. Inst. Tech., Ph. D. dissertation, 193-200). *Bug Scuffle ls. memb.*—Upper massive cliff-forming lss. of *Gobbler fm.* Predom. light-gray sublithographic to very finely crystalline very pure ls., with interbedded and gradationally interfingering clastic beds. Clastic beds largely sh., ss., siltstone, and clastic ls. Light-gray chert nodules common. Thickness 0 to 1,200 ft. Intergradational with lower part Gobbler fm.; conf. overlain by Beeman fm. (Penn.).

L. C. Pray, 1954 (NMGS Guidebook, 5th Field Conf., 93), indicated *Bug Scuffle ls. memb.* on a stratigraphic chart as a manuscript name.

Type locality and section: NW¼NE¼NW¼ sec. 15, T. 17 S., R. 10 E., Sacramento Mtns.

Name: From Bug Scuffle Hill, sec. 15, T. 19 S., R. 11 E., Sacramento Mtns.

Burrego formation. (Of Hansonburg group.)

Pennsylvanian (Missourian): Central and southern New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 64-65). *Burrego fm.*—At type loc. 52 ft of massive to massively bedded and nodular gray lss., with a few thin beds of purple or orange ls. Becomes more clastic to N. and S. Type section (ascending): (1) ls., light-gray, fine-grained and dense, glistening, irregularly bedded, 5 ft; (2) ls., crinoidal, weathers like sand, abund. fusulinids, 5 ft; (3) ls., gray, highly algal, massively bedded, 8 ft; (4) ls., gray, highly nodular, algal, 4 ft; (5) ls., purple, highly crinoidal, weathers like sand, 2.5 ft; (6) ls., nodular to irregular beds, gray, highly algal, highly cherty, brachiopods abund., 7.5 ft; (7) ls., algal, gray, massively bedded, forms ledge, 8 ft; (8) ls., nodular, bluish-gray, 5 ft; (9) ls., gray, nodular at base, algal at top, 5 ft; (10) ls., gray, nodular at base, algal at top, 2 ft. Lies conf. on Council Spring ls.; conf. overlain by Story fm.

Type locality and section: NE. side of Oscura Mtns., in SE¼ sec. 31, T. 5 S., R. 6 E., Socorro Co.

Name: From Burrego Spring, NE. side of Oscura Mtns.

‡Burro quartzites.

Cambrian (Middle): Southwestern New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 5). *Burro qtzites.*—Main body of the Mid Cambric qtzites which immediately overlie the Chloridian series of lss. near Silver City.

Type locality: Not designated.

Name: Derivation not indicated.

Bursum formation.

Permian (Wolfcampian): Central and southeastern New Mexico.

R. H. Wilpolt et al., 1946 (USGS Oil and Gas Inv. Prelim. Map 61). *Bursum fm.*—Consists of dark purplish-red and green sh. in beds up to 40 ft thick, separated

by thinner beds of arkose, arkosic cgl., and gray ls. A thin rubbly nodular purplish-gray ls., consisting of reworked ls. of the underlying arkosic memb. of the Madera fm. occurs locally at base. The ls. beds above, which are 1 to 6 ft thick, carry marine invertebrates. The fusulinid *Schwagerina,* in association with very obese *Triticites ventricosus,* has been collected from several localities. The Bursum fm. ranges from 28 to 234 ft in thickness. As shown by the fusulinids, the Bursum fm. is of Wolfcamp age.

R. L. Bates et al., 1947 (N. Mex. Bur. Mines Bull. 26, 23-26), give measured section of *Bursum fm.*

E. R. Lloyd, 1949 (N. Mex. Bur. Mines Bull. 29, 32-34). The name *Bursum fm.* is preferred to several other names given the same beds by different authors, but it is unfortunate that the only adequate descriptions of the fm. were from areas nearly 40 mi N. of the type loc.

Type section: NE¼ sec. 14, T. 2 N., R. 4 E., Socorro Co. (as designated by Lloyd).

Name: From Bursum Triangulation station, SE¼ sec. 1, T. 6 S., R. 4 E., Socorro Co.

Caballero formation.

Mississippian (Kinderhookian): South central New Mexico.

L. R. Laudon and A. L. Bowsher, 1941 (AAPG Bull., v. 25, 2114, 2116-2125). *Caballero fm.*—Soft gray silty ls. beds that weather to rounded, nodular, rubbly chunks on fresh exposures. The light dove-gray color of weathered exposures is in itself diagnostic; the very uneven bedding is caused by the nodular nature of the ls. beds; interbedded soft shs. curve around the ls. nodules. The upper portion of the section is distinctly more shaly; the basal ledges may locally form a small cliff. Little chert is present. Thickness 0 to 80 ft (28 to 80 ft in Sacramento Mtns.). Lies unconf. on Dev. strata; unconf. overlain by Lake Valley fm. (Miss.).

Type section: Upper end Deadman Canyon, Sacramento Mtns., in S. center sec. 3, T. 17 S., R. 10 E.

Name: From Caballero Canyon, main tributary of Alamo Canyon, Sacramento Mtns.

Cable Canyon sandstone. (Of Montoya group.)

Upper Ordovician: Southern New Mexico.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 58-59). *Cable Canyon ss.*—Coarse-grained granulitic ss. with dolo. cement. Medium gray when fresh, with angular grains of white, gray, pale-rose, smoky, and blue-gray qtz. Weathered exposures are characteristically rough, with protruding grains, and mottled gray and brown. Characteristic texture is unsorted small-pebble and granule cgl., though some well-sorted medium-grained ss. occurs. Lies unconf. on Bat Cave fm.; overlain conf. and gradationally by Upham dol. Thickness 17-35 ft in Caballo Mtns.

Type locality and section: Cable Canyon, Caballo Mtns., NW¼ sec. 10, T. 16 S., R. 4 W.

Name: From Cable Canyon.

Cabresto metaquartzite.

Precambrian: Central northern New Mexico (Taos Range).

P. F. McKinlay, 1956 (N. Mex. Bur. Mines Bull. 42). *Cabresto metaqtzite.*—The Cabresto metaqtzite was named from exposures along the S. end of Costilla

quad. Thick ledges of qtzite also are exposed in 7 other localities within Costilla and Latir Peak quads. The qtzite in these areas ranges from 200 to over 1,000 ft in thickness. Exposures are gray to cream and are composed of 2- to 10-ft layers of coarsely crystalline glassy to milky-white qtz, with scattered muscovite flakes. The massive layers are separated by thin muscovite and biotite-magnetite-garnet bands. Locally magnetite grains are arranged in narrow layers, 2 in. to more than 1 ft apart, which parallel the mica layers. Relict structures include outlines of qtzite cobbles and pebbles in the lower part.

Type locality: Along Cabresto Canyon, Taos Range.

Name: From Cabresto Canyon.

Caloso formation.

Mississippian (Kinderhookian): Central New Mexico (Ladron Mountains).

E. A. Noble, 1950 (N. Mex. Univ., unpub. Master's thesis), quoted by V. C. Kelley and C. Silver (N. Mex. Univ. Pub., geol. ser., n. 4, 86-87). *Caloso fm.*— 86 ft of Miss. ls. lithologically similar to Kelly ls. (Miss.).

A. K. Armstrong, 1955 (N. Mex. Bur. Mines Circ. 39, 3, 32). *Caloso fm.*—Upper 35 ft of Noble's Caloso fm. is Kelly fm. Caloso fm. restricted to Kinderhook part of the section. Max. thickness 45 to 50 ft. The lower 20 to 28 ft consists of sss., shales, and thin-bedded fine-grained gray ls. In exposures near the Rio Salado, the basal ss. is arkosic and contains considerable chlorite and feldspar, whereas near Ladron Peak the basal ss. is fine-grained clean white qtz. S. of Navajo Gap the basal ss. is a qtz cgl. with silica cement. The upper 17 to 23 ft consists of massive dark-gray dense to granular ls. containing stringers of chert, 5 to 8 in. thick and 40 to 60 ft long. The chert bands are brown or black and in places very fossilif. Lies unconf. on Precamb.; unconf. overlain by Kelly fm.

Type locality and section: Arroyo Caloso, Ladron Mtns., T. 2 N., R. 2 W.

Name: From Arroyo Caloso.

Canas gypsum member (of Yeso formation).

Permian (Leonardian): Central and southeastern New Mexico.

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1667). *Canas gyp. memb.*—Thick bed of gyp. above middle evaporite memb. of Yeso fm. At most places pure; locally contains thin silt partings or thin ls. beds. Overlain by Joyita ss. memb. Thickness 0 to 115 ft; disappears to N., thickens to S., W., and SE.

Type locality and section: Secs. 4, 5, T. 2 S., R. 2 E., and sec. 33, T. 1 S., R. 2 E., near Mesa del Yeso, Socorro Co.

Name: From Lomo de las Canas, a range of hills 9 mi due E. of town of Socorro.

Canutillo formation.

Middle Devonian: Western Texas (Franklin and Hueco Mountains).

L. A. Nelson, 1940 (AAPG Bull., v. 24, 157-172). *Canutillo fm.*—175 ft of sediments consisting of light-brown cherty ls., immediately overlying the Fusselman (Sil.); a thin bed of fossilif. gray ls.; a thin bed of dense almost black ss., which weathers brown; and about 40 ft of black fissile sh. at the top of the fm. Identified as Middle Dev.

F. V. Stevenson, 1942 (N. Mex. Bur. Mines Bull. 18, 22-24). Although the Canutillo fm. in Tex. is considered to be medial Dev. in age, its fauna and the geol. history of the Southwest indicate that it is more probably early late Dev. The Canutillo

rests unconf. upon the Fusselman ls. of Sil. age. The basal part consists chiefly of massive calc. siltstone. It is overlain by thin beds of varicolored sh. interbedded with massive thick beds of calc. brown siltstone. The shs., which constitute less than 20 percent of the fm., tend to pinch out laterally along the outcrop. The entire fm. is more silic. and massive than the overlying Sly Gap fm. (Dev.). The aver. thickness is btw. 25 and 30 ft. The most complete known exposure, with a thickness of 88 ft, is in San Andres Canyon, in the San Andres Mtns.

F. V. Stevenson, 1945 (Jour. Geol., v. 53, 217-245). The upper 40 ft of black sh. may equal Ready Pay memb. of Percha sh. Beds formerly classed as Canutillo fm. in N. Mex. (N. Mex. Bur. Mines Bull. 18, 1942) are renamed Onate fm.; no Canutillo fm. occurs in N. Mex.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 36), describe the Canutillo fm. as 15 ft of soft thin-bedded gray siltstone lying on 42 ft of very cherty ls., probably Dev. [This is not as described by Nelson. Nelson includes the cherty ls. in the Canutillo fm.]

Type section: Franklin Mtns., opposite Vinton. Most complete section is in San Andres Canyon, San Andres Mtns. (Stevenson).

Name: From town of Canutillo, on A.T.&S.F. Ry., 13 mi N. of El Paso.

Canyon.

A time term used by many geologists in central and western Texas and New Mexico to cover the epoch during which the Canyon series (Upper Penn.) was deposited. Same time connotation as Missourian.

Canyon series.

Term used by many geologists in central and western Texas and New Mexico to indicate those strata which are of the same age as the Upper Penn. Canyon series of north central Texas (as redefined by M. G. Cheney, AAPG Bull., v. 24, 65-118, 1940). This series is equiv. to Missouri series of midcontinent region.

Capitan limestone. (Of Guadalupe group.)

Permian (Guadalupian): Western Texas and southeastern New Mexico.

G. B. Richardson, 1904 (Tex. Univ. Min. Surv. Bull. 9, 41). *Capitan ls.*—Massive white ls., 0 to 1,800 or more ft thick. Conf. overlies Delaware Mtn. fm. in Guadalupe Mtns. Top not seen but believed to underlie Castile gyp. unconf.

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 925, etc.), extended Capitan ls. into eastern Glass Mtns. and included in it the Tessey, Gilliam, and Vidrio deposits.

R. C. Moore, 1933 (Historical Geol., 325), called the Capitan ls. in Glass Mtns. the *Glass Mtns. fm.*, a name (preoccupied) proposed by P. B. King.

P. B. King, 1934 (Am. Jour. Sci., 5th ser., v. 45, 736). *Glass Mtns. fm.* abandoned (preoccupied), and *Capitan ls.* applied in Glass Mtns. to include (descending): on E. side of Mtns., Tessey massive memb., Gilliam thin-bedded memb., and Vidrio massive memb.; and, in lower part of Capitan ls. on W. side of Glass Mtns., the Altuda shaly memb. (equiv. to lower part of Vidrio memb.).

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). In Pecos Valley of SE. N. Mex., the nonbedded Capitan ls. of reef zone grades laterally into Carlsbad ls. and is in places overlain by a thin wedge of Carlsbad; in other places it grades laterally into the Carlsbad ls. (here treated as a distinct fm.). It also grades laterally into upper part of Delaware Mtn. fm. of forereef zone.

P. B. King, 1937 (USGS Prof. Paper 187), treated Tessey ls. as a distinct fm., instead of including it in Capitan ls. This is present adopted definition of USGS.

M. G. Wilmarth, 1938 (USGS Bull. 896, 343). Upper fm. of Guadalupe group. According to N. H. Darton and J. B. Reeside, Jr. (GSA Bull., v. 37, 420, 1926),

the Castile gyp. unconf. overlies Capitan ls. K. H. Crandall (AAPG Bull., v. 13, 941-943, 1929), R. E. King (Tex. Univ. Bull. 3042, 13, 1931), W. B. Lang (AAPG Bull., v. 19, 1935), and other geologists are also now satisfied that: (1) Castile gyp. is younger than Capitan ls. (although there is diversity of opinion regarding the unconf.); (2) typical Delaware Mtn. fm. of Delaware Mtns. includes in its upper part the time equiv. of Capitan ls.; and (3) the beds underlying Capitan ls., and called Delaware Mtn. fm. in Guadalupe Mtns., are equiv. only to lower part of Delaware Mtn. fm. of Delaware Mtns.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14), restrict Capitan ls. to massive reef facies.

P. B. King, 1948 (USGS Prof. Paper 215, 59-62). *Capitan ls.*—1,000 to 2,700 ft of compact light-gray cream-colored or white calcitic ls., which breaks under the hammer into splinters of conchoidal chips. Associated with the calcitic lss. are gray or buff finely crystalline dolo. lss. Both the calcitic and dolo. lss. are irregularly distributed through the fm. In the main mass of Capitan ls., none of the beds are sandy, and there is no interbedded ss. Capitan ls. consists of beds from 15 to more than 100 ft thick, separated by indistinct bedding planes, and with very few interbedded thinner layers.

Type locality: Exposures on Guadalupe Peak, about 1 mi N. of El Capitan Summit, Texas.

Name: From El Capitan Peak, Culberson Co., Texas.

Carlsbad group (formerly **limestone**).

Permian (Guadalupian): Southeastern New Mexico.

O. E. Meinzer, B. C. Renick, and Kirk Bryan, 1926 (USGS Water-Supply Paper 580A, 12-13 and map), and N. H. Darton, 1926 (GSA Bull., v. 37, 419). *Carlsbad ls. memb. of Chupadera fm.*—Ls. with thin beds of ss. and possibly some rock salt, underlying Castile fm. and overlying Seven Rivers gypsif. memb. of Chupadera fm. According to Darton, it is top memb. of Chupadera fm. and also forms upper part of Capitan ls., which caps El Capitan at S. end of Guadalupe Mtns. in Tex. Thickness 40 to 800 or more ft.

A. G. Fiedler and S. S. Nye, 1932 (USGS Water-Supply Paper 639). *Carlsbad ls. tongue of Capitan ls.*—In Roswell artesian basin, it is almost entirely thin-bedded dolo. ls., 35 to 40 ft thick, but disappears entirely E. of Lakewood. Overlies Seven Rivers tongue of Pecos fm.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). Further studies show: (1) Uppermost part of Carlsbad ls. is younger than Capitan ls., and the rest of it is contemp. with and grades laterally into the Capitan. (2) In places the Carlsbad is overlain by a thin wedge of uppermost part of Castile anhydrite, and in other places its uppermost part grades laterally into Three Twins memb. of Chalk Bluff fm. (3) Lower part of the Carlsbad grades laterally into Seven Rivers gypsif. memb. of Chalk Bluff fm. (4) In places a thin tongue (Azotea tongue) of upper part of Carlsbad ls. overlies Seven Rivers gypsif. memb. of Chalk Bluff fm. (5) The Carlsbad rests on Queen sand memb. of Chalk Bluff fm. (This is present approved definition of USGS.)

W. B. Lang, 1939 (AAPG Bull., v. 23, 1569-1572), changed definition of Salado fm. and Castile anhydrite, so that Salado fm., not Castile anhydrite, overlies Carlsbad ls.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14), defined *Carlsbad ls.* as the thin-bedded lagoonal facies of the massive Capitan reef ls. Carlsbad ls. grades laterally into Seven Rivers, Yates, and Tansill fms.

R. K. DeFord, N. H. Wills, and G. D. Riggs, 1940 (W. Tex. Geol. Soc. 1940 Road-log, Eddy Co., N. Mex., mimeographed). On above definition of *Carlsbad ls.*, *Azotea tongue* of Lang must be included as upper ls. memb. of *Seven Rivers fm.*

N. D. Newell et al., 1953 (The Permian reef complex, 45-47). The strat. boundaries of the upper Guadalupian backreef rocks are well defined. The lower limit is at top of Shattuck memb. of Queen fm., and upper limit is drawn at top of Tansill fm. The more calcareous facies of these rocks near the Capitan reef is known as the *Carlsbad gp.* Carlsbad ls. is made up of near-reef facies of Seven Rivers, Yates, and Tansill fms.

Type locality and section: Not designated.

Name: From Carlsbad, New Mexico.

‡Carrasco limestone.

Upper Cambrian(?): Southwestern New Mexico (Silver City region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 5). *Carrasco lss.*—Main calc. memb. of Late Ord. age well displayed back of Carrasco smelter property, near Silver City. Thickness 75 ft. [On p. 4, Keyes puts it in "Late Camb.;" on p. 5, in "Late Ord."]

Type locality: Not designated.

Name: From Carrasco smelter, near Silver City.

Castile formation (in New Mexico), Castile gypsum (in some areas), and Castile anhydrite (in Delaware Basin).

Permian (Ochoan): Western Texas and southeastern New Mexico (Pecos Valley).

G. B. Richardson, 1904 (Tex. Univ. Min. Surv. Bull. 9, 43). *Castile gyp.*—Massive white granular gyp., in places of grayish or dark color, in other places stained red by iron oxide. Some thin beds of ls. Thickness 50 to more than 300 ft. Underlies Rustler fm., and believed to overlie Capitan ls. unconf., but may be contemp. with part of Capitan.

R. E. King, 1931 (Tex. Univ. Bull. 3042, 13). SE. of reef escarpment (of Capitan ls.) of Guadalupe Mtns., the Frijole ls. is overlain by Castile gyp. and Rustler ls. At one time these were believed to be laterally equiv. to Capitan ls. The revised interpretation of Frijole ls. (i. e., equiv. to top part of Capitan ls.) now makes it clear that these 2 fms. (Castile and Rustler) are younger than the Capitan, as originally announced by Darton and Reeside (GSA Bull., v. 20, 37, 1926), and later by Crandall and others.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898), discriminated Castile anhydrite much farther N. in Pecos Valley, where it is overlain by Salado halite and rests on Chalk Bluff fm. (new name).

M. G. Wilmarth, 1938 (USGS Bull. 896, 364). In Delaware Basin of SE. N. Mex. and western Tex., there occurs, btw. Rustler ls. and Castile gyp. of Richardson, an unexposed series of salt beds (1,400 ft thick in well borings) known as "upper salt series," in contradistinction to "lower salt series" or Castile anhydrite. These rocks were known also as Upper Castile fm. To these unexposed rocks W. B. Lang, in 1935 (AAPG Bull., v. 19, 262-270), applied the name *Salado halite.* Neither the Castile nor the Rustler fm. is restricted by the introduction of the name Salado, because in all surface exposures the Rustler rests upon the Castile. (See under *Salado halite.*)

W. B. Lang, 1939 (AAPG Bull., v. 23, 1569-1572), redefined Salado fm. in such a manner that it conformed much more to old usage of Upper Castile fm., and old Lower Castile fm. is Castile fm. of Richardson.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14). Lang's (1939) definition of Salado fm., restricting *Castile* fm. to Delaware Basin and to definition of Richardson, is acceptable geologically and terminologically.

Type locality and section: Not designated.

Name: From Castile Spring, Culberson Co., Texas, which is in midst of the gyp.

‡Ceja Glorieta sandstone.

Permian: New Mexico.

C. R. Keyes, 1935 (Pan-Am. Geol., v. 64, 263). A name applied to the Permian ss. of N. Mex. that has been called "Glorieta ss." by other geologists.

Type locality: Not designated.

Name: Probably from Glorieta Mesa.

Chalk Bluff formation.

Permian (Guadalupian): Southeastern New Mexico (Pecos Valley region).

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Chalk Bluff fm.*—Comprises all sediments lying btw. San Andres ls. (below) and Salado halite (above). Consists of anhydrite, dolo. anhydrite, sss., red beds, and dolo. lss. Contains numerous beds of greenish bentonite, some 5 or more ft thick. Is essentially a back-reef fm. but is contemp. with fms. of the reef zone. Thickness 1,000± ft. Interfingers with upper (Azotea) tongue of Carlsbad ls., also with underlying part of Carlsbad, and with the still older Dog Canyon ls. Same as Pecos fm. of Nye. Divided into (ascending): (1) Queen ss. memb., 60 to 100 ft of white, buff, to pinkish fine-grained ss.; (2) Seven Rivers gypsif. memb., a series of sss., anhydritic sss., and red beds with intercalated anhydrite and thin dolo. lss.; (3) Three Twins memb., sss., anhydritic sands, sandy red beds, anhydrites, fine greenish sss., thin greenish-gray sandy shs. and dolo. lss.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14). *Chalk Bluff fm.* is essentially same as Whitehorse gp. of subsurf. and consists of (ascending): Grayburg, Queen, Seven Rivers, Yates, and Tansill fms., the latter two being roughly equiv. to Three Twins memb. of Chalk Bluff fm.

Though the term Chalk Bluff fm. is still used by USGS in its rpts., subsurf. geologists and petroleum geologists in general use term Whitehorse gp. as divided by DeFord and Lloyd.

Type locality: Exposure at Chalk Bluff, on E. bank of Pecos River, SE. of Artesia.

Name: From Chalk Bluff, SE. of Artesia.

‡Chaves shale.

Permian: Southeastern New Mexico (Guadalupe Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 258; Conspectus of geol. fms. of N. Mex., 3, 6). *Chaves shs.*—Lowermost section of red shs., 425 ft thick, which rest on the great Capitan lss. in Guadalupe Mtns., N. Mex. [See also Pan-Am. Geol. v. 65, 42, 46, 49, 1936.]

Type locality: Not designated.

Name: Derivation not indicated.

Cherry Canyon formation. (Of Delaware Mountain group.)

Permian (Guadalupian): Western Texas and southeastern New Mexico.

P. B. King, 1942 (AAPG Bull., v. 26, 525-763). *Cherry Canyon fm.*—1,000 ft, largely ss.; no coarser grained beds present; has several prom. ls. membs. The sss. of the Cherry Canyon fm. are thin bedded and finely laminated, and have straight,

smooth bedding planes. In lower half of fm., ripple marking and channeling of the sss. is rather common. Associated with the ls. beds are dark platy and shaly sss. Lss. are interbedded rather commonly with the sss., either in nodules and thin lenticular layers or in members that locally have considerable prominence. Three are given separate names, the Getaway, South Wells, and Manzanita lss.

P. B. King, 1948 (USGS Prof. Paper 215, 33-38). *Cherry Canyon fm.*—1,000 to 1,200 ft of very fine-grained ss. interlayered with lenticular ls. beds as much as 200 ft thick. The sss. of the Cherry Canyon fm. lie in beds a few in. thick, with occasional thicker layers and layers of hard platy shaly ss. The thinner beds are all marked by light and dark laminae, possibly varves, of which there are commonly 10 or 20 to the in. In some exposures, individual beds can be traced for long distances. In others, the bedding is less regular, and the sss. are cut by channels several ft deep, which are filled by more massive, more shaly, or more calc. strata than those beneath. Channeling of the sss. is most common in the lower two-thirds of the fm. The ls. membs. of the Cherry Canyon fm. are lenticular, consisting in places of solid ls. membs. 100 ft or more thick, and in other places of thin ls. beds interbedded with thicker layers of ss. They exhibit considerable variety in lithologic character from place to place. The two membs. distinguished in the lower part of the fm., the Getaway and South Wells lss., change in this manner; btw. them other thinner, less continuous ls. beds are locally prom. The upper memb. of the fm., the Manzanita ls., is more persistent than the lower membs. in lithologic character and thickness over wide areas. The upper three-fourths of Cherry Canyon fm. intergrades with Goat Seep ls.; the lower fourth underlies Goat Seep ls. as Cherry Canyon ss. tongue. Lies on Brushy Canyon fm.; overlain by Bell Canyon fm.

Type locality: Outcrops along Cherry Canyon, southern Guadalupe Mtns., for about 9 mi from Pine Springs SE. to a point 3 mi E. of D ranch headquarters, where it joins Lamar Canyon.

Name: From Cherry Canyon, Culberson Co., Texas.

Cherry Canyon sandstone tongue (of Cherry Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

P. B. King, 1948 (USGS Prof. Paper 215, 38). *Cherry Canyon ss. tongue.*—The upper three-fourths of the Cherry Canyon fm. interfingers with the Goat Seep ls. The lower fourth of the Cherry Canyon fm., however, persists as a layer of ss. 200 or 300 ft thick, called Cherry Canyon ss. tongue. The sss. are buff or pink, soft, and very fine grained. In the upper part are some interbedded brown sandy cherty lss. The ss. grades into the overlying Goat Seep ls., and the two types of rock are interbedded at the contact.

***Chester group.**

Mississippian (Upper): Type area only.

Chesterian.

A time term used by many geologists to cover the epoch during which the Chester gp. (upper Miss.) of the midcontinent region was deposited. A recognized subdivision of the Miss. Period (J. M. Weller et al., GSA Bull., v. 59, 91-196, 1948).

Chesterian (Chester) series.

Term used by many geologists to indicate strata deposited at the same time as the Upper Miss. Chester gp. of the Miss. Valley region.

‡Chiricahua limestone.

Permian: Southeastern Arizona (Chiricahua Mountains).

A. A. Stoyanow, 1936 (GSA Bull., v. 47, 532, 536). *Chiricahua ls.*—The youngest Permian beds in SE. Arizona which have the same fauna as occurs in memb. B of Kaibab fm. of Grand Canyon. Considered younger than Snyder Hill fm. Forms top of carbf. sequence in Chiricahua Mtns. near N. Mex. border.

F. F. Sabins, Jr., 1957 (AAPG Bull., v. 41, 496-499). *Concha ls.*—Undoubtedly the same unit which Stoyanow (1926, 1936) briefly mentioned from the Chiricahua Mtns. and correlated with the Kaibab. No type section was named or described, and the name has seldom been used by later writers. Suggested terms "Chiricahua ls." and "Snyder Hill fm." be suppressed and "Concha ls." be used for the light-colored, cherty lss. of SE. Arizona that contain the Kaibab fauna and overlie the Scherrer fm. This appears to be the opinion of most of the geologists working in SE. Arizona and SW. N. Mex.

Elliot Gillerman, 1958 (N. Mex. Bur. Mines Bull. 57, 41-43). *Chiricahua ls.*—Follows usage of Stoyanow because of priority, even though no type section given, and lithology of type not described. Stratigraphic position of Chiricahua ls. and Concha ls. are the same, but as the lithology of the "type" Chiricahua ls. was not described, it cannot be compared with the unit in the Peloncillo Mtns. Principally thick-bedded light-gray medium-grained ls. containing abund. irregularly shaped grayish-pink chert nodules. No section measured in the Peloncillo Mtns., but max. estimated as 800 ft; thickness varies greatly, owing to pre-Cretaceous erosion.

Type locality: Near Paradise, eastern Chiricahua Mtns., Arizona.

Name: From Chiricahua Mtns.

‡Chiricahuan series.

Cambrian: New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 6). *Chiricahuan series.*—Late Cambric ls. succession well developed in the Chiricahua and Caballos Ranges, in which is placed a 300 ft thick unit called the *Lone qtzite.*

Type locality: Not designated.

Name: From Chiricahua Range.

‡Chloride formation.

Devonian or Mississippian(?): Southwestern New Mexico (Sierra County).

C. R. Keyes, 1904 (Am. Jour. Sci., 4th ser., v. 18, 360-362). *Chloride fm.*—Dev. lss., 200 ft thick. Underlies Lake Valley ls.; overlies Ord. lss.

M. G. Wilmarth, 1938 (USGS Bull. 896, 437). *Chloride fm.*—Probably refers to Dev. Percha sh. of present nomenclature or lower part of Lake Valley ls. (Miss.).

Type locality: Not designated.

Name: From village of Chloride in NW. part of Sierra Co.

‡Chloridian series.

Cambrian (Upper): New Mexico (Grant County) and Bisbee, Arizona.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 6). *Chloridian series.*—Mid Cambric ls. succession extensively exposed in Grant Co.; and probably the eastern attenuation of the Abrigo sequence of lss. at Bisbee, Ariz.

Type locality: Not designated.

Name: From village of Chloride.

Chupadera formation.

Permian (Leonardian): New Mexico.

E. H. Wells, 1919 (N. Mex. Bur. Mines Bull. 3, 10-11, 17-18). N. H. Darton's plan of combining San Andreas and Yeso fms. under name of *Chupadera fm.* is followed. The plane of separation btw. Yeso and San Andreas is in many places difficult to locate, and plan of combining them under name of Chupadera fm. is especially appropriate in this (Puertecito) dist. The massive pink and light-yellow ss. 150 to 200 ft thick, which is usual top memb. of old Yeso fm. of eastern Socorro Co., is absent near Puertecito, where upper part is entirely lss. and gyp. beds, with gyp. predom.; the colors of this part are cream, buff, and light bluish gray. Shaly strata are more abund. in lower part and decrease in amount toward top. Near base the colors are dark gray, yellowish brown, pink, and red. Thickness of fm. 1,000 to 1,200 ft. Rests on Abo ss., usually conf.; unconf. overlain by Triassic. Is top fm. of Manzano gp.

N. H. Darton, 1922 (USGS Bull. 726E, 176-182). (The name *Chupadera fm.* was adopted by USGS for this rpt. in July 1919, but rpt. was not published until March 31, 1922.) The name *Chupadera fm.* is introduced here for upper part of Manzano gp., which Lee divided into Yeso fm. and San Andreas ls. In mapping these deposits it was found that although Lee's subdivisions were discernible in places, it was impracticable to separate them generally. Although ls. is conspicuous feature of San Andreas ls., much of that subdivision consists of thick beds of gyp. and ss., which are not well exposed in the type localities. In future, wherever Lee's subdivisions can be recognized, they will be treated as members of Chupadera fm., instead of as distinct fms. Rests on Abo ss.; is overlain by Triassic.

A. G. Fiedler and S. S. Nye, 1933 (USGS Water-Supply Paper 639), divided the Perm. rocks of Roswell artesian basin of SE. N. Mex. into (descending): (1) Pecos fm., (2) Picacho ls. (considered to be same as San Andres ls. memb. of Chupadera fm. to W.), and (3) Nogal fm. (considered to be same as Yeso memb. of Chupadera fm. to W.).

W. B. Lang, 1935 (AAPG Bull., v. 19, 262-270), abandoned Pecos fm., dividing it into (descending): Pierce Canyon red beds, Rustler fm., Salado halite, and Castile anhydrite.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898), replaced *Picacho ls.* with San Andres ls. memb. of Chupadera fm. and replaced *Nogal fm.* with Hondo ss. memb. of Chupadera fm. and Yeso memb. of Chupadera fm. and Yeso memb. of Chupadera fm. (below). The recognition of Hondo ss. (new) involves a slight redefinition of both San Andres ls. and Yeso. The Hondo ss. is approx. equiv. of Glorieta ss.

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1688). Yeso, Glorieta, and San Andres fms. redefined, with new type sections. Old usage of Chupadera fm. discarded.

To a large extent the use of the term Chupadera fm. has been abandoned, and the rock units included in it are divided now into Yeso, Glorieta, and San Andres fms., as a result of more detailed mapping. [The term Chupadera Mesa was not employed by the USGS in preliminary maps published from 1944 on.]

Type locality and section: Not designated.

Name: From Chupadera Mesa, a prom. topographic feature in eastern Socorro Co.

‡Cibola limestone.

Silurian(?): Southwestern New Mexico (Silver City district).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 3, 6). *Cibola lss.*—Important mid-Sil. ls. memb. cropping out at Cibola mill, at Silver City. Thickness 175 ft. Underlies Naiad ls. and with it comprises Santa Ritan series. Assigned to Sil.

Type locality: Not designated.

Name: From Cibola mill, at Silver City.

‡†Cimarron formation.

Carboniferous: New Mexico.

C. R. Keyes, 1904 (Am. Jour. Sci., 4th ser., v. 18, 360-363). A term applied to 1,000 ft of sss. and shs. of N. Mex. unconf. underlying Comanche deposits, overlying the Carbf., and assigned to Triassic.

C. R. Keyes, 1905 (Am. Jour. Sci., 4th ser., v. 20, 425). Cimarron shs. are assigned to Permian.

Name is preoccupied by Cimarron group (Permian) of Kansas.

Type locality: Not designated.

Name: Probably from the Cimarron Mtns.

‡Cimarronian series.

Carboniferous (post-Guadalupian): New Mexico (Rio Grande Valley).

C. R. Keyes, 1909 (Iowa Acad. Sci. Proc., v. 16, 159-163). A term introduced for the post-Guadalupian Carbf. rocks of Rio Grande Valley, which is divided into (descending): Moencopie shs., unnamed sss., and Pecos shs.

Type locality: Not designated.

Name: Probably from the Cimarron Mtns.

Cisco.

A time term used by many geologists in central and western Texas and New Mexico to cover the epoch during which the Upper Penn. Cisco series of north central Texas was deposited.

*Cisco group.

Pennsylvanian: Texas.

Cisco series.

Term used by many geologists in central and western Texas and New Mexico to indicate strata of same age as Cisco series of north central Texas. Cisco series is equiv. to uppermost Penn. and/or Virgil series of midcontinent region (M. G. Cheney, AAPG Bull., v. 24, 65-118, 1940).

Cleveland Gulch quartzite member (of Hopewell series).

Precambrian: Central northern New Mexico (Petaca area).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 42). *Cleveland Gulch qtzite memb.*—A prom. qtzite and qtz-mica schist of sed. origin exposed between the Tusas and Kiawa Mtns. May correlate with Badito qtzite of the Picuris area.

Type locality: Not designated.

Name: From gulch near Cleveland, Mora Co.

Coane formation. (Of Veredas group.)

Pennsylvanian (Missourian): Central and southern New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 59-61). *Coane fm.*—At type loc., 59 ft of light bluish-gray to gray cherty ls. In other areas of central N. Mex., the lower part of the fm. contains clastic beds of gray shs. and sss. Type section (ascending): (1) ls., light- to tannish-gray, fine-grained, hard, in beds up to 2 ft thick, upper 1 ft highly crinoidal, 7 ft; (2) ls., bluish-gray, fine-grained, dense, massively bedded, irregular masses of chert abund., 5 ft; (3) ls., bluish-gray, massively bedded, abund. irregular masses of chert, in two sequences (with algae abund. in upper part of each), 16 ft; (4) ls., medium-gray, very dense and hard, irregular thin beds, to 0.1 ft thick, interbedded with irregular lenses and masses of chert which weather brown, 12 ft; (5) ls., bluish-gray, dense, massive, scattered masses of chert, upper 10 ft very highly algal, 19 ft. Lowest fm. of Veredas gp. Lies conf. on Bolander gp.; conf. overlain by Adobe fm.

Type locality and section: NW. side of Oscura Mtns., in SE¼ sec. 36, T. 5 S., R. 5 E.

Name: From old station of Coane on E. side of Oscura Mtns.

***Colina limestone.**

Permian (Wolfcamp and lower Leonard?): Southeastern Arizona and extreme southwestern New Mexico (Peloncillo and Big Hatchet Mountains).

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 23-25, 38-41). *Colina ls.*—Relatively uniform dark lss.; most characteristic feature is dominance of dense ls. that appears very dark gray to almost black on fresh fracture. Gastropods are abund., several genera being very striking, notably a very large obtuse-angled *Omphalotrochus.* Base taken arbitrarily above the highest orange-red weathering dol. bed of the underlying Earp fm. Upper limit is transition zone of ls. mottled with dol. in proportions that increase upward until it finally passes into the massive dol. of the Epitaph dol. Thickness of type section is 633 ft.

Elliot Gillerman, 1958 (N. Mex. Bur. Mines Bull. 57, 38-39). *Colina ls.*—Very fine-grained ls., which is dark gray or black on fresh-fractured surface; absence of chert and abundance of large gastropods (especially *Omphalotrochus)* and scaphopods are characteristic. No complete section found in Peloncillo Mtns.; thickness 504 ft plus.

R. A. Zeller, Jr., 1958 (unpub. Ph. D. thesis, Univ. Calif., Los Angeles, 96-99). *Colina ls.*—Medium to dark gray and black on fresh fracture, weathers medium to light gray with a smooth surface, very finely crystalline with residual calcarenite texture, thin bedded, and has almost no chert. Thin brown-weathering crosslaminated siltstone beds in lower half of fm.; upper *Colina* ls. is interbedded with the Epitaph dol., the upper contact chosen within wide limits where the predominance of ls. gives way to dol. Thickness, 355-509 ft.

Type locality and section: W. slope of Colina Ridge, in Tombstone Hills, 4,000 ft S. of Horquilla Peak.

Name: From Colina Ridge in Tombstone Hills, sec. 35, T. 20 S., R. 22 E., 4 mi S. of Tombstone, Arizona.

***Concha limestone.**

Permian (Leonard and Guadalupe?): Southeastern Arizona and extreme southwestern New Mexico (Hidalgo County).

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 29-30, 42-430). *Concha ls.*—Lower part, about 50 ft thick, consists mostly of fine-grained calc. ss. which is more calc. and gray rather than the rusty brown of

the underlying Scherrer fm. sss. Above basal sandy beds, fm. consists of gray, medium-grained ls. which is highly fossiliferous and contains abundant irregular nodules of light-colored chert weathering pale brown. Large productid brachiopods are the most common fossils. Top is an unconformity of major importance beneath Lower Cretaceous beds. Thickness of type section, 130 ft. Age is probably Leonard, perhaps extending into the Guadalupe. Probably correlative with the Chiricahua ls.

Elliot Gillerman, 1958 (N. Mex. Bur. Mines Bull. 57, 42). *Chiricahua* [Concha] *ls.*—The Chiricahua ls. and Concha ls. are believed to be the same stratigraphic unit, and the terms are synonymous. Because of priority, the name used should be Chiricahua ls.

R. A. Zeller, Jr., 1958 (unpub. Ph. D. thesis, Univ. Calif., Los Angeles, 107-111). *Concha ls.*—Outstanding feature is great abundance of chert nodules and silicified robust productids. Lower half of fm. consists of medium- to light-gray ls., lithographic to coarsely crystalline, largely composed of fossil-shell detritus, beds 0.5 to 8 ft thick, and contains abund. gray, red, and lavender chert nodules. Upper half of fm. consists mostly of light-gray, finely crystalline dol., with abundant chert nodules and silicified fossils. Contact with overlying Lower Cretaceous rocks is an unconformity, beneath which parts of the upper dol. memb. are missing. Max. thickness, 1,376 ft. Fusulinids suggest the age as upper Leonard.

Type locality and section: E. end of Concha Ridge, Gunnison Hills, NW¼ sec. 28, T. 15 S., R. 23 E.

Name: From Concha Ridge, a conspicuous transverse spur of Scherrer Ridge, Gunnison Hills, 5 mi N. of Dragoon, Arizona.

Connell sandstone member (of Oil Creek formation).

Middle Ordovician: Subsurface of western Texas and eastern New Mexico.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038). *Connell ss. memb.*—40 ft of light-tan medium- to coarse-grained loosely cemented ss., 93 ft above top of Ellenburger dol. and at base of Oil Creek fm.

Type locality and section: Texas Co. W. E. Connell No. 33, in NE¼NE¼ sec. 1, Blk B-22, P. S. L. Surv., Jordan area, Ector Co., Texas.

Name: From well name.

Contadero formation.

Upper Devonian: Central New Mexico (San Andres Mountains, local).

F. V. Stevenson, 1945 (Jour. Geol., v. 53, 217-245). *Contadero fm.*—A series of carb. shs. and lss. above the Sly Gap fm. and below the Miss. Caballero fm., in the central part of the San Andres Mtns. The basal gray ls. beds of the Contadero rest without apparent disconf. on the Sly Gap fm., but the gray-black shs. and thin ls. top beds of the Contadero are separated from the overlying Caballero fm. by an erosional disconf. Fauna similar to that of the Sly Gap fm. Thickness 0 to 70 ft. The Contadero may be a facies equiv. in age to the Ready Pay memb. of the Percha sh., and a tongue in the Sly Gap fm. The fm. is gray, olive brown, green, and gray green; uppermost beds weather red.

R. H. Flower, 1955 (NMGS Guidebook, 6th Field Conf., 69). The age of the Contadero is probably not materially younger than that of the Sly Gap, which it overlies. It contrasts with the Sly Gap primarily in lithology and preservation of fossils.

F. E. Kottlowski, 1955 (NMGS Guidebook, 6th Field Conf., 140). The contact of the Sly Gap and Contadero is drawn where gray lss. overlie tan beds of the Sly Gap. The combined Ready Pay-Contadero fm. would thicken S. from Rhodes Canyon and thin or be absent to the N. In Rhodes Canyon the Caballero fm. (Miss.) is

absent (Laudon and Bowsher, 1949), and the Contadero underlies the upper Percha.

Type locality and section: S½ sec. 8, T. 13 S., R. 4 E., 2,000 ft N. of road through Rhodes Pass, San Andres Mtns.

Name: From a Minor Civil Division Map, of the Bureau of Census, issued in 1934. The Contadero political division includes Rhodes Pass and the surrounding area.

Council Spring limestone. (Of Veredas group.)

Pennsylvanian (Missourian): Central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 59, 62). *Council Spring ls.*—At type loc., 18 ft of light-gray to white coarsely crystalline to fine-grained massive to massively-bedded ls. which weathers to a cliff. Upper unit of Veredas gp. Lies conf. on Adobe fm.; conf. overlain by Hansonburg gp.

Type locality and section: NW. side of Oscura Mtns., in SE¼ sec. 36, T. 5 S., R. 5 E.

Name: From Council Spring, about 5 mi S. of N. end of Oscura Mtns.

Cowden anhydrite member (of Salado formation).

Permian (Ochoan): Subsurface of western Texas and southeastern New Mexico.

G. A. Kroenlein, 1939 (AAPG Bull., v. 23, 1682-1693), first mentions Cowden anhydrite in "Upper Castile fm."

S. S. Giesey and F. F. Fulk, 1941 (AAPG Bull., v. 25, 593-629). *Cowden anhydrite memb.*—Lowermost anhydrite bed in Salado fm. Named in subsurf. Thickness 15 ft at type loc. Varies from 10 to 50 ft. Consists of white porous anhydrite and buff to brown slightly dolo. anhydrite.

Type locality and section: Southern Crude Oil Purchasing Co.'s J. M. Cowden No. 1, sec. 26, Blk. 43, T. 1 N., Tex. & Pac. Ry. Surv., Ector Co., Texas, from -2590 to -2605 ft.

Name: From North Cowden Field, Ector Co., Texas.

Coyote sandstone member (of Madera limestone).

Pennsylvanian: Central New Mexico.

C. L. Herrick, 1900 (Jour. Geol., v. 8, 115; Am. Geologist, v. 25, 234-237; N. Mex. Univ., Hadley Lab., Bull., v. 2, fasc. 3, 1-14). *Coyote ss.*—Thick ss. or cgl. Separated from overlying Manzano series by a thick series of massive gray silic. lss., and from underlying Sandia series by a series of dark conchoidal lss. and shs. Present in Sandia, Manzano, and San Andres Mtns.

Type locality: In Coyote Canyon, S. end of the Sandia Mtns.

Name: From Coyote Springs, Sandia Mtns.

‡Cristobal limestone.

Ordovician: Southern New Mexico.

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 6). *Cristobal lss.*—Main body of late Ord. ls. section in Franklin, Caballos, Fra Cristobal, and Mimbres Ranges. Thickness 165 ft.

Type locality: Not designated.

Name: From Fra Cristobal Range.

Cuchillo Negro formation. (Of Mud Springs group.)

Pennsylvanian (Derryan): Central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 37, 39). *Cuchillo Negro fm.* —At type loc., 28 ft, almost entirely of medium- to light-gray massive to nodular cherty ls. Calc. algae extremely abund. in some portions of the fm. Two thin beds of greenish to brownish coarse-grained ss. to granule cgl. occur in the lower part of the fm. in some areas in Mud Springs Mtns., one at base, the other 15 ft above base. Type section (ascending): (1) ls., medium- to light-gray, algal, beds 1 to 1.5 ft thick, 8 ft; (2) covered, ls.(?), 3 ft; (3) ls., brownish-gray, very highly algal, irregular masses of light-gray chert in upper portion, 2.5 ft; (4) ss., coarse-grained to granular, greenish-gray, mainly quartz, abund. small white pellets, locally subqtzitic, 3.5 ft; (5) ls., gray to medium-gray, slabby bedded, 3 ft; (6) ls., medium- to light-gray, dense and hard, beds up to 3 ft thick, large nodules and irregular masses of chert common, 8 ft. Fusulinid fauna: *Millerella, Eoschubertella, Pseudostaffella,* and *Fusulinella.*

Type locality and section: W. end of Whiskey Canyon in N. Mud Springs Mtns., SW¼ sec. 1, T. 13 S., R. 5 W.

Name: From Cuchillo Negro Peak at S. end of Mud Springs Mtns.

Culebra dolomite member (of Rustler formation).

Permian (Ochoan): Southeastern New Mexico and western Texas.

J. E. Adams, 1944 (AAPG Bull., v. 28, 1596-1625). W. B. Lang, 1938 (N. Mex. State Eng. 12th and 13th Bien. Rpt., 84), measured Rustler fm. in central Eddy Co., N. Mex. His section is as follows (descending): (1) gyp., 30 ft; (2) gypsif. dol., 30 ft; (3) gyp., 100 ft; (4) red beds, 30 ft; (5) gyp., 20 ft; (6) dol., 35 ft; (7) red beds, 30 ft; (8) gray ss., 70 ft; (9) red beds, 35 ft; (10) gyp., 130 ft; (11) red beds, 5 ft. First five membs. of foregoing sequence belong to upper Rustler, and the others to lower part of the fm. For the 35-ft dol., no. 6 in the section, Lang favors name *Culebra memb. of Rustler fm.* This memb. is a good subsurf. marker over a wide area.

Type locality and section: Not designated.

Name: From Culebra Bluff, E. side of Pecos River, Eddy Co., New Mexico, where fm. is well exposed.

Cutler formation.

Pennsylvanian(?) and Permian: Southwestern Colorado, southeastern Utah, northeastern Arizona, and northwestern New Mexico.

W. Cross and E. Howe, 1905 (USGS Silverton folio, n. 120). Beds here named *Cutler fm.* compose greater part of red beds of region. Hitherto they were included provisionally in Dolores fm. Field work of 1904 in Ouray quad. revealed notable angular unconf. immediately below the most commonly fossilif. beds of Dolores fm. Through this unconf. the Dolores (restricted) can be seen to transgress more than 1,000 ft of old red beds and several hundred ft of Rico and Hermosa. In view of these facts, the name *Dolores* is here restricted to the Triassic strata, embracing the fossilif. cgl. and overlying beds up to La Plata ss., of Jurassic age, and the nonfossilif. strata btw. Rico fm. below and base of Triassic are named *Cutler fm.*, from exposures on Cutler Creek, which enters the Uncompahgre River about 4 mi N. of Ouray, Colo. The Cutler is a complex of bright-red sss. and lighter red or pinkish grits and cgls. alternating with sandy shs. and earthy or sandy lss. of varying shades of red. Rests conf. on Rico fm.; unconf. overlain by Telluride cgl. (Tert.), the Triassic Dolores fm. being absent in this (Silverton) quad. Thickness 1,000+ ft.

Wilmarth, M. G., 1938 (USGS Bull. 896, 561). The present definition of Cutler fm. in its type region (SW. Colo.) conforms to above original definition; namely, it rests conf. on Rico fm. and is unconf. overlain by Dolores fm. (Upper Triassic and Jurassic?), where that fm. is present. In SE. Utah, NE. Ariz., and NW. N. Mex., the Cutler is overlain by Moenkopi fm. (Lower Triassic) and underlain by Rico fm. (See A. A. Baker and J. B. Reeside, Jr., AAPG Bull., v. 13, 1413-1448, 1929.) In part of SE. Utah (Salt Valley anticline and NW. flank of Uncompahgre Plateau, Grand Co.) where the lss. of Rico fm. are absent, the red beds corresponding to Rico fm. of SW. Colo. are included now in Cutler fm. (See C. H. Dane, USGS Bull. 863, 1935.)

S. A. Wengerd and J. W. Strickland, 1954 (AAPG Bull., v. 38, 2157-2199). Rico fm. (Penn.-Perm.), first mentioned as a fm. differentiated from the overlying Cutler by the presence of marine fossils (Cross, 1899), is considered here to be a transitional memb. btw. *Cutler* continental strata above and Hermosa marine strata below. For convenience, and because of its closer affinities with the Cutler fm., it is considered here the basal memb. of that fm. It is distinctly not a mappable unit of any strat. constancy over a wide area and should probably not be called a fm. This usage follows to some extent that of Dane (1935), who placed the red beds corresponding to the Rico fm. of SW. Colo. in the Cutler fm. in SE. Utah.

D. R. Turnbow, 1955 (Four Corners Geol. Soc. Guidebook, 66-69). *Cutler fm.* is in part Pennsylvanian in age.

Type locality: Outcrop on Cutler Creek, 4 mi W. of Ouray, Colorado.

Name: From Cutler Creek, which enters the Uncompahgre River 4 mi N. of Ouray, Colorado.

Cutoff shaly member (of Bone Spring formation).

Permian (Leonardian): Western Texas and southeastern New Mexico.

P. B. King, 1948 (USGS Prof. Paper 215, 18). *Cutoff shaly memb.*—230 ft of thin-bedded dense ls. of black, buff, or gray color, weathering to dove-gray or ashen hackly conchoidal fragments. Some of lower beds contain irregular masses of black chert. In upper part, much platy black silic. sh., brown sandy sh., and soft ss. is interbedded. Lies on Victorio Peak ls.; overlain by Brushy Canyon fm. or unconf. by Cherry Canyon fm.

Type locality: Exposures on the W. slope of Cutoff Mtn., S. Guadalupe Mtns., Culberson Co., Texas.

Name: From Cutoff Mtns., S. Guadalupe Mtns., Culberson Co., Texas.

Cutter formation. (Of Montoya group.)

Upper Ordovician: Southern New Mexico and western Texas.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 62-64). *Cutter fm.*—Light gray-weathering generally unfossilif. claystone, ls., calcitic dol., and dol. The ls. is medium gray to dark gray on fresh surfaces. The dol. is light gray to dark gray. The ls. weathers blue gray; the dol. and calcitic dol. weather light gray or tan. Both the ls. and dol. are generally microgranular or sublith. and have conchoidal fracture. Chert is unevenly distributed as occasional black bands 2 to 6 in. in diameter. Thickness 50 to 130 ft in Caballo Mtns.

L. C. Pray, 1953 (AAPG Bull., v. 37, 1907). The Cutter fm. of Kelley and Silver is the same as the Valmont fm. The Cutter fm. probably should not be included in the Montoya fm. The Cutter (Valmont) probably is related more correctly to the Fusselman dol. (Sil.).

Type locality and section: Cable Canyon, Caballo Mtns., NW¼ sec. 10, T. 16 S., R. 4 W.

Name: From Cutter station on A.T.&S.F. Ry., E. of Caballo Mtns.

*Deer Mountain red shale member (of Hueco limestone).

Permian (Wolfcampian): Western Texas and southeastern New Mexico.

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 925). *Deer Mtn. red beds,* shown in section of Hueco Mtns. as resting on Gym ls. and as equiv. to upper part of Hess fm. of Sierra Diablo.

P. B. King, 1934 (GSA Bull., v. 45, 697-798), called these beds *Deer Mtn. red sh. memb. of Hueco ls.* and assigned them to Permian(?).

L. C. Pray and C. Otte, Jr., 1954 (GSA Bull., v. 65, 1296). Abo fm. of Sacramento Mtns. (Wolfcampian) extends S. as two major tongues of red beds separated by, but transitional with, a southward-thickening sequence of brackish to marine carbonates, fine clastics, and minor gypsum of the Hueco fm. The upper tongue forms the *Deer Mtn. red sh.* in the Hueco fm.

Recognized in Texas only by USGS.

Type section and locality: Exposures on Deer Mtn., 4 mi SE. of Cerro Alto, Hueco Mtns., Texas.

Name: From Deer Mtn.

Delaware Mountain group. (Formerly **formation** [of Guadalupe group].)

Permian (Guadalupian): Western Texas and southeastern New Mexico (Delaware and Guadalupe Mountains and Sierra Diablo).

G. B. Richardson, 1904 (Tex. Univ. Min. Surv. Bull. 9, 38). *Delaware Mtn. fm.*—Essentially light and dark ss. and ls., though locally includes some sh. At base 200 ft or more of blue-black thin-bedded ls. Greatest exposed thickness 2,300 ft, but base not seen, and relations to Penn. Hueco fm. not determined. Underlies Capitan ls.

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 921-922, 924, 925). As lower fm. of Guadalupe gp., Delaware Mtn. fm. has been divided into following membs.: (1) Upper dark ls.; (2) Delaware Mtn. ss.; (3) basal black ls. (here named Bone Canyon memb. of Leonard fm.). A short distance N. of Bone Canyon, on W. side of Guadalupe Mtns., a wedge of gray ls. (here named Victoria Peak memb. of Leonard fm.) appears beneath the unconf. at base of Delaware Mtn. ss. and separates that ss. from Bone Canyon memb. The Delaware Mtn. fm. as originally defined is not a natural gp. but consists of beds of Leonard and Word age, separated by an unconf. For this reason it is suggested that if term *Delaware Mtn.* be retained, it should be restricted to the beds above the basal black ls. (also to the beds above Victoria Peak memb.). Includes near base a thin bed of gyp. (named *Dos Alamos gyp.*).

R. E. King, 1931 (Tex. Univ. Bull. 3042, 13 and chart opp. 146). *Delaware Mtn. fm.* restricted to beds overlying (unconf.) Bone Canyon ls. (equals Bone Spring ls., the approved name).

K. H. Crandall, 1929 (AAPG Bull., v. 13, 941-943), R. E. King, 1931 (Tex. Univ. Bull. 3042, 13), W. B. Lang, 1935 (AAPG Bull., v. 19, 262-270), and other geologists are now satisfied that typical Delaware Mtn. fm. of Delaware Mtns. includes in its upper part the time equiv. of Capitan ls., and that the beds underlying Capitan ls. and so-called Delaware Mtn. fm. in Guadalupe Mtns. are equal only to lower part of Delaware Mtn. fm. of Delaware Mtns.

P. B. King, 1934 (GSA Bull., v. 45, 697-795). *Delaware Mtn. fm.* restricted to beds above Bone Spring ls. (here treated as a distinct fm.) and below Castile gyp. in

Delaware Mtns., and below Capitan ls. and above Bone Spring ls. in Guadalupe Mtns., the Victorio Peak memb. being included here in Bone Spring ls.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). Upper part of *Delaware Mtn. fm.* in the reef zone is replaced by Capitan ls., and upper portion of middle part of the Delaware Mtn. grades laterally into Dog Canyon ls. The Delaware Mtn. rests on Bone Spring ls.

P. B. King, 1948 (USGS Prof. Paper 215, 27-28), raised the *Delaware Mtn. fm.* to gp. status and included in it the Brushy Canyon fm., the Cherry Canyon fm., and the Goat Seep ls.

Type locality: Outcrop at S. end of Guadalupe Mtns., Texas.

Name: From Delaware Mtn., Culberson Co., Texas.

Delaware Mountain sandstone.

A name that has been applied by some geologists to the basal sandy beds of Delaware Mtn. fm. in Guadalupe Mtns., Tex., that overlie the black Bone Spring ls. and underlie the upper dark ls. memb. of Delaware Mtn. fm. (See under *Delaware Mtn. gp.*)

Del Cuerto formation. (Of Keller group.)

Pennsylvanian (Virgilian): Central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 71-72). *Del Cuerto fm.*—At type loc., 81 ft of irregularly bedded to nodular ls., highly arkosic ss., ls. cgl., and gray and red sh. In other areas of central N. Mex. the fm. is generally thicker and more highly clastic than at type sec. Type section (ascending): (1) slope, lower half shows red sh., upper half green to brown arkosic ss., 9 ft; (2) ls., gray, slabby to irregular nodular beds, 6 ft; (3) ls., light-gray, nodular to irregularly bedded, dense and hard, 5 ft; (4) slope, with poor exposures of coarse reddish-brown arkosic ss., nodular ls. in upper part, 6 ft; (5) ls., massively bedded, bluish-gray, 8 ft; (6) poorly exposed nodular to slabby ls., 6 ft; (7) irregular masses of ls., gray, slightly purplish tinge, 2 ft; (8) poorly exposed, lower part irregularly bedded lss., upper 3 to 4 ft ls. cgl., 9 ft; (9) poorly exposed reddish-brown highly arkosic ss., 5 ft; (10) ls., light-gray, 12 ft; (11) ls., argil., thin irregular beds, weathers light yellowish red to orange, 13 ft. Fusulinid fauna: *Triticites.*

Type locality and section: N. Oscura Mtns., in NE¼ sec. 31, T. 5 S., R. 6 E.

Name: From Del Cuerto Spring, on E. slope of Oscura Mtns.

Derryan.

A time term used by some geologists to cover the epoch during which the Middle Penn. Derry series of New Mexico was deposited.

R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302), state that the Derryan is almost exact equiv. of the Atokan of Okla., but the Derry series includes rocks that seem more nearly to fill the recognized break btw. the Morrowan of Ark. and the Atokan of Okla. Derryan also approx. equiv. of Lampasan of Texas.

Derry series.

Pennsylvanian (Middle): New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 26-30). *Derry series.*—Term proposed for all rocks in the central and extreme south central areas of N. Mex. btw. base of Penn. system and the basal part of the Penn. Des Moines series. Always unconf. on older rocks. Overlain by Des Moines strata. Younger

than type Morrow. Largely marine lss., shs., cgls., and coarse sss. However, locally contains, especially in lower portion, dark shs., sss., and thin coal beds of continental origin. 130 ft thick at type loc., where it is composed of marine lss., with a few sss. and shs. In Hueco Mtns., over 600 ft, almost entirely marine lss.; NW. of Ladron Peak, about 600 ft, largely marine and nonmarine clastics, shs., thin coals, and sss. Divided into 2 gps., 4 fms. Also used as a term to include strata deposited at the same time as the type Derry series.

Type locality and section: ¾ mi E. of center of Derry, near center of sec. 32, T. 17 S., R. 4 W.

Name: From village of Derry, Sierra Co.

*Des Moines group.

Pennsylvanian (Middle): Midcontinent only.

Desmoinesian.

A time term used by many geologists to indicate the epoch during which the Middle Penn. Des Moines series of the midcontinent region was deposited. A recognized subdivision of the Penn. Period (R. C. Moore et al., GSA Bull., v. 55, 657-706, 1944).

Des Moines series.

Term used by many geologists to indicate strata of the same age as the Middle Penn. Des Moines series of the midcontinent region.

Dewey Lake formation (red beds).

Permian (Ochoan): Southeastern New Mexico and subsurface of western Texas.

L. R. Page and J. E. Adams, 1940 (AAPG Bull., v. 24, 52-64). *Dewey Lake fm.*—Originally these beds were included in Pierce Canyon fm., but they are Perm. and were excluded from the Triassic Pierce Canyon beds. No complete section was found in outcrops; so the fm. was named from subsurf. Consists of fine to very fine orange-red sss. and silts. The silts and sands are well lithified; many have an anhydrite cement. A zone of coarse frosted qtz grains is commonly marked by a zone of bleaching. Lies conf. on Rustler fm.; unconf. overlain by Tecovas fm. (Triassic). Thickness 0 to 250 ft.

Type locality and section: Penn's Habenstreit No. 1, sec. 47, Blk. 36, T. 3 S., Tex. & Pac. Ry. Surv., Glasscock Co., Texas, from -1155 to -1407 ft.

Name: From Dewey Lake, N. Glasscock Co., Texas.

‡Dixon granite.

Precambrian: Central northern New Mexico (Picuris Range).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 13, 24-25). *Dixon granite.*—The typical Dixon granite is fairly coarse grained but varies considerably in texture and composition from place to place. In the gorge of the Rio Pueblo, it is even-grained pink and gray biotite granite; in the hills near the Harding mine, it is pink, almost lacking in ferromag. minerals, and the qtz grains are rounded. At the E. end of the Rio Pueblo gorge, the granite is dark, from an abundance of biotite, and contains large twinned orthoclase phenocrysts of light flesh tint. At the last mentioned locality, the porphyritic phase is intruded by aplite dikes. In places flowage has converted the granite to schist. Most specimens of the granite studied in thinsection show extensive granulation not perceptible to the naked eye. The Dixon granite is younger than the Proterozoic rocks of sed. origin and is intrusive into them.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 37). The *Embudo granite* borders the Picuris range of the S. and E. This rock was called by Just (1937) the Dixon granite, but this name has priority elsewhere.

Type locality: Not designated.

Name: From the town of Dixon. The new name Embudo is taken from the town of Embudo, located 2 mi W. of Dixon and 4 mi W. of extensive outcrops of the granite.

‡†Dog Canyon limestone.

Permian (Guadalupian): Southeastern New Mexico (Pecos Valley region).

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Dog Canyon ls.*—Bedded lss. more than 1,000 ft thick, which grade along their base into the thinning ss. of Delaware Mtn. fm.; to S. merge with middle sss. of that fm. and possibly with basal part of Capitan ls. Of Middle Delaware Mtn. age. To N. gradually thins out above San Andres ls. Overlain by Queen ss. memb. of Chalk Bluff fm. Exposed on W. flank of Guadalupe Mtns., in Dog Canyon, N. Mex.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14). *Dog Canyon fm.* is so often confused with Dog Creek sh., of similar strat. position in Okla., that west Texas geologists are abandoning the term Dog Canyon.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Goat Seep ls.*—Upper ls. beds of Cherry Canyon fm. coalesce to become thick-bedded massive reef lss., 700 to 1,200 ft thick. This unit was described earlier as Chupadera ls., and later as *Dog Canyon ls.* by W. B. Lang (1937). Dog Canyon term is abandoned because the fm. is not so well defined as at Goat Seep; moreover, Dog Canyon is confused with Dog Creek of Okla.

Type locality: W. flank of Guadalupe Mtns., in Dog Canyon.

Name: From Dog Canyon, in Guadalupe Mtns. Abandoned by USGS; replaced by Goat Seep ls.

‡Don limestone.

A name applied by geologists of mining companies, in their company reports, to upper 260 ft of Syrena fm. (Penn.) of Santa Rita dist., New Mexico.

Dona Ana member (of Lake Valley formation).

Mississippian (Osagian): South central New Mexico.

L. R. Laudon and A. L. Bowsher (AAPG Bull., v. 25, 2116, 2136-2138). *Dona Ana memb.*—Medium-bedded to massive gray and brown to black coarsely crystalline very cherty crinoidal ls., interbedded with dark crinoidal marl beds. Crops out in bold massive overhanging cliffs. The normal even bedding generally is complicated by the introduction of local small biohermal masses. The basal portion commonly contains much more soft marly material than the central portion. The upper portion is filled with large masses of light-colored chert. In some beds the ls. is replaced almost completely with these chert masses. In some areas the chert is not abund., and the upper part of the memb. consists of massive gray to brown coarsely crystalline crinoidal ls. Thickness 0 to 175 feet. Gradational with underlying Arcente memb.; unconf. with overlying Penn. beds.

Type section: Upper end of Deadman Canyon, Sacramento Mtns., in S. center sec. 3, T. 17 S., R. 10 E.

Name: From Dona Ana Co.

‡Dragoonan series.

Cambrian (Middle): Southwestern New Mexico and southeastern Arizona.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 6). *Dragoonan series.*—Mid Cambric section finely exposed in the vicinity of Silver City. Originally defined in the Dragoon Range of southeastern Arizona, consisting of (ascending order): 100 ft, Mangas qtzite; 50 ft, Hawkins lss.; 500 ft, Burro qtzites.

Type locality: Not designated.

Name: From Dragoon Mtns., SE. Arizona.

Drinkard sandy member (of Yeso formation).

Permian (Leonardian): Subsurface of southeastern New Mexico and western Texas.

R. E. King, 1944 (N. Mex. Bur. Mines Bull. 23, 13-15). The name *Drinkard sandy memb.* of the Yeso fm. is given to a widespread clastic zone in the middle or lower part of the Yeso or "Clear Fork" that is a strat. marker easily recognized in much of the S. Permian Basin. The names "Fullerton sand" and "Tubb sand" (Moore, J. H., AAPG Bull., v. 28, 1541-1542, 1944) have been in general use among Permian Basin geologists for this unit. Drinkard is 90 to 110 ft thick in E. Lea Co. Consists of very fine-grained calc. and argil. gray and brown ss. and sandy sh., in part pyritic, interbedded with brown sandy dol.

Type locality and section: Texas Co. No. 1 Blinebry, SE¼ sec. 19, T. 22 S., R. 38 E., Drinkard area, Lea Co., New Mexico.

Name: From Drinkard area, Lea Co., New Mexico.

*Earp formation.

Pennsylvanian (middle and upper Virgil) and Permian (Wolfcamp): Southeastern Arizona and extreme southwestern New Mexico (Hidalgo County).

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 18-23). *Earp fm.*—(1) Basal portion consists of thin shaly ls. and interbedded reddish shs. overlain by (2) shs., a few beds of ls. and sh. pebble cgl., and sss. (the latter most abund. about 150 ft above base); these overlain by (3) massive lss., with a few beds of dol. which weather a brilliant orange or red; these dols. are 1 to 6 ft thick, commonly crossbedded, and somewhat cherty, and have a few thin sss. associated with them. The topmost of these dol. beds forms the top of the Earp. The massive lss. are thick bedded, dense, blue gray, pink to dove gray, or mottled pink and white. Thin red sh. partings or beds throughout. Thickness varies from 600 to 1,126 ft. Overlies the Horquilla ls. conf.; underlies the Colina ls. with transitional conf.

Elliot Gillerman, 1958 (N. Mex. Bur. Mines Bull. 57, 35-38). *Earp. fm.*—interbedded thin shaly ls. and sh. and some ss. Unit much more clastic than underlying Horquilla ls. Dated in middle Wolfcamp and Leonard.

Type locality and section: From the saddle south of Earp Hill up to a conspicuous mottled pink and gray ls.; then completed by the excellently exposed section above this bed, about half a mile E. on the same slope.

Name: From Earp Hill in sec. 5, T. 21 S., R. 23 E., 6½ miles SE. of Tombstone, Arizona.

‡Eddy sandstone.

Permian (Guadalupian): Southern New Mexico.

C. R. Keyes, 1906 (Jour. Geol., v. 14, 147-154). *Eddy sss.*, 1,500 ft thick, underlie Capitan lss. The name is substituted for Richardson's name *Delaware Mtn. fm.*, which is preoccupied.

M. G. Wilmarth, 1938 (USGS Bull. 896, 659). *Delaware Mtn. fm.* of Richardson [is] not preoccupied; there is, therefore, no occasion to rename it.

Type locality: Outcrop at S. end of Guadalupe Mtns., Texas.

Name: Derivation not given; presumably from town of Eddy, New Mexico.

***Elbert formation.**

Upper Devonian: Southwestern Colorado and subsurface in southeastern Utah, northeastern Arizona, and northwestern New Mexico (Four Corners area).

W. Cross, 1904 (Am. Jour. Sci., 4th ser., v. 18, 245-252). *Elbert fm.*—The strata overlying Ignacio fm. (chiefly qtzite and believed to be of Upper Camb. age), underlying Ouray ls., and carrying fish remains at base and near top, which appear unquestionably to form a lithologic, strat., and faunal unit. At Devon Point the Elbert consists of (descending): (1) Red sh. or clay, 5 ft; (2) ss. or qtzite, containing fish scales in places, 1± ft; (3) calc. shs. and thin ls., buff or gray, breaking readily into slabs, salt casts common, 25 ft; (4) thin layers of alternating qtzite, dull-gray aren. ls., and red calc. sh., 8 ft; (5) hard fine-grained gray qtzite, 2½ ft; (6) red calc. sh., 1⅓ ft; (7) yellow earthy ls., ¾ in.; (8) calc. and sandy shs., variegated yellow, buff, lilac, 1⅓ ft; (9) fine-grained yellow-brown qtzite, 1 ft; (10) sandy sh., red, greenish, or mottled, a harder layer in middle, 5 ft; (11) sandy ls., shaly in part, rich in fish scales and plates, 1± ft; (12) red sh., calc., and sandy, with specks of bone or shell, 2 ft. Total thickness at Devon Point 54 ft. The Elbert has been observed below Ouray ls. in several quads. of San Juan region, and many exposures have been studied. Its most persistent feature is the crumbling calc. sh. div., with its casts of salt crystals. The most important variation in its lithology is appear. of dense earthy ls. of conchoidal fracture in several beds in upper part. Only fossils found are fish remains. Appears to correlate with "Parting qtzite" of central Colo.

R. L. Knight and J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 56-58), redefined the Elbert fm. into two membs., an upper memb. and the underlying McCracken ss. memb. The type locality for the two membs. is that logged by the Shell Bluff No. 1, located in sec. 32, T. 29 S., R. 22 E., San Juan Co., Utah.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 63). The *McCracken ss.*, ranging from 0 to 580 ft, underlies a great portion of the Four Corners area. To the W., in central Utah, this unit passes into Elbert fm. undiff. The McCracken ss. consists predom. of white, light-gray to red ss., fine- to medium-grained, some coarse, poorly sorted, commonly glauconitic, with a few streaks of sandy dol. The McCracken ss. grades upward into the sandy dol. of the upper memb. of the Elbert fm. The Aneth fm. underlies the McCracken ss., probably unconf. The McCracken ss. is believed to be equiv. to the Ignacio ss. as exposed at Baker's Bridge, Colo., which, in the past, has been assigned an Upper Camb. age (see Ignacio qtzite). The upper memb. of the Elbert fm., ranging in thickness from 0 to 307 ft, consists of thin-bedded dense to finely sucrose dol., locally anhydritic, commonly with floating frosted sand grains. The dol. is associated with thin interbeds of gray-green, waxy, and red clayey shs., generally sandy. The lower portion of the unit contains thin ss. beds which grade downward into the underlying McCracken ss. The upper memb. is probably unconf. overlain by the Ouray ls.

Type locality: Exposures at Devon Point on Elbert Creek.

Name: From Elbert Creek, a western tributary of the Animas River, Colorado.

‡†El Capitan limestone.

A term applied by some geologists to Capitan ls. of Texas; preoccupied by El Capitan granite (probably Cret.), Yosemite Nat. Park, California.

Elephant Butte formation. (Of Armendaris group.)

Pennsylvanian (Desmoinesian): Central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 47-49). *Elephant Butte fm.*—At type loc. 81.5 ft, largely ls., with one thin bed of cgl. ss. about 22 ft above the base, and several beds of calc. gray silty and micaceous sh. near the middle. Lower 22 ft is medium- to light-gray dense and cherty ls. (*Warmington ls. memb.*). Type section (ascending): (1) Warmington ls. memb., 22 ft; (2) cgl., pebbles to large granules, dark-reddish, subqtzitic, 1 ft; (3) covered, sh. and ss. on slope, 4 ft; (4) ls., light-gray, fine-grained, dense and hard, beds to 2 ft thick, middle 3 ft crinoidal, 8 ft; (5) ls., slabby, highly fossilif., 2 ft; (6) sh., light-gray, 2 ft; (7) ls., yellowish, weathers light gray, 2 ft; (8) ls., gray, fossilif., 2 ft; (9) ls., medium- to light-gray, fossilif., weathers purplish brown, 2 ft; (10) ls., gray, argil., 2 ft; (11) sh., light-gray, silty, 6 ft; (12) ls., thin-bedded, 3 ft; (13) sh., light-gray, micaceous, 8 ft; (14) ls., algal and cherty in upper part, 4.5 ft; (15) ls., light-gray to brownish, prominent red and yellow mottling, appears finely sandy, 7 ft; (16) ls., light-gray, beds to 4 ft thick, cherty, chert dendritic, weathers dark brown, algal, 6 ft. Conf. overlain by Whiskey Canyon ls.; lies unconf.(?) on Mud Springs gp. Fusulinid foraminifera (*Millerella, Eoschubertella, Fusulinella, Fusulina, Wedekindelina*) abund.

Type locality and section: W. end of Whiskey Canyon, just W. of westernmost box canyon, in SW¼ sec. 1, T. 13 S., R. 5 W., in Mud Springs Mtns.

Name: From Elephant Butte, in Rio Grande Valley, at Elephant Butte dam.

***Ellenburger group (limestone).**

Lower Ordovician (Canadian): Central Texas and subsurface of western Texas and southeastern New Mexico.

S. Paige, 1911 (USGS Bull. 450, 24). *Ellenburger ls.*—Chert-bearing lss. and dols., with usually a cgl. ls. at top. Thickness probably 1,000 ft. Unconf. may exist near top. Overlies, possibly unconf. at places, Wilberns fm.; underlies Carbf.

T. Cole, 1942 (AAPG Bull., v. 26, 1398-1409), divided the Ellenburger ls. into 5 zones and 15 units on basis of chert residues. Gave standard section for western Tex. as Loffland Bros. et al. J. B. Tubb No. 3, sec. 9, Blk. B-27, P.S.L. Surv., Crane Co., Tex.

P. E. Cloud, Jr., V. E. Barnes, and J. Bridge, 1945 (Tex. Univ. Pub. 4301, 133-161). the *"Ellenburger limestone"* of early reports is revised to *gp.* status, restricted to rocks of Lower Ord. age, and divided into 3 fms. In upward succession, the named divs. of the Ellenburger gp. are the *Tanyard fm.*, comprising the *Threadgill* and *Staendebach membs.;* the *Gorman fm.;* and the *Honeycut fm.* Although the 3 fms. of the Ellenburger gp. are essentially equiv. to previously named strat. units in Mo., new strat. names were introduced for the Llano region because of lithic differences and geographic isolation.

P. E. Cloud, Jr. and V. E Barnes, 1948 (Tex. Univ. Pub. 4621). Reconnaissnace study of the rocks comprising the Ellenburger Hills indicates that they belong principally, if not wholly, to the Tanyard fm.; yet, by definition and subsequent usage, the "Ellenburger ls." had come to include not only all Lower Ord. dols.

and lss. in the Llano region and the adjacent subsurface, but the immediately subjacent carbonate rocks of the Upper Camb. as well. The carbonate rocks of the Llano region that were formerly lumped as the "Ellenburger ls." are divisible at most places along a boundary set up on conventional faunal evidence into two clearly different sets of rock units, one Upper Camb. and the other Lower Ord. As revision was necessary, the term Ellenburger was used as a gp. term because it required the least revision of previous concepts. The lss. of the Ellenburger gp. are predom. sublith. and pearl gray to wood-ash gray and old ivory, varying to ordinary brownish grays and light browns. They are commonly, though not generally, stromatolitic, indicating an at least partial algal origin and generally a shallow-water environment. Deposition in shallow waters is indicated also by ripple marks and intraformational breccias; local, temporary subaerial exposure is suggested by the presence of contraction polygons in some of the more thinly bedded lss. Pellet lss. occur locally throughout the Ellenburger gp. The lss. tend to weather smooth to solution pitted or grooved, and medium to light bluish gray, or locally almost white. The dols. vary from microgranular to coarse grained. The more vividly colored microgranular to very fine-grained dols. occur in the Honeycut fm. and show greater lateral persistence than the coarser grained, light-colored dols. of the Tanyard fm. The latter are apt to grade laterally to ls. with great abruptness. The fine- to coarse-grained dols. weather rough to pitted, and medium gray to iron gray. The microgranular to very fine-grained dol. weathers sphenoidally jointed to hackly surfaced, smooth, and medium gray to light yellowish gray. As a rule the lss. of the Ellenburger gp. are lighter colored and finer grained than the Carbf. lss. above or those of the Camb. below. The dols. tend to be coarser grained and lighter colored, or finer grained and more vividly colored, than the dol. of the Camb. Dol. is rare in the Carbf. strata.

L. Hendricks, 1953 (Tex. Univ. Bur. Econ. Geology Rpt. Inv. 11), divides the Ellenburger gp. into its formational units in the subsurf. on the basis of the character of insoluble residues. However, change in quality of the residue does not in all places coincide with formation boundaries within the gp. but is evidently consistent enough to yield a clue to formation identity. Ellenburger gp. correlative with El Paso ls.

Type section: A series of type sections given for each of the units of the gp. (which see).

Name: From Ellenburger Hills, Burnett Co., Texas.

‡El Pasan series.

A term employed by C. R. Keyes to cover the Ord. lss. of western Tex. and southern N. Mex., which were formerly all included in El Paso ls., but which are now divided into Montoya ls. (above) and El Paso ls. restricted (below). He also applied the name to supposedly contemp. deposits in other States.

El Paso group (limestone).

Lower Ordovician: Western Texas and southern New Mexico.

G. B. Richardson, 1904 (Tex. Univ. Min. Surv. Bull. 9, 29). *El Paso ls.*—Mainly massive gray fossilif. ls., locally aren. at base and containing throughout bands of chert irregularly distrib. Of variable hardness. Ranges in color from drab and buff, with locally reddish and bluish streaks, to prevailing gray. Thickness 1,200 ft. Comprises all of Ord. in Franklin Mtns. Underlies Sil. ls.; in places overlies Camb. Bliss ss. and in other places rests on Precamb. rocks.

G. B. Richardson, 1908 (Am. Jour. Sci., 4th ser., v. 25, 476, 477-478), restricted *El Paso ls.* to lss. of Lower Ord. age and named the lss. of Upper and Middle

Ord. age the *Montoya ls.* He described El Paso ls. thus restricted as gray chiefly mag. ls., usually massive but locally thin-bedded; lower 100 ft characteristically aren. and weathers brownish. Thickness 750 ft in Van Horn quad. and 1,000 ft in El Paso quad. Not sharply separated from Montoya ls. In El Paso quad., overlies Bliss ss. with appar. conformity, where that fm. is present; where it is absent, the El Paso rests on Precamb. In Van Horn quad., it overlies Van Horn ss.

P. E. Cloud, Jr. and V. E. Barnes, 1948 (Tex. Univ. Pub. 4621, 72-75, 361-369). The El Paso section, at the S. end of the Franklin Mtns., and just outside the corporate limits of El Paso, El Paso Co., Texas, would make a good type section for the El Paso formation. 1,590 ft of section was measured in detail at this locality.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 39-56), raise the *El Paso* to a *gp.* in southern N. Mex. It includes 2 fms., the *Sierrite ls.* (lower) and the *Bat Cave fm.* (upper). The type section for these units is Cable Canyon, Caballo Mtns., sec. 10, T. 16 S., R. 4 W. The El Paso originally was thought to contain some beds of Upper Camb. age. It has been restricted to beds of Lower Ord. age.

Type locality: At S. end of the Franklin Mtns., above Scenic Drive, El Paso, Texas.

Name: From El Paso, Texas.

Embudo granite.

Late Precambrian: Central northern New Mexico (Picuris Range).

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 37-46). *Embudo granite.*—The Embudo granite borders the Picuris range on the S. and on the E. This rock was called by Just (1937) the *Dixon granite,* but this name has priority elsewhere. The Embudo granite consists of several distinctive rock types, all related to a single magma source. The rock is a quartz monzonite. It consists of: (1) coarse-grained partly-porphyritic biotite granite; (2) light-colored partly-porphyritic gneissic granite; (3) flesh-colored coarse-grained to pegmatitic leucogranite. Modes range as follows: Qtz, 26%-35%, microcline, 20%-35%, albite-oligoclase, 26%-33%, biotite, etc., 0%-10%. The Embudo granite is younger than the Ortega and Vadito fms. and is intrusive into them.

Type locality: Extensive outcrop 4 mi E. of Embudo, Rio Arriba Co.

Name: From town of Embudo.

***Epitaph dolomite.**

Permian (Leonard?): Southeastern Arizona and extreme southwestern New Mexico (Big Hatchet Mountains area).

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 25-27, 41). *Epitaph dol.*—Base arbitrarily taken at base of first massive dol. above zone of partially dolomitized ls. at top of Colina ls. About 200 ft of dol. forms lowest memb.; ranges from medium to light gray on fresh fracture and weathers light to very dark gray. One characteristic feature is knots of silica, along with granules of silica strewn parallel to the bedding. Toward top of this memb. partings of red sh. occur; overlying beds are poorly exposed sandy ls. or limy ss., with a higher proportion of maroon sh.; some of these beds are intraformational breccias. The uppermost part of the fm. is an assemblage of dol., ls., red sh., and thin sandy layers. Upper limit of the fm. is a very marked unconformity, above which is the Glance conglomerate or other rocks of Comanche age. Thickness of type section, 783 ft. Sparse fauna suggests Leonard age, equivalent to lower Kaibab.

R. A. Zeller, Jr., 1958 (unpub. Ph. D. thesis, Univ. of Calif., Los Angeles, 99-104). *Epitaph dol.*—Exposed in southwestern part of Big Hatchet Mtns. Lower 400 ft consists of thin-bedded dol. interbedded with red sh., claystone, and siltstone; overall weathered color is reddish brown, with the dol. dark gray on fresh fracture; finely to very finely crystalline, contains abundant knots of intergrown quartz and calcite, and is thin bedded. In one area thick massive deposits of white and light-gray gyp. are found interbedded with the thin beds of dol. The upper part of the fm. is composed entirely of uniform dol. in beds 1 to 10 ft thick; the dol. is medium and light gray on fresh fracture, is finely crystalline to lithographic, shows residual clastic texture, has many brecciated beds, and is rich in knots and small geodes having quartz shells and calcite cores. Light-gray dol. increases to become dominant in the upper 200 ft. Upper contact is sharp and is chosen where quartz sand grains appear in the overlying Scherrer fm.; lower contact gradational. Fm. is about 1,500 ft thick.

Type locality and section: Eastern dip slope of Colina Ridge, W. side of Epitaph Gulch, 1 mi S. of Horquilla Peak.

Name: From Epitaph Gulch, on Colina Ridge, Tombstone Hills, sec. 35, T. 20 S., R. 22 E., 4 mi S. of Tombstone, Arizona.

***Escabrosa limestone.**

Mississipian (Lower): Southeastern Arizona and adjoining extreme southwestern New Mexico (Hidalgo County).

F. L. Ransome, 1904 (USGS Prof. Paper 21, 42-44). *Escabrosa ls.*—Rather thick-bedded nearly white to dark-gray granular lss. made up largely of fragments of crinoid stems. Lower 100 ft usually in beds 10 to 15 ft thick; above that in beds of 1 to 5 ft, with occasional occurrences of more massive strata. As a whole, a pure nonmag. ls. containing practically no aren. sediments and only occasional irregular bunches and nodules of chert in upper part. Thickness 800± ft. Apparently lies conf. on Martin ls; overlain conf. by Naco ls.

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 2-13). *Escabrosa ls.*—White to light-gray coarse granular largely crinoidal lss.; thick-bedded; a few beds of finely crystalline dark-gray ls. in lower part; no ss. or sh.; chert absent in lower part, and only a few thin, fairly continuous bands in middle, but nodular chert common in upper part. Aver. thickness in S. 750 ft, but appears to thin to N. to 600± ft.

W. L. Quaide, 1953 (Geology of the Central Peloncillo Mountains, Hidalgo County, New Mexico, Univ. of Calif., unpub. Master's thesis, 25-31). *Escabrosa ls.*—Basal memb. a thin sequence of sh. and ls., with base at first crinoidal ls. In lower 75 ft, lss.; medium- to thin-bedded blue-gray coarse crinoidal clastic ls. which grades up into creamy-gray coarsely crystalline fetid calcarenites. The latter grade rapidly into the Black memb.: gray and black finely crystalline fetid medium- to thick-bedded ls., with black and brown chert throughout but most abund. in middle. Top unit: White memb.: massive-bedded creamy-white fetid calcarenites of crinoidal debris, much chert. Thickness 730 ft. Overlies Percha sh. with a conf. gradational contact; underlies the Paradise fm., also with a conf. gradational contact.

R. A. Zeller, 1956 (Prelim. composite stratigraphic section, Big Hatchet Peak quadrangle, Hidalgo County, New Mexico, New Mex. Bur. Mines, in manuscript). *Escabrosa ls.*—A basal 120 ft of interbedded nodular ls. and ls. lenses and shs., overlain by: (1) 200 ft of thick-bedded crinoidal ls. containing fenestellid beds, two zones of oölitic ls., and a massive cliff-forming clastic ls. (at the top of the unit) that contains some chert; (2) 100 ft of thin-bedded black fossilif. argil. ls. capped by a 40-ft cliff-forming massive black ls.; (3) 700 ft of massive-bedded light- to dark-gray ls.; the lower 300 ft shows cyclic deposition of

dark-gray fine-grained fossilif. ls., thin-bedded shaly ls., and dark-gray to black chert beds; the upper 400 ft consists of a very massive crinoidal ls., with a few widely scattered white chert layers.

Type locality: Escabrosa Ridge, Bisbee quadrangle, Arizona.

Name: From Escabrosa Ridge, Bisbee quadrangle, Arizona.

‡†Fierro limestone.

Permian, Pennsylvanian, and Mississippian: Southwestern New Mexico (Silver City region).

S. Paige, 1916 (USGS Silver City folio, n. 199). *Fierro ls.*—Gray to blue fossilif. ls. having max. thickness of 800± ft. Contains Penn. and Miss. faunas, which suggests an unconf. btw. upper and lower parts, but even in well-exposed sections no separation can be made by lithologic differences. Includes beds ranging from light gray to dark blue or purplish. West of Silver City, upper half is chiefly light gray or light blue, and lower half is darker blue except where whitened, probably by intrusions. The beds are characteristically cherty except in lower 100 ft. The chert is either black or white; near base some red chert. Rests on Percha sh. (Dev.) with apparent conformity; unconf. overlain by Beartooth qtzite (Cret.). Fossils listed. Faunas are early Miss. and early Penn. (Girty). The older fauna is correlated with that of Lake Valley ls.; the younger fauna with that of the Magdalena gp.

M. G. Wilmarth, 1938 (USGS Bull. 896, 730). Name abandoned in 1933, having been subdiv. into (descending) Abo red beds (Perm.); Magdalena group (Penn.), consisting of Syrena fm. above and Oswaldo fm. below; and Lake Valley ls. (Miss.).

Type locality and section: Unnamed gulch W. of Silver City.

Name: From town of Fierro, in NE. part of Silver City quadrangle.

Fletcher anhydrite member (of Salado formation).

Permian (Ochoan): Subsurface of southeastern New Mexico and western Texas.

W. B. Lang, 1942 (AAPG Bull., v. 26, 63-79). *Fletcher anhydrite memb.*—50 to 100 ft; basal anhydrite bed of Salado fm. Top gradational with overlying halite. Mostly massive, pure anhydrite, with some magnesite (up to 5 percent) and wood-brown dol. Some pure anhydrite is bluish gray. Lies unconf. on Carlsbad ls.

Type locality and section: Fletcher No. 1 potash test, U. S. Potash Co., sec. 1, T. 21 S., R. 28 E., Eddy Co., New Mexico.

Name: From Fletcher potash test, U. S. Potash Co.

Fra Cristobal formation. (Of Mud Springs group.)

Pennsylvanian (Derryan): Central and southern New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 37-39). *Hot Springs fm.*—At type loc., 85.5 ft of dark-gray to light-gray massive to nodular highly cherty ls. and thick beds of red and gray sh. To S., at Derry, 24 ft, almost entirely ls. To N., overlaps Precamb., contains coarse clastics at base. Type section (ascending): (1) slope, dark-gray sh. and ls., poorly exposed, 14 ft; (2) ls., gray, hard, glistening, beds to 1.6 ft thick, black masses of hard chert in upper part, 6 ft; (3) sh., interbedded with cherty ls., 5 ft; (4) sh., red, fissile, soft, 3 ft; (5) sh., calc., interbedded with nodular ls., 5 ft; (6) ls., crinoidal, gray to light-gray, beds to 1 ft

thick, 7 ft; (7) sh., light-gray, contains nodular lime, 3 ft; (8) ls., gray to light-gray, dense and hard, one massive bed, 2.5 ft; (9) ls., slabby, argil., interbedded with sh., brownish-gray, weathers light gray, 14 ft; (10) ls., medium- to dark-gray, evenly bedded, crinoidal in upper part, upper 6 ft highly cherty, 13 ft; (11) ls., gray to light-gray, beds to 1 ft thick in lower part, 2.5 ft thick in upper part, stained brown along bedding, 13 ft. Fusulinid fauna: *Millerella, Ozawainella*(?), *Eoschubertella, Pseudostaffella,* and *Fusulinella.* Lies conf. on Green Canyon gp.; conf. overlain by Cuchillo Negro fm.

M. L. Thompson, 1948 (Kans. Univ. Paleont. Contr., Protozoa, art. 1, 74). The name *Fra Cristobal formation* here proposed for the rocks called the Hot Springs formation by Thompson (1942).

Type locality and section: W. end of Whiskey Canyon in N. Mud Springs Mtns., SW¼ sec. 1, T. 13 S., R. 5 W.

Name: From the Fra Cristobal Range on east side of the Rio Grande, Sierra Co.

Fresnal group.

Pennsylvanian (Virgilian): Southern and central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 73-82). *Fresnal gp.*—Name proposed for all sedimentary rocks definitely referable to Virgil series btw. top of Keller gp. below and base of Perm. above. At type loc., 530 ft thick, but apparently over 1,000 ft thick at some places in San Andres Mtns. In Oscura Mtns., 113 ft thick; at Abo Canyon, 120 ft thick, but only lower part present. At type section, Fresnal gp. is argil. to essentially pure ls., arkosic ss., cgl., and gray to red sh. Over 50 percent of rocks at type section are clastics, but most are of marine origin. The conglomerates contain large pebbles of igneous and metamorphic rocks. In central N. Mex., the Fresnal gp. is largely red shs., with interbedded thin nodular to irregularly bedded and highly fossilif. ls. and arkosic ss. Fusulinid faunas indicate that this is among youngest portions of Virgil strata known in N. Am. The name *Bruton fm.* is proposed for the lower portion of the Fresnal gp. in the area of the Oscura Mtns. and the region W. and N. of the Oscura Mtns. along the Rio Grande Valley, where the Bruton fm. is the only part of the Fresnal gp. exposed.

Type locality and section: Fresnal Canyon, along State Highway 83, E. of La Luz, at N. end of Sacramento Mtns., in NW¼ sec. 30, T. 15 S., R. 11 E., Otero Co.

Name: From Fresnal Canyon, in northern Sacramento Mtns.

‡†Frijole limestone member (of Delaware Mountain formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

W. G. Blanchard, Jr. and M. J. Davis, 1929 (AAPG Bull., v. 13, 973, 987). Delaware Mtn. fm. in Guadalupe Mtns. is capped by a dark shaly ls. designated in this paper as *Frijole ls.* This memb. is extremely persistent and is recognizable in well cuttings as far E. as western Winkler Co. Below Frijole ls., deep in underlying Delaware Mtn. ss., other ls. membs. are present and lithologically are practically indistinguishable from Frijole ls. Typical Delaware Mtn. fm. of Delaware Mtns. (p. 988) included in its top part the equiv. of Capitan ls.; Frijole ls. was its top bed. [This interpretation of the position of Frijole ls. is also that of R. E. King (Tex. Univ. Bull. 3042, 11-13, 1931) and E. H. Sellards (Tex. Univ. Bull. 3262, 159, 160, 181, 1933).]

M. G. Wilmarth, 1938 (USGS Bull. 896, 781). Although the 1929 publication cited is first known appearance of Frijole ls. in print, the name had for 2 or 3 years previously been in common use among geologists working in the region.

Type locality: Outcrop at Frijole Post Office, Culberson Co., Texas.

Name: From Frijole Post Office, Culberson Co., Texas. Name now replaced by *Lamar ls. memb.*, it having been found that the ls. at Frijole Post Office is not top memb. of Delaware Mtn. fm. but an older ls. See W. B. Lang, 1937 (AAPG Bull., v. 21, 833-896).

‡Frondosa limestone.

Ordovician: Southern New Mexico.

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 7). *Frondosa lss.*—Main body of Middle Ord. series in Franklin Mtns., which carries a Galena-Trenton fauna. Thickness 100 ft.

Type locality: Not designated.

Name: Derivation not indicated.

Fusselman limestone (dolomite).

Silurian: Western Texas and southern New Mexico.

G. B. Richardson, 1908 (Am. Jour. Sci., 4th ser., v. 25, 476-480). *Fusselman ls.*—Massive whitish mag. ls., approx. 1,000 ft thick. Overlies Montoya ls., apparently conf.; underlies Hueco ls., also apparently conf. Contains fossils of upper Niagaran age. Outcrops in El Paso quad., in Franklin and Hueco Mtns.

N. H. Darton, 1917 (USGS Prof. Paper 108C, 42-43). *Fusselman ls.*—In the San Andres and Sacramento Mtns., the fm. comprises two membs., an upper memb. of hard dark-colored massive ls. marked by a cliff at most places, and a lower memb. of fine-grained dol., most of which weathers nearly white. The upper memb. contains fossils, but the lower has yielded no fossils and is arbitrarily placed in the fm. because it is distinct from the underlying cherty beds that are characteristic of the upper part of the Montoya.

K. C. Dunham, 1935 (N. Mex. Bur. Mines Bull. 11, 43), refers to the Fusselman as *Fusselman dol.* because of its largely dolo. character.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 62-68), designate Darton's (1917) lower unit of the Fusselman as a new fm., the *Cutter fm.* of the Montoya gp. (Ord.).

L. C. Pray, 1953 (AAPG Bull., v. 37, 1911-1917). The Fusselman(?) fm. of the Sacramento Mtns. consists almost entirely of dark-weathering chert dol. Lower Fusselman of Darton (1917) has been separated from Fusselman as *Valmont fm.* of Upper Ord. age. Fusselman(?) in the Sacramento Mtns. appears to be Lower Sil. and may not be same as type Fusselman (Upper Sil.).

Flower, R. H., 1955 (NMGS Guidebook, 6th Field Conf., 69). Recently Pray (1953) reported a fauna from the restricted Fusselman of the Sacramento Mtns. regarded as Alexandrian (Lower Sil.). If this is correct, the Fusselman may actually contain several divisions of the Sil., for the large *Pentamerus oblongus* suggests Clinton or Racine age, and the smaller Conchidium suggests a similar age range.

Type locality: At S. end of Franklin Mtns., El Paso, Texas.

Name: From Fusselman Canyon, Franklin Mtns.

‡Gallegos sandstone.

Pennsylvanian(?): Central New Mexico (Sandia Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of the geologic formations of New Mexico, 3, 7). *Gallegos sss.*—Thick ss. beds in middle of Maderan lss. in Sandia Range. Thickness 100 ft.

Type locality: Not designated.

Name: Derivation not indicated.

Garcia formation. (Of Armendaris group.)

Pennsylvanian (Desmoinesian): Central New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 42-43, 50-51). *Garcia fm.*—At type loc., 213 ft of essentially pure highly fossilif. ls., argil. to slightly aren. and cherty lss., several thin gray to red shs., and a 50-ft bed of highly cgl. ss. at the base. Fusulinid fauna: *Wedekindellina* and *Fusulina*. Lies conf. on Whiskey Canyon ls.; conf. overlain by Bolander gp.

Type locality and section: W. end of Whiskey Canyon, just E. of westernmost box canyon, in Mud Springs Mtns., sec. 1, T. 13 S., R. 5 W.

Name: From Garcia road, 4 to 5 miles W. of Mud Springs Mtns.

‡Garnuan series.

Precambrian: New Mexico (Manzano Mountains).

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 7). *Garnuan series.*—Thick argillaceous sequence which lies below the Tijeras qtzite in the Tijeras and Coyote Canyons at the north end of the Manzano Mtns. Still other sediments underlie it. Thickness 2,000 feet which is called the Antonito slate.

Type locality: Not designated.

Name: Derivation not indicated.

Getaway limestone member (of Cherry Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico (Delaware Mountain, Guadalupe Mountains).

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Getaway ls. memb.*—Black or dark-gray ls., with some lighter gray granular very fossilif. ls. and some ss. partings. Thickness 0 to 200 ft. Lies 100 to 200 ft above base of Cherry Canyon fm.

P. B. King, 1948 (USGS Prof. Paper 215, 34-35). *Getaway ls. memb.*—Group of ls. beds in lower part of Cherry Canyon fm. Separated from uppermost massive sss. of Brushy Canyon fm. by 192 ft of thin-bedded ss. Consists largely of fine-textured black or dark-gray ls., which weathers to mouse-gray or ash-gray surfaces. Most beds are from a few in. to a ft thick, but some parts are thinly laminated or platy. Many of the bedding surfaces are straight and smooth, but others are nodular, wavy, and hummocky, with straighter bedded layers deposited over the uneven surface. Btw. some of the ls. beds are thin-bedded or platy ss. layers and rare partings of marl. Interbedded with the dark thin-bedded lss. are some lenses of light-gray more granular ls., in places dolo., in massive beds from 2 to 10 ft thick, which extend 25 to 100 ft along the outcrop. Where the ls. beds of the memb. thin out, their place is taken by platy, shaly sss., which crop out in ragged ledges. These shaly sss. contain zones of ls. nodules, which are probably the equiv. of continuous beds elsewhere. Thickness 0 to 200 ft.

N. D. Newell et al., 1953 (The Permian reef complex, etc., 28), include two Getaway membs., one of which is the lower part of King's (1948) Goat Seep ls. In view of the fact that it is not part of the overlying reef, it is considered here as an independent unit (Upper Getaway ls.).

Type locality and section: Getaway Gap, S. Guadalupe Mtns., Texas.

Name: From Getaway Gap, 6 mi SE. of El Capitan, S. Guadalupe Mtns., Culberson Co., Texas.

Glorieta sandstone (Glorieta sandstone member of San Andres formation).

Permian (Leonardian): Central northern, central, and southeastern New Mexico, and subsurface of western Texas.

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257, 262; and Conspectus of geol. fms. of N. Mex., 2, 7). *Glorieta sss.*—Main body of Dakotan series (Cret.) around S. end of Rocky Mtns. Thickness 300 ft.

D. Hager and A. E. Robitaille, 1919 (Geol. rpt. on oil possibilities in eastern N. Mex.). *Glorieta ss.* is top memb. of Yeso fm. It consists of 500 ft of massive ss., even-grained and white, when broken open, but weathering reddish brown.

C. L. Baker, 1920 (Am. Jour. Sci., 4th ser., v. 49, 111, 118, 119, 126). *Glorieta* ss., basal memb. of Upper Trias, outcrops along valley of Pecos from Glorieta Mesa downstream to somewhere btw. Puerto de Luna and Fort Sumner, N. Mex., and at Santa Rosa, N. Mex. Near Anton Chico it rests on Yeso fm.

J. L. Rich, 1921 (Am. Jour. Sci., 5th ser., v. 2, 295, 296). Baker has confused Glorieta ss. in parts of area with the younger (Upper Triassic) Santa Rosa ss. The Glorieta ss. is coarse, gray, massive, and 300 to 500 ft thick; underlies San Andres ls., overlies Yeso fm., and is of Perm. age.

M. G. Wilmarth, 1938 (USGS Bull. 896, 831). As there is no fm. btw. San Andres ls. and Yeso fm. as defined (now called Yeso memb. of Chupadera fm.), the ss. of Glorieta Mesa is top part of Yeso memb. of that area.

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1668). *Glorieta ss.*—On account of its wide distribution, persistence of lithology, bold topographic expression, and strat. importance, the Glorieta ss. is considered to be a fm. At the newly designated type loc., consists of 116 ft of white to gray medium-coarse qtzitic ss., in beds 2 to 6 ft thick; weathers pale yellow and forms cliff with 20 ft of buff to white soft thin-bedded ss. at base. Conf. with Yeso fm.; unconf.(?) overlain by San Andres fm. Thickness 12 to 300 ft. Thins in Sacramento Mtns.; thickens again to SE. Same as Hondo ss. of Lang.

R. E. King, 1945 (N. Mex. Bur. Mines Bull. 23, 10-11). In Eddy and Lea Cos. distinction btw. Glorieta sand and upper sands of Yeso fm. is difficult, because Glorieta thins southeastward from its source in N. central N. Mex., and dol. and anhydrite wedge into Joyita memb. of Yeso. In general, the base of a sand 150 ft or more below the top of Glorieta is identified as top of Yeso. Because of the known southeastward thinning of the Glorieta, the possibility must be considered that only the highest sand, in places less than 10 ft thick, of the so-called Glorieta of Lea Co. may actually be equiv. to the type Glorieta, and that the remainder of the sandy zone may be Joyita (upper Yeso). It is even possible that the Glorieta wedges out completely toward SE., and that the top of the so-called Glorieta sand of most of Lea Co. is the top of the Yeso.

In many rpts., USGS personnel have used Glorieta ss. as lower memb. of San Andres fm. after 1940, rather than as upper memb. of Yeso fm. First known occurrence of this usage is by C. B. Read and D. A. Andrews (USGS Oil and Gas Inv. Prelim. Map 8, 1944): San Andres fm. is shown as upper memb., 0-80± ft, light terra cotta to orange gypsif. siltstone and fine-grained ss.; ls. memb., 1-20+ ft, light-gray, thick-bedded, cavernous-weathering ls.; and *Glorieta ss. memb.*, 100-250 ft, light-gray, crossbedded, medium-grained ss.

In many areas in N. Mex., the N. Mex. Bur. Mines and Min. Res. recognizes Glorieta ss. as separate fm. This usage is followed also by petroleum geologists in the area.

Type locality and section: Designated by Needham and Bates as S. central part of T. 15 N., R. 12 E., on Glorieta Mesa, 1 mi W. of village of Rowe, San Miguel Co., New Mexico.

Name: From Glorieta Mesa, San Miguel Co., New Mexico.

Goat Seep limestone.

Permian (Guadalupian): Western Texas and southeastern New Mexico (Guadalupe Mountains).

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Goat Seep ls.*—Upper ls. beds of Cherry Canyon fm. coalesce to become thick-bedded massive reef lss., 700 to 1,200 ft thick. This unit was earlier described as Chupadera ls., and later as †Dog Canyon ls. by W. B. Lang (1937). Dog Canyon term abandoned because fm. not so well defined as at Goat Seep; confused, moreover, with Dog Creek of Okla.

P. B. King, 1948 (USGS Prof. Paper 215, 38-41). *Goat Seep ls.*—At type loc. consists of massive lenticular gray dolo. lss. in beds as much as 10 ft thick, many of which rest on channeled surfaces of the underlying sss. or slabby lss. Nearly all sss. pinch out to N. Fm. thickens to N., where thick lower half consists of light-gray dolo. ls., weathering to dirty gray, with jagged surfaces, in beds 10 to 50 ft thick, interbedded with some buff, calc. medium-grained ss. Upper half of fm. stands as single massive bed of ls., without a trace of bedding planes. The upper part is a sandy buff dolo. ls.; at other places, thick-bedded, slightly dolo. To N. and S., fm. is thinner and contains more interbedded sss. Lower part may be mostly massive buff ss., with few interbedded lss.

N. D. Newell et al., 1953 (The Permian reef complex, etc., 28), remove lower half (bedded part) of King's *Goat Seep fm.* from Goat Seep and term it *Upper Getaway ls. memb.* of Cherry Canyon fm., because it is a "bank facies." "In view of the fact that it is not part of the over-lying reef, it is considered here as an independent unit."

Type locality and section: 2 mi N. of Goat Seep, beyond Shirttail Canyon, SW. end of Guadalupe Mtns.

Name: From Goat Seep, on SW. slope of Guadalupe Mtns., Culberson Co., Texas.

Gobbler formation.

Pennsylvanian (Morrowan?, Atokan, Desmoinesian, lower Missourian): Southeastern New Mexico (Sacramento Mountains).

L. C. Pray, 1952 (Calif. Inst. Tech., Ph. D. dissertation, 189-200). *Gobbler fm.*—Largely sh., argil. ls., and very coarse-grained qtz ss. in lower half, and gray cherty ls. in medium to thick beds in upper half. The gray cherty ls. that forms prom. cliffs in middle and upper part is called *Bug Scuffle ls. memb.* Ls. in lower part, dark-gray, argil. to silty, massive, contains nodules of black and gray chert. The Bug Scuffle ls. memb. forms sheer 500- to 700-ft cliffs. Locally it grades to clastic beds. It is predom. light-gray sublithographic to finely crystalline very pure ls. Light-gray chert common. Clastic facies largely sh., ss., siltstone, and clastic ls. Lies unconf. on Miss. strata; conf. overlain by Beeman fm.

L. C. Pray, 1954 (NMGS Guidebook, 5th Field Conf., 93), indicated *Gobbler fm.* on a strat. chart as a manuscript name.

Type section: NW¼NE¼NW¼ sec. 15, T. 17 S., R. 10 E., Sacramento Mtns.

Name: From Gobbler triangulation station, in sec. 19, T. 18 S., R. 11 E., Sacramento Mtns.

***Gorman formation.** (Of Ellenburger group.)

Lower Ordovician: Central Texas and subsurface of western Texas and southeastern New Mexico.

P. E. Cloud, Jr., V. E. Barnes, and J. Bridge, 1945 (Tex. Univ. Pub. 4301, 133-161), named *Gorman fm.* [See this ref. under Ellenburger gp.]

P. E. Cloud, Jr., and V. E. Barnes, 1948 (Tex. Univ. Pub. 4621). *Gorman fm.*—The lowest microgranular dol. in significant quantities in the outcropping Ellenburger rocks is at the base of the Gorman fm.; it occurs intermittently from the Tanyard-Gorman contact to the top of the Ellenburger gp. The Gorman has a lower dol. facies, 80 to 240 ft thick, of microgranular to fine-grained dol., varicolored in yellowish, pinkish, and brownish tones. These dols. commonly weather to smooth, crudely sphenoidal blocks of gray and dull yellow. The upper calcitic facies, 240 to 390 ft thick, consists principally of sublith. thickly to thinly bedded ls., with locally interbedded microgranular to fine-grained dol. The ls. is mostly pearl gray to wood-ash gray, grading to old ivory and brownish gray, and locally mottled pink or yellow. It weathers to medium or light bluish gray and is not commonly reticulate. A sequence of unusually pure and thickly bedded ls. occurs in the top 40 to 60 ft of the Gorman fm. and is succeeded immediately by the thin-bedded dols. and lss. of the lower Honeycut, commonly aren. at the base. Chery in the lower Gorman consists of porcelaneous white to wood-ash gray chert, with scattered dolomolds and qtzose matter, irregularly interlayered with qtz druse weathering russet and commonly containing fossils. Porcelaneous to subporcelaneous white shiny-weathering chert is less qtzose in the upper Gorman. Thickness of Gorman is 430 to 500 ft. Correlated with the Roubidoux fm. of Mo.

Type section: Near Gorman Falls, on Gorman Creek, SE. San Saba Co. and SW. Lampasas Co., Texas.

Name: From Gorman Falls.

Grande limestone.

Mississippian: Southwestern New Mexico (Sierra County).

C. R. Keyes, 1908 (AIME Bull. 19, 7-10). *Grande ls.*—Blue ls., 25 ft thick, containing Lake Valley silver ores, which were first opened at Sierra Grande workings. Consists of (descending): (1) hard, compact, heavily bedded pure soluble ls., 10 ft; (2) black subcrystalline ls., 2 ft; (3) massive hard grayish-blue coralline rocks, 13 to 15 ft. Underlies Lake Valley ls. (restricted to beds containing lower Burlington fossils) at Lake Valley; unconf. overlies Dev. Berenda ls.

L. R. Laudon and A. L. Bowsher, 1941 (AAPG Bull., v. 25, 2109). *Grande ls.* is a recognizable facies of the Alamogordo memb. as used in this paper.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 1-88). Restricted *Alamogordo memb.* of Lake Valley fm. described in the same terms used by Keyes in describing his *Grande ls.* It appears that the Alamogordo memb. may be same as Grande ls.

Type locality and section: Not designated.

Name: Probably from Grande workings, 0.4 mi NW. of Lake Valley, Sierra Co.

‡†Graphic-Kelly limestone.

Mississippian: Central New Mexico (Kelly district).

C. L. Herrick, 1904 (Am. Geologist, v. 33, 310-312). *Graphic-Kelly fm.*—Crystalline and light-colored lime, separated by close-grained dense lime resembling lithographic stone known locally as *"Silver-pipe" lime.* The beds above the separating "Silver-pipe" lime are called *Kelly lime,* and the beds below it are called *Graphic lime.* Overlain by Sandia fm.; underlain by qtzite. (Occurs in Kelly mining dist., Socorro Co.)

Type locality: Kelly mining district, Socorro Co.

Name: From Graphic and Kelly mines, Kelly mining district, Socorro Co.

‡Graphic lavas.

Precambrian: Central New Mexico (Magdalena Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 7). *Graphic lavas.*—Bedded volcanic sequence superposed on Precamb. Rocks of Magdalena Mtns. On p. 4 they are shown as Precamb.

Type locality: Not designated.

Name: From Graphic mine.

Grayburg formation.

Permian (Guadalupian): Southeastern New Mexico and western Texas.

R. I. Dickey, 1940 (AAPG Bull., v. 24, 37-51). *Grayburg fm.*—Lowest beds of Whitehorse gp. (May be equiv. of beds referred to Dog Canyon of Lang.) Characterized by a predominance of dol. beds which vary in color from gray to pink and white. These dol. beds are locally sandy and interbedded with gray and red sands, which in many places carry frosted qtz grains. Beds of anhydrite are present in structurally low areas; also beds of sandy gray sh. and gray and green bentonite. Lies unconf. on San Andres fm.; conf.(?) overlain by Queen fm. Thickness about 300 ft. Thins to E. Type section given in detail.

J. W. Skinner, 1946 (AAPG Bull., v. 26, 1857-1874), claims that *Grayburg* of subsurf. is equiv. to lower part of Queen fm. of surface exposures and should be reduced to memb. of Queen fm. if retained at all.

W. R. Moran, 1954 (GSA Bull., v. 65, 1288 [abs.]). Recent mapping has shown that *Grayburg* deserves formational status. Since a great deal of confusion has arisen because this commonly used name has never been defined adequately in its surface outcrops, a type section is proposed. The proposed surface type section of Grayburg fm. is on a spur, and in an unnamed canyon above Sitting Bull Spring, in NE¼ sec. 9, T. 24 S., R. 22 E., where a total thickness of 475 ft of alternating ss. and dol. is exposed.

Type locality and section: (subsurf.) Cecil R. Lockhart's Root Permit No. 2, in SW¼SW¼ sec. 7, T. 17 S., R. 30 E., Eddy Co., New Mexico (from -2,380 ft to -2,674 ft); (surface) NE¼ sec. 9, T. 24 S., R. 22 E., Eddy Co., New Mexico.

Name: From Grayburg pool, Eddy Co., New Mexico.

Gray Mesa member (of Madera limestone).

Pennsylvanian (Lampasan?-Desmoinesian): North central New Mexico (Lucero uplift area).

V. C. Kelley and G. H. Wood, 1946 (USGS Oil and Gas Inv. Prelim. Map 47). *Gray Mesa memb.*—900 ft of thick-bedded sometimes massive cherty gray ls. One or more massive ledges are prom. above the middle of the memb. The upper limit of the Gray Mesa memb. is the top of a rather conspicuous thin-bedded tan-weathering ls. about 200 ft above the top of the massive ledges. Lies conf.(?) on Sandia fm.; conf. overlain by Atrasado memb. Madera ls. Is basal memb. of Madera ls.

C. B. Read and G. H. Wood, 1947 (Jour. Geol., v. 55, 229, 232-236). Based on fusulinid fauna *(Fusulinella, Fusulina), Gray Mesa memb.* of Madera ls. in Lucero uplift area is probably Des Moines in age. Basal portion may be of Lampasas age.

Type locality: Along steep E. face of Gray Mesa, from Comanche Arroyo to Monte de Belen, T. 5 N., R. 3 W., Valencia Co.

Name: From Gray Mesa.

Green Canyon group.

Pennsylvanian (Derryan): Southern and central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 34-36). *Green Canyon gp.*—Name proposed for the rocks of the two basal fms. of the Derry series, *Arrey fm.* and *Apodaca fm.* The Arrey fm. is 32 to 300 ft thick, consists of dense massive lss., highly nodular lss. with irregularly interbedded highly calc. shs., and very common irregular masses and lenses of chert. More highly clastic in N.; essentially pure ls. to S., where it is thicker. The Apodaca fm., 55 to 65 ft thick, consists of dense gray lss. with common masses and lenses of chert, nodular lss., calc. shs., black to dark-gray calc. siltstones, and greenish to bluish-gray shs. Lies unconf. on Miss. or Dev.; conf. overlain by Mud Springs gp.

Type locality and section: Three-fourths mi E. of Derry, near center of sec. 32, T. 17 S., R. 4 W.

Name: From Green Canyon, one-half mi N. of Derry.

Guadalupian.

A time term used by many geologists to indicate the epoch during which the Guadalupe series of western Texas and southeastern New Mexico was deposited. A recognized subdiv. of Perm. time.

Guadalupe series (Guadalupe group).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

G. H. Girty, 1902 (Am. Jour. Sci., 4th ser., v. 14, 363-368). Not only are these faunas very different from any known elsewhere in America, but they give evidence of being later in geol. time. For this reason it is proposed to give them a regional name, which shall be employed in a force similar to *Mississippian* and *Pennsylvanian*. For this none is more appropriate than one derived from the loc. where they were first discovered; the term *Guadalupian*, therefore, is suggested. The strat. limits of *Guadalupian period* will have to be determined on intrinsic evidence. At present it appears to include the whole section at S. end of Guadalupe Mtns., but the central fauna will be that of the "white" and "dark Permian" as described by Shumard. (The faunas to which name was applied were obtained from 1,700 to 1,800 ft of ls. (afterward named *Capitan ls.*), underlain by 2,000 to 2,500 ft of yellow quartzose ss., underlain by 500 or more ft of thin-bedded black ls., the ss. and basal ls. being afterward named *Delaware Mtn. fm.* The basal ls. (now known as *Bone Spring ls.*) is, because of faunal and lithologic differences, now excluded from Delaware Mtn. fm., with which it is unconf., and therefore may not properly be a part of Guadalupe gp., although included in original definition. At time "Guadalupian" was introduced, the Bone Spring ls. had yielded only a few fossils.)

G. H. Girty, 1908 (USGS Prof. Paper 58, 10-11). *Guadalupian series.*—Includes Capitan ls. and Delaware Mtn. fm. Appears to be younger than Hueco fm. Overlying fm. undet., being absent in Guadalupe Mtns.

M. G. Wilmarth, 1938 (USGS Bull. 896, 884). Adopted as group term to include, originally, Capitan ls. and Delaware Mtn. fm., which are characterized by unique fauna of Perm. age. Now known unconf. to underlie Castile gyp. (also of Perm. age) and considered to be in part younger and in part contemp. with beds that have been described as Hueco ls. The Delaware Mtn. fm. of Dela-

ware Mtns. is now known to include in its upper part the time equiv. of Capitan ls. of Guadalupe Mtns. See rpts. by P. B. King, (GSA Bull., v. 45, 697-793), 1934), and W. B. Lang, (AAPG Bull., v. 19, 262-270, 1935; v. 21, 833-898, 1937).

J. E. Adams et al., 1939 (AAPG Bull., v. 23, 1673-1681). *Guadalupe gp.* (restricted) here raised to series rank and designated a div. of Perm. of N. America. Restricted Guadalupe gp. includes beds of post-Leonard and pre-Ochoa age. Thickness at type loc. 5,250 ft. Type section is Getty Oil Co.'s Dooley No. 7, sec. 24, T. 20 S., R. 29 E., Eddy Co., N. Mex. (from —1,020 to —6,270 ft). Equiv. to Whitehorse gp. and its equivalents.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). In this paper the terms Wolfcamp, Leonard, *Guadalupe,* and Ochoa series are considered to be provincial terms.

P. B. King, 1948 (USGS Prof. Paper 215, 28). In Delaware Mtns., according to the new definitions, the Delaware Mtn. gp. and the Guadalupe series have the same limits in the sequence, but each has a different connotation. The name Delaware Mtn. is applied to a distinctive facies of dominantly sandy rocks, which project as tongues btw. other units of different facies but in part of same age. The name Guadalupe, on the other hand, is used for a time unit applied over the whole of the west Texas region to rocks of the same age.

F. E. Kottlowski et al., 1956 (N. Mex. Bur. Mines Mem. 1, 47). Noteworthy is a decision by the Geologic Names Committee of USGS, dated July 28, 1955, here quoted in part: "The Chief Geologist has approved [that] . . . the use of provincial series be continued as subdivisions of the Perm. system in preference to lower, middle, and upper."

Thus, the term *Guadalupe series* has been extended to include those strata deposited at the same time as the Guadalupe series of western Tex.

Type locality and section: Guadalupe Point, S. end of Guadalupe Mtns., Culberson Co., Texas.

Name: From Guadalupe Point.

Gym limestone.

Permian (Manzano; i. e., lower): Southwestern New Mexico (Deming region).

N. H. Darton, 1916 (USGS Bull. 618, 19, 35). *Gym ls.*—Chiefly light-gray ls., in greater part massively bedded, showing brecciated structure in many beds. In Gym Peak (type loc.) and vicinity, the lower memb. is dark, and the one next above of much lighter color, with abrupt change btw. them; thickness there at least 700 ft. Occurs in central and SE. parts of Florida Mtns. and central part of Victorio Mtns., and extends part way around N. end of Tres Hermanas Mtns. Total thickness near 1,000 ft. Rests unconf. on Magdalena, Lake Valley, and older fms.; unconf. overlain by Lobo fm. (Triassic?) or Tert. agglomerate. Fossils discussed.

V. C. Kelley and L. E. Bogart, 1952 (AAPG Bull., v. 36, 1644-1648). *Gym ls.* in Florida Mtns. is mostly Fusselman fm. There is no Gym ls. in Victorio Mtns. (i. e., no Perm. lss.). All the Gym ls. as originally defined is in Luna Co., N. Mex. The original delineation of the fm. included rocks that range in age from Sil. to Cret. No Gym ls. occurs at type loc. in Gym Peak, and little Perm. ls. in the entire Florida Mtns. The largest outcrops and thickest sections appear to be in the Tres Hermanas Mtns., and this "Gym" ls. is lithologically considerably different from the restricted Gym of the Florida Mtns. Until all Gym localities can be restudied, it appears best to restrict the term Gym to small outcrops in the southeastern part of the Florida Mtns.

Jicha, H. L., Jr. (N. Mex. Bur. Mines Bull. 37, 24). On basis of faunal evidence, the beds formerly classified as Gym by Darton in Cooks Range are referred to the Penn.

It appears that the Gym limestone must either be redefined or discarded.

Type section: On Gym Peak, Florida Mtns., where, however, the exposures are all of the Fusselman fm. (Sil.).

Name: From Gym Peak, Florida Mtns.

‡†Hanover limestone.

Mississippian (Lower): Southwestern New Mexico (Central mining district).

H. Schmidt, 1933 (AIME Contr. 39). *Hanover ls.*—Crinoidal ls. forming top part of Lake Valley ls. in Central mining dist. (or Santa Rita-Hanover-Fierro dist.). Because of deformation by the centrifugal peripheral thrust during intrusion of Hanover "stock," the Hanover ls. varies in thickness from 80 to 150 ft, the max. measurement having been made at the crest, and the min. on a limb of the peripheral anticline. Aver. thickness in undisturbed areas 110 ft. No other fms. in vicinity of Hanover are known to be greatly deformed.

Name is preoccupied by Hanover shale (Late Devonian) in New York State.

Type locality: Hanover mine.

Name: From Hanover mine.

Hansonburg group.

Pennsylvanian (Missourian): Central New Mexico.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 63-69). *Hansonburg gp.*—Name proposed for strata in upper part of Missouri series btw. Veredas gp. below and Keller gp. (Virgilian) above. Consists of *Burrego fm.* below and *Story fm.* above. *Burrego fm.* is massive to massively bedded and nodular lss. at type loc., though thick sss. and shs. occur at other localities. Thickness 52 ft. *Story fm.* is 20 ft of reddish-brown sh., arkosic and micaceous ss., and gray sh., overlain by 38 ft of light-gray massive to massively bedded and highly fossilif. ls. Thickness of Hansonburg gp. 115 ft at type loc.; 200 ft at Mockingbird Gap. Fusulinid fauna: *Triticites, Dunbarinella*(?), and *Pseudostaffella*(?).

Type locality and section: NE. side of Oscura Mtns., in SE¼ sec. 31, T. 5 S., R. 6 E., Socorro Co.

Name: From Hansonburg, the headquarters of the Bursum ranch, about 5 mi E. of N. end of Oscura Mtns.

‡Hawkins limestone.

Cambrian: Southwestern New Mexico (Grant County).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 8). *Hawkins lss.*—Important calc. beds of Camb. age intercalated in basal section of qtzites exposed in Grant Co. Thickness 50 ft. [According to E. Kirk and others, Middle Camb. is absent in N. Mex.]

Type locality: Not designated.

Name: From town of Hawkins, Grant Co.

Hegler limestone member (of Bell Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico (Guadalupe Mountains).

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Hegler ls. memb.*—15 ft of dark-gray lumpy slabby ls., which generally forms a double ledge on hillsides. Forms base of Bell Canyon fm.

P. B. King, 1948 (USGS Prof. Paper 215, 54-55). *Hegler ls. memb.*—Basal bed of Bell Canyon fm. At type loc. lies about 25 ft above Manzanita memb. of Cherry Canyon fm. Consists of dark-gray fine-grained ls., made up of closely spaced lumps about 1 in. thick. In most places these lss. stand in two groups of ledges, with a total thickness of 12 to 15 ft, separated by a break of sand or marl. In some localities the memb. disappears, and the first ls. above the Manzanita ls. is the Pinery memb. To the N. the Hegler thickens and intergrades with the lower part of the Capitan ls.

Type locality and section: Near Hegler ranch, S. Guadalupe Mtns., Texas.

Name: From Hegler ranch.

Helms formation.

Mississippian (Chesterian): Western Texas (Hueco Mountains).

J. W. Beede, 1918 (Tex. Univ. Bull. 1852, 8, 30, 36). *Helms gp. (Miss.).*—Yellowish thin-bedded rocks. Local facies vary somewhat from place to place, but main features are almost always present. Locally there are thin sss. in top of Helms gp. To N. of Long Canyon, nearly the whole series is made up of platy drab to dark-buff lss. (which as a rule weather buff), with, locally, considerable chert in concentrations, masses, and layers, and some ss., all separated by thin layers of marl that weathers buff. Below is a covered slope largely composed of clay sh. Fossils in most beds, but rare except locally in uppermost part of section. According to S. Weller, is of Chester age. Thickness of fm. 400 to 600 ft. (Gives detailed section 1± mi S. of Helms Peak, Hueco Mtns.) Unconf. underlies Magdalena gp. (Penn.). (Originally included in Hueco ls.)

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 909). *Helms gp.*, 400 to 700 ft thick, includes beds of Chester, Lower Miss., and Upper Dev. age.

G. H. Girty, unpub. rpt. The upper 500 ft of Helms fm. of Hueco Mtns. contains a Chester fauna; the remainder of fm. is unfossilif.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 19). *Helms fm.*—Beede (1918, 8) designated all rocks btw. the Sil. and Penn. systems in the Hueco Mtns. as the Helms. This name is here restricted to the upper part of these strata. The lower part is included in the *Rancheria fm.* of Meramecian age. The Helms fm., thus restricted, consists of green sh., shaly ss., and impure ls. beds, containing Chester fossils. Aver. thickness 98 ft. In type area, the Helms fm. rests unconf. on the Rancheria fm. and lies unconf. beneath Penn. rocks.

Type locality and section: 1± mi S. of Helms Peak, Hueco Mtns.

Name: From Helms Peak, Hueco Mtns.

Hermosa formation.

Pennsylvanian (Morrowan?-Virgilian): Southwestern Colorado, southeastern Utah, northeastern Arizona (subsurface), and northwestern New Mexico.

W. Cross and A. C. Spencer, 1899 (USGS La Plata folio, n. 60, 8). From the section displayed in the Animas Valley and at Rico one can assume presence of other sed. fms. below Dolores fm. (oldest exposed) in La Plata dome. These embrace *Rico* and *Hermosa* (Carbf.), the *Ouray* (Dev.), and the *Ignacio* (Camb.), all in apparent structural conformity.

W. Cross and A. C. Spencer, 1900 (USGS 21st Ann. Rpt., pt. 2, 48). *Hermosa fm.*—The upper part is a complex of shs. with occasional lss.; middle part is many bands of massive dark-gray ls., often highly fossilif., alternating with sss. and cgls.; lower part is greenish-gray sss. and shs., the latter sometimes nearly black. Thickness 1,800 ft. Underlies Rico fm.; overlies Dev. ls. and qtzite.

W. Cross and E. Howe, 1905 (USGS Silverton folio, n. 120, 4) applied *Molas fm.* to 75 ft of Penn. strata which intervene btw. Hermosa fm. and Ouray ls., and which are absent in area where Hermosa fm. was first defined.

M. G. Wilmarth, 1938 (USGS Bull. 896, 945). In SE. Utah and parts of SW. Colo., the "intrusive" Paradox fm. intervenes below Hermosa fm. and is believed by J. B. Reeside, Jr. and A. A. Baker to be younger than Molas ls.

R. I. Roth, 1934 (AAPG Bull., v. 18, 945). Since Spencer gave no specific type loc. for *Hermosa fm.*, the type section has been selected as in secs. 26 and 35, T. 37 N., R. 9 W., La Plata Co., Colo. Total thickness 2,146 ft. Fauna of typical Hermosa is of Cherokee age.

N. W. Bass, 1944 (USGS Oil and Gas Inv. Prelim. Chart 7). *Hermosa fm.*—In Animas River Valley, is about 2,000 ft thick and consists of alternating thick beds of greenish tan-gray arkosic ss., grit, and locally cgl., and thin beds of arkosic blue-gray dense fossilif. ls.; at least one zone contains beds of gyp. Other beds of gyp. may be present in a concealed interval 200 ft thick that lies 130 ft above the gyp. beds. The thickest unit of ls. seen on the outcrop lies directly above this concealed interval. This ls. is overlain by black sh., 80 ft thick, which, in turn, is overlain by interbedded dark-gray abund. fossilif. ls. interbedded with dark-gray sh. and tan ss. The lowermost 90 ft of the Hermosa is composed mainly of dark blue-gray dense very fossilif. ls. and a few thin beds of dark-gray to black sh. Nearly all the ls. beds emit a strong petrolif. odor on fresh fracture. The top boundary of the fm. was drawn at the top of a bed of gray ls. containing abund. fragments of crinoid stems. This contact lies about 100 ft below the contact of predom. gray beds, with red beds above; it forms a prom. ledge. This contact may be about 100 ft below the position described by Cross and Howe (USGS Engineer Mountain folio, n. 171, 1910), but there is considerable doubt as to the precise position of the boundary as described by them. L. G. Henbest has correlated the Hermosa fm. with the Morrow, Lampasas, and Des Moines series of the midcontinent region. M. L. Thompson (in Bates et al., N. Mex. Bur. Mines Bull. 18, 118, 1942) correlated the upper part of the Hermosa fm. in the Rattlesnake Field with the Missouri and Virgil series. The most striking feature of the Hermosa fm. in the subsurf. is the almost total absence of ss. and cgl., which comprise so much of the total thickness of the fm. on the outcrop. The deep wells in the Rattlesnake Field and in SE. Utah penetrated almost wholly beds of dense gray to dark-gray ls., some of which are cherty, with only a few beds of sh. and scarcely any ss. The Hermosa fm. is indicated to include the Paradox fm. as the Paradox memb. (see under Paradox fm.).

S. A. Wengerd and J. W. Strickland, 1954 (AAPG Bull., v. 38, 2157-2199) have restricted and redefined the *Hermosa fm.* The lower Hermosa memb. of Bass (1944) is renamed the Pinkerton Trail ls. and defined as a dark-gray intergrading sequence of fine to coarsely crystalline crinoidal ls., dol., and clastics, 0 to 200 ft thick, of Atoka and earliest Des Moines age. The Paradox memb. of Bass (1944) is called the Paradox fm., defined as a sequence of cyclic deposits of thick salt, anhyd., gyp., thin to thick lentils of euxinic black sh., dol., siltstone, and some lss., divisible into 3 intergradational membs.; max. initial thickness prob. 5,000 ft. The upper Hermosa memb. of Bass (1944), and part of the Rico fm., is the *restricted Hermosa fm.*, consisting of a carbonate facies (gray argil. ls. and gray calc. sh. in lower part; gray fine-crystalline silty to sandy ls. in upper part) and a clastic facies (coarse arkosic ss., fine to med. red-orange qtzose ss., clayey siltstone, claystone, thin arkosic to micaceous ls.). Fm. thickness, 0 to 5,000 ft; age (from fusulinids), Des Moines, Missouri, Virgil, and Wolfcamp.

Type locality: Animas River Valley, near Hermosa, Colorado. No type section of the restricted Hermosa fm. designated by Wengerd and Strickland.

Name: From Hermosa Creek, La Plata County, Colorado.

Holder formation.

Pennsylvanian (Virgilian): Southeastern New Mexico (Sacramento Mountains).

L. C. Pray, 1952 (Calif. Inst. Tech., Ph. D. dissertation, 208-218). *Holder fm.*—400 to 900 ft, largely light-gray to white noncherty massive ls. which forms conspicuous light-colored cliffs and interbedded red shs., nodular lss., and minor coarse clastic rocks. In lower part of fm., light-gray to white noncherty ls. is dominant rock type and is interbedded with ss., red and gray sh. and marl, nodular ls., and ls. cgl. The proportion of clastic sediments increases toward the top. Basal thick lss. are biohermal. Bioherms are 50 to 100 ft thick and convex upward. Lies conf. on Beeman fm.; unconf. overlain by Bursum or Abo fm.

Type locality and section: NW¼NW¼ sec. 14, T. 17 S., R. 10 E., Sacramento Mtns.

Name: From Holder Ridge, in sec. 36, T. 17 S., R. 10 E., and sec. 31, T. 17 S., R. 11 E., Sacramento Mtns.

Hondo sandstone member (of San Andres formation).

Permian (Leonardian): Southeastern New Mexico (Pecos Valley region).

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Chupadera fm.* of Pecos Valley region here divided into (descending): (1) *San Andres ls. memb.* (replaces Pichacho ls. of Fiedler and Nye), (2) *Hondo ss. memb.*, and (3) *Yeso memb.* The Hondo ss. consists of coarse white qtz grains, variably streaked yellowish to brownish red and cemented by iron and lime. In places it is crossbedded, and iron concretions and nodules are abund. in upper part. Thickness usually 50± ft. Has been commonly referred to in the field as "Glorieta ss.," but it has never been shown definitely that this ss. is wholly or in part the ss. of Glorieta Mesa. Crops out near bottom of valley of the Hondo and its tributaries. Of great value in subsurf. correlation. [The adoption of *Hondo ss. memb.* involves a slight redefinition of both San Andres ls. and Yeso as originally defined and heretofore used.]

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1668). The writers consider the Glorieta ss. identical with the Hondo ss. of Lang.

Though *Hondo ss. memb.* is a term recognized officially in the nomenclature by the USGS, it is seldom used, and the term *Glorieta ss.* has been used consistently for this lithic unit by geologists working in southeastern N. Mex.

Type locality: Probably along base of Algerita escarpment, on E. side of Big Dog Canyon, T. 23 and 24 S., R. 20 E.

Name: From Hondo Valley, Lincoln Co.

‡Hondo slate.

Precambrian: Central northern New Mexico (Picuris area).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 23). *Hondo slate.*—The Hondo slate is characteristically black and has well-developed schistosity. In a few localities, zones are exposed that resemble streaks of "iron fm." In many places the black slate grades into qtz-muscovite schist. Lies on Ortega qtzite. Thickness up to 1 mi.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 19). The *Pilar phyllite,* or *Hondo slate* of Just, is the youngest rock of the Ortega fm. and the most distinctive horizon-marker in the Picuris range. The old name *Hondo* had been applied to other rocks prior to Just's usage; hence seems best to be abandoned.

Type locality: Not designated.

Name: From Arroyo Hondo, Picuris Range.

***Honeycut formation.** (Of Ellenburger group.)

Lower Ordovician: Central Texas and subsurface of western Texas and southeastern New Mexico.

P. E. Cloud, Jr., V. E. Barnes, and J. Bridge, 1945 (Tex. Univ. Pub. 4301, 133-161), named *Honeycut fm.* [See this ref. under Ellenburger gp.]

P. E. Cloud, Jr. and V. E. Barnes, 1948 (Tex. Univ. Pub. 4621). *Honeycut fm.*—All strata above the Gorman fm. at the surface in central Tex. are termed Honeycut fm. Thickness 0 to 678 ft. Appears to be absent W. of long. 98°55′ on surface. The Honeycut consists of thin-bedded lss. and dols., intimately interbedded. The microgranular to very fine-grained dols. of the Honeycut fm. are light gray to yellowish gray, pale beige, flax, and old ivory. Dols. are microgranular to very fine grained and yellowish, pinkish, and brownish gray. The ls. weathers to medium and light tones of bluish gray; the dol. weathers in tones of dull gray and yellow. Where fully developed, the Honeycut fm. may be divided into a lower facies of interbedded lss. and dols., a median facies of predom. microgranular to very fine-grained dol., and an upper facies of predom. ls. The basal bed of the Honeycut is typically aren. Cannon balls of chert and silic. ls. are common in the Honeycut fm. Equiv. to Jefferson City gp. in Mo. Equivs. of the Honeycut fm. appear in the type section of the El Paso fm., at El Paso, Texas.

Type section: 5 mi E. of Johnson City, Blanco Co., Texas.

Name: From Honeycut Bend on Pedernales River, Blanco Co., Texas.

Hopewell series.

Precambrian: Central northern New Mexico (Picuris and Petaca areas).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 21). *Hopewell series.*—Dark schists formed from a succession of basalt and andesite extrusives, with some qtzite membs. Although some of the basalts are readily identifiable from their porphyritic and amygdaloidal texture, the series contains a considerable amount of black hornblende-chlorite schist for which an igneous origin is merely inferred. Locally schists are composed of biotite, muscovite, and qtz, presumably sed. in origin. Lowest Precamb. fm. in area. Overlain by Ortega qtzite. Thickness about three-fourths of a mi to 1 mi.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 21). The Vadito fm. is the *upper fm.* of the Precamb. series in the Picuris Range. This fm. is at least the partial equiv. of the Hopewell series of Just.

Type locality: Not designated.

Name: From the town of Hopewell, Rio Arriba Co.

***Horquilla limestone.**

Pennsylvanian (Derry, Des Moines, Missouri, and basal Virgil): Southeastern Arizona and adjoining extreme southwestern New Mexico (Hidalgo County).

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 16-18). *Horquilla ls.*—Basal zone of sh. or thin-bedded lss. forming topographic sag, overlain by a series of thin-bedded blue-gray lss. with a few thicker beds. A few red-weathering shaly lss. intercalated in upper part. Most of lss. dense and pinkish-gray when fresh; thicker beds are coarsely crystalline and crinoidal. Presence of small fusulinids characteristic. Thickness 1,200 ft. Underlain with

poorly defined unconf. by the Black Prince ls. or the Escabrosa ls.; overlain conf. by the Earp fm.

Elliot Gillerman, 1958 (N. Mex. Bur. Mines Bull. 57). *Horquilla ls.*—Consists of alternating 10- to 14-ft units of a medium-grained dark-gray calcarenite of crinoidal debris with black chert nodules, and a coarser crystalline light-pink to tannish-gray crinoidal ls. with nodules of pink chert. About 250 ft above base a 14-ft argil. ss. Chert not more than 5%, except very locally (as much as 30% to 50%). Fusulinids very abund. Est. thickness 1,350 ft. Overlies the Paradise or Escabrosa with slight disconf.; underlies Earp conf. with a transitional contact.

Type locality and section: Eastern spur of Horquilla Peak, about 1 mi SE. of Ajax Hill, in the Tombstone Hills, Arizona.

Name: From Horquilla Peak, in Tombstone Hills, 3¼ mi S. of Tombstone, Arizona.

‡†Hot Springs formation. (Of Mud Springs group). (See Fra Cristobal formation.)

Name is preoccupied by Hot Springs fm. (Quaternary) in Yellowstone National Park, Wyoming.

Hueco limestone.

Permian (Wolfcampian): Western Texas and southern New Mexico.

G. B. Richardson, 1904 (Tex. Univ. Min. Surv. Bull. 9, 32-38). *Hueco fm.*—Mainly massive gray fossilif. nonmag. ls., locally including beds of sh. and ss. Thickness at least 5,000 ft. Represents the Penn. in Diablo Plateau and in Franklin, Cornudas, Diablo, Finlay, and Hueco Mtns. Fossils assigned to Penn. by G. H. Girty. Relations to Delaware Mtn. fm. (Perm.) not determined but supposed to be older.

M. G. Wilmarth, 1938 (USGS Bull. 896, 991). Later studies by many geologists resulted in differentiating the great mass of lss. called *Hueco ls.* in early rpts. on Franklin and Hueco Mtns. into Helms fm. (Miss.) at base, Magdalena ls. (Penn.), and an unconf. overlying series of beds of Perm.(?) age, to which some geologists restricted the name *Hueco ls.*, and which included Powwow cgl. at base, and near top the Deer Mtn. red sh. memb., 150± ft thick. This restricted definition is that now employed by USGS and geologists generally.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). As now defined, *Hueco ls.* includes all beds from the prom. unconf. at the base, up through the highest occurrence of *Pseudoschwagerina* and associated fusulinids, to the beds next beneath the lowest occurrence of Leonard fossils. It is, therefore, Wolfcamp in age. Lies unconf. on Penn.; unconf. overlain by Bone Spring ls.

Type locality: West-facing scarp of Hueco Mtns., El Paso Co., Texas.

Name: From Hueco Mtns.

Hueconian.

A name that has been applied, provincially, to the time during which the Hueco ls. of western Texas and southern New Mexico was deposited.

‡†Humboldt formation.

Pennsylvanian: Southwestern New Mexico (Central mining district).

H. Schmitt, 1933 (AIME Contr. 39, 2, 13). Upper Magdalena fm. of A. C. Spencer is here divided into *Humboldt fm.* above, 261 ft thick, and *Mountain Home sh.* below, 130 ft thick. These names are introduced for convenience in mapping

and probably will be replaced by USGS in rpt. in preparation by A. C. Spencer. The Upper Magdalena fm. rests on blue ls. (Lower Magdalena ls. of Spencer).

Name is preoccupied by Humboldt fm. (Pliocene) in NW. Nevada.

Type locality: Not designated.

Name: Derivation not indicated and not apparent.

***Hunton group (limestone).**

Silurian and Devonian: Southeastern Oklahoma and subsurface of western Texas and southeastern New Mexico.

J. A. Taff, 1902 (USGS Atoka folio, n. 79). *Hunton ls.*—Nearly pure white ls. and limy marls. Overlies Sylvan sh. and underlies Woodford chert.

J. A. Taff, 1903 (USGS Tishomingo folio, n. 98). Hunton ls., 0 to 200 ft thick, is divisible into 3 membs. (descending): (1) Crystalline (in part cherty) bluish to white ls., with occasional thin marly strata, in places overlain by several ft of very cherty ls.; (2) 100 ft of white or cream-colored (occasionally pinkish) rather soft ls. interstratified with more friable marly lime and (rarely) calc. clay, with a few ft of marly white ls. at top; (3) whitish massive crystalline ls., which in places includes a bed of oölite at or near base and thin-bedded compact ls. at top; thickness from a few ft to 25± ft. Upper memb. contains Oriskany and perhaps Onondaga fossils; middle memb. contains Helderberg fossils; and basal memb. contains Niagara fossils in thin-bedded compact ls. at top and Clinton fossils in underlying beds.

C. A. Reeds, 1911 (Am. Jour. Sci., 4th ser., v. 32, 256-268). Hunton ls. of Taff is here divided into 4 fms. in Arbuckle Mtns. (descending): (1) Bois d'Arc ls., 0 to 90 ft, of Becraft (Oriskany) age, according to C. Schuchert (1922) and E. O. Ulrich (1927); (2) Haragan sh., 0 to 166 ft, of New Scotland age; (3) Henryhouse sh., 0 to 233 ft, of Niagaran age; and (4) Chimneyhill ls., 0 to 53 ft, of Alexandrian age. Overlies Sylvan sh. with unconf. The Bois d'Arc ls. corresponds to the upper Hunton of Taff; the Haragan and Henryhouse correspond to the middle Hunton of Taff; and the Chimneyhill corresponds to lower Hunton of Taff.

C. N. Gould, 1927 (Okla. Univ. Bull., Proc. Okla. Acad. Sci., v. 6, pt. 2, 235). Hunton probably will remain as a gp. name, for purposes of mapping.

S. W. Lowman, 1930 (AAPG Bull., v. 14, 618-619), identified rocks equiv. to Sil. part of Hunton gp. in well in western Tex.

T. S. Jones, 1949 (Strat. Problems Comm., West Tex. Geol. Soc.), zoned the Hunton-age rocks of western Texas into 7 mappable units.

E. R. Lloyd, 1949 (N. Mex. Bur. Mines Bull. 29), indicates that the use of the term *Hunton* was extended to the subsurf. of SE. N. Mex.

Type locality: Outcrops near former hamlet of Hunton, SE. Coal Co., Oklahoma.

Name: From former hamlet of Hunton.

***Ignacio quartzite.**

Upper Cambrian or Lower Ordovician: Southwestern Colorado and subsurface of southeastern Utah, northeastern Arizona, and northwestern New Mexico.

W. Cross and A. C. Spencer, 1899 (USGS La Plata folio, n. 60, 8).

W. Cross, 1901 (USGS Bull. 182, 35). Earliest Paleozoic fm. of Silverton quad., Colo., is a qtzite with some sandy shs. 100 to 200 ft thick, which is seen on W. side of Animas River from the monzonite contact to Molas Lake, and imperfectly on E. side of the Animas. This qtzite has been traced down the Animas to below Rockwood and is called *Ignacio qtzite,* from its characteristic develop-

ment on the bench where the lake of that name is situated. A southerly dip carries this qtzite onto S. slope of Needle Mtns., where a few indistinct fossils indicate its Camb. age. The rather shaly beds, often calc. (Elbert fm.), succeeding the qtzite have not yielded fossils. The Ignacio qtzite overlies Algonkian qtzites and slates.

H. Barnes, 1954 (AAPG Bull., v. 38, 1780-1791). Neither an eroded surface nor a distinct lithologic change occurs at the contact of the *Ignacio qtzite* and the Elbert fm. as might be expected if the two fms. were separated by an unconf. On the contrary, the descriptions of the Elbert fm. suggest a lithologic transition that should be expected between sandy and calc. rocks in an interfingering sequence. The paleontological evidence that has been used to establish a late Camb. age for the Ignacio qtzite is not conclusive. The geographic distribution of the two fms. is similar. Therefore, in view of the weakness of available fossil evidence and the relative strength of the strat. evidence, the Ignacio, Elbert, and Ouray fms. are believed to represent essentially continuous deposition. Further, because fossils of Late Dev. age occur at the base of the Elbert (or the top of the Ignacio), it is suggested that the Ignacio is also Dev. in age.

R. L. Knight and J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 56-58), apply the name McCracken ss. memb. of Elbert fm. to a subsurf. Upper Dev. sand, which they correlate tentatively with the Upper Dev.(?) Ignacio qtzite on the basis of well evidence.

F. H. T. Rhodes and James H. Fisher, 1957 (AAPG Bull., v. 41, 2508). The Ignacio quartzite of southwestern Colorado is referred to the highest Late Cambrian or lowest Early Ordovician on the basis of the occurrence of oboloid brachiopods. This is contrary to the recent conclusion of Barnes (1954), but in support of the age provisionally assigned by earlier workers. A major unconformity occurs between the Ignacio and the overlying Elbert formation of Late Devonian age.

Type locality: Exposures at Ignacio Lake, La Plata Co., Colorado.

Name: From Ignacio Lake.

Incarnacion fire clay.

Pennsylvanian: Central New Mexico.

C. L. Herrick, 1904 (Jour. Geol., v. 12, 237-251). *Incarnacion fire clay,* basal bed of Sandia fm. near Socorro, N. Mex. Unconf. overlies Incarnacion granite.

Type locality: Incarnacion mining district, about 4 mi E. of town of Socorro.

Name: From Incarnacion mining district.

‡Incarnacion granite.

Precambrian(?): Central New Mexico.

C. L. Herrick, 1904 (Jour. Geol., v. 12, 237-251). Near Socorro the *Incarnacion granite* unconf. underlies Sandia fm.

Name is preoccupied by Incarnacion fireclay.

Type locality: Not designated.

Name: From Incarnacion mining district.

***Joins formation.**

Lower and Middle Ordovician: Central southern Oklahoma (Arbuckle Mountains) and subsurface of western Texas and southeastern New Mexico.

C. E. Decker, 1930 (AAPG Bull., v. 14, 1498-1505). *Joins fm.*—Chiefly ls.; some ss. and sh. Underlies Oil Creek fm. [Overlies Beekmantown(?) cgl., according to table on p. 1498, but in sections on p. 1500 and 1501 this cgl. is included in Joins fm.] Occurs only in W., SW., and central parts of Arbuckle Mtns. Of early Chazy age. Thickness 30 to 300 ft.

C. E. Decker and C. A. Merritt, 1931 (Okla. Geol. Surv. Bull. 55). The *Simpson ls.* is here raised to a *gp.*, divided into 5 fms. (ascending): *Joins*, Oil Creek, McLish, Tulip Creek, and Bromide. Fossils believed to be very local Chazy.

C. E. Decker, 1941 (AAPG Bull., v. 25, 650-667). The *Joins* consists chiefly of thin lss., some of which are shaly. It has a thin cgl. at the base and a few other cgls. within it at various intervals above the base. Considered to be partly of Beekmantown (Lower Ord.) age, on the basis of graptolites.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038). Since, on paleontological grounds, all the formational units of the Okla.-type Simpson can be shown to be represented in the subsurf. of western Tex., and since the gp. in western Tex. can also be subdivided on lithologic grounds, not in conflict with the former, it is proposed that the Okla. formational names be applied to the recognized subdivisions of the subsurf. Simpson.

See also 1933 entries under Simpson fm.

Type locality: Exposures on Joins ranch, in Carter Co., T. 2 S., R. 1 W., N. and NW. of Woodford, Oklahoma.

Name: From Joins ranch.

Joyita sandstone member (of Yeso formation).

Permian (Leonardian): Central New Mexico.

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1668). *Joyita ss. memb.*—Uppermost unit of Yeso fm. consists of soft crossbedded ss. and pink, orange, and yellow thin-bedded ss.; weathers rounded. Underlain by Canas gyp. memb. or by lss. of middle evaporite memb.; overlain by Glorieta ss. Thickness 100 to 185 ft. In a few places the boundary btw. Joyita memb. and Glorieta ss. is hard to place, because of similar lithology.

Type locality and section: Sec. 33, T. 1 S., R. 2 E., near Mesa del Yeso, Socorro Co.

Name: From La Joyita Hills, Socorro Co.

Kawvian.

A term proposed by R. C. Moore and M. L. Thompson, 1949, to cover the epoch during which their Kawvian series (Upper Penn.) was deposited.

Kawvian series.

A term proposed by R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302) as a substitute for Upper Penn. (Missouri and Virgil series). Missourian and Virgilian are designated as stages in the Kawvian series.

Keller group.

Pennsylvanian (Virgilian): New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 69-73). *Keller gp.*—Name proposed for rocks btw. top of Hansonburg gp. and base of Fresnal gp. At type loc. composed largely of ls., with several thick beds of arkosic ss., cgl., and sh. in lower two-thirds. At type loc. two distinct lithologic units: Lower unit (*Del Cuerto fm.*), 81 ft. thick, composed of numerous nodular to irregularly bedded lss., interbedded with calc. shs., arkosic sss., and cgl.; upper unit (*Moya fm.*), 51

ft thick, composed of massive and irregularly bedded light-gray ls. Lithology of the gp. varies markedly in some localities. Fusulinid fauna: *Triticites.*

Type locality and section: N. end of Oscura Mtns., mainly in NE¼ sec. 31, T. 5 S., R. 6 E.; top extends into W. central part of sec. 32.

Name: From Keller Spring, on E. slope of Oscura Mtns., about 2 mi E. of South Oscura Peak.

Kelly limestone.

Mississippian (Osagian): Central and southwestern New Mexico.

C. L. Herrick, 1904 (Am. Geologist, v. 13, 310-312). (See under †*Graphic-Kelly ls.*)

C. H. Gordon, 1907 (Jour. Geol., v. 15, 807, and Am. Jour. Sci., 4th ser., v. 24, 62-63). *Kelly ls.,* of Magdalena Mtns., consists of 125 ft of subcrystalline ls. with compact 5-ft layer near middle called *"Silver Pipe ls."* by miners. Most important ore bodies are just beneath *"Silver Pipe ls."* Underlies Sandia fm.; overlies Precamb. rocks. Same as Herrick's Graphic-Kelly ls. So far as known, confined to Magdalena dist. Cannot yet be correlated with Lake Valley ls.

G. F. Loughlin and A. H. Koschmann, 1942 (USGS Prof. Paper 200, 14-16). *Kelly ls.*—Mostly light bluish-gray medium- to coarse-grained thick-bedded high-calcium ls., with a persistent bed of dense argil. ls. in middle part known as the "silver pipe" or "indicator" because of its close association with ore shoots. Basal beds, 6 to 16 ft thick, characterized by grains and small pebbles, mostly of qtz, with some pink feldspar, argillite, gabbro, or diabase. Locally basal 2 to 6 ft is feldspathic ss., qtzite, or argillite. Lss. above and below "silver pipe" are crystalline and crinoidal. Faunas are Lower Miss. but cannot be correlated with Lake Valley faunas (Girty).

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 15-16). *Kelly ls.* is exposed in Lemitar Mtns. (51 ft) and there is considered inconclusively to be Osage in age. Somewhat massive gray to tan cherty crinoidal ls. beds, tentatively referred to the Kelly fm., are exposed in the Mimbres Range and in the Silver City area. Thickness 130 ft on Bear Mtn., W. of Silver City. Lies on Lake Valley fm. Kelly fm. does not occur where rocks of Meramec age are exposed.

A. K. Armstrong, 1955 (N. Mex. Bur. Mines Circ. 39, 3, 32-33). *Kelly fm.* exposed in S. Ladron Mtns. Max. thickness 35 ft of crinoidal slabby light-buff to light-gray fossilif. ls., with nodular white fossilif. chert. Large fauna of definite Osage age.

Type locality: Kelly mining dist., Magdalena Mtns., Socorro Co.

Name: From town of Kelly, Socorro Co.

***Kinderhook group.**

Mississippian (Lower): Type area only.

Kinderhookian.

A time term used by many geologists to cover the epoch during which the Lower Miss. Kinderhook gp. of the Miss. Valley region was deposited. A recognized subdivision of the Miss. period (J. M. Weller et al., GSA Bull., v. 59, 91-196, 1948).

Kinderhookian (Kinderhook) series.

Terms used by many geologists to indicate strata deposited at the same time as the Lower Miss. Kinderhook gp. of the Miss. Valley region.

Lacorocah metatuff member (of greenstone complex, North Manzano Mountains).

Precambrian: Central New Mexico (North Manzano Mountains).

P. Reiche, 1949 (GSA Bull. v. 60, 1183-1212). *Lacorocah metatuff memb.*—Light-gray, crudely bedded weakly schistose metatuff, with clastic texture and rare or no qtz. Some beds are crowded with light-gray slaty flattened pebbles. A thickness in excess of 1,000 ft is present btw. a fault on the NW. and a SE. contact of undet. character. The memb. shows a great diversity; it ranges from altered acidic lava, now qtz-albite rock, to a talc-tremolite aggregate presumably of very basic igneous origin.

Type locality and section: NW¼ sec. 22, T. 8 N., R. 5 E., SE. Bernalillo Co.

Name: From Hell's Canyon, N. Manzano Mtns. Tewa word for *Hell's Canyon* is *Lacorocah.*

‡Ladronesian series.

A term introduced by C. R. Keyes (Sci., n. ser., v. 23, 921, and Am. Jour. Sci., 4th ser., v. 21, 298-300, 1906) for 0 to 200 ft of Carbf. (Penn.) shs., said to underlie unconf. his Manzanan series and to overlie his Socorran series (lss.) in SW. part of N. Mex.

Type locality: Not designated.

Name: Apparently from Sierra Ladrones (Ladron Mtns.), 30 mi N. of Socorro, N. Mex.

La Huerta silt member (of Salado formation).

Permian (Ochoan): Subsurface of southeastern New Mexico and western Texas.

W. B. Lang, 1942 (AAPG Bull., v. 26, 63-79). *La Huerta silt memb.*—Btw. the Cowden anhyd. memb. and the basal anhyd. memb. of the Salado fm. is a 147-ft section of halite, with variable amounts of red silt. Mostly the silt is scattered, but at -1,295 ft (type loc.) red silt becomes prominent and makes up about 35 percent of the fm. for a thickness of 5 ft. This silt bed marks a definite horizon in the Salado over the reef and back-reef areas but is not a continuous red silt bed in the Delaware Basin. This silt bed is here called *La Huerta silt memb.* of Salado fm.

Type locality and section: Fletcher No. 1 Potash test, U. S. Potash Co., in sec. 1, T. 21 S., R. 28 E., Eddy Co., New Mexico, at -1,295 to -1,300 ft.

Name: From La Huerta townsite, N. of Carlsbad, New Mexico.

Lake Valley limestone (formation).

Mississippian (Osagian): Southern New Mexico.

E. D. Cope, 1882 (Eng. and Mining Jour., v. 34, 214). First to determine Carbf. age of *Lake Valley ls.*

C. R. Keyes, 1903 (Ores and Met., v. 12, 48). The Lower Carbf. is clearly differentiated in N. Mex. at several localities. Principal of these places is Lake Valley, Sierra Co. Here have been found extensive lss. carrying fauna of Lower Burlington ls. of Mo., Iowa, and Ill. To this remarkable ls. the local geographic name *Lake Valley* appears appropriate.

C. R. Keyes, 1904 (Am. Jour. Sci., 4th ser., v. 18, 360-362). *Lake Valley fm.* consists of 200 ft of lss., underlying Sandia fm. and overlying Dev.

C. R. Keyes, 1905 (Iowa Acad. Sci. Proc., v. 12, 169-171). *Lake Valley ls.* is a remarkable blue crinoidal ls. carrying typical Lower Burlington fauna.

C. H. Gordon, 1907 (Am. Jour. Sci., 4th ser., v. 24, 58-64). *Lake Valley ls.* at Lake Valley is divisible into (descending): (1) Coarse subcrystalline yellowish-white

ls. in moderately thick beds, more shaly below, with some cherty beds, and abund. crinoids and other fossils, 60+ ft; (2) blue sh. with thin beds of bluish ls., same fossils as no. 3 but not so many crinoids, 75 ft; (3) grayish-blue hard compact ls., more or less siliceous at top, 25 ft (locally called "footwall lime"); (4) compact grayish ls., filled with nodular chert, and sh. partings, usually rather thick, 50 ft. Rests on Percha sh. (Dev.); overlain by andesite.

L. R. Laudon and A. L. Bowsher, 1941 (AAPG Bull., v. 25, 2114, 2125-2158). Heretofore all Miss. rocks exposed in Sacramento Mtns. have been referred to *Lake Valley fm.* Since rocks of both Kinderhook and Osage age appear in the section, it seems best to divide them into two fms. The basal gray nodular shaly ls. beds are separated from the overlying Lake Valley fm. by a disconf. and carry a fauna closely related to that of the Chouteau fm., of Kinderhook age, in the Upper Mississippi Valley region. The name *Caballero* is proposed for this fm. The *restricted term Lake Valley* is retained for the remaining portion of the Miss. section. Topographically the Lake Valley fm. divides itself naturally into 3 membs. The basal memb. *(Alamogordo memb.)* crops out in bold escarpments of resistant ls. The middle memb. *(Arcente memb.)* consists of relatively soft siltstone, which weathers to rubbly slopes forming a retreating portion of the mtn. front. The upper memb. *(Dona Ana memb.)* consists of bold escarpments of cherty crinoidal ls.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 1-88). *Lake Valley fm.* divided into 6 membs., instead of 3 membs. as in 1941. *Alamogordo memb.* subdivided into 4 membs. (ascending): (1) *Andrecito memb.*, consisting of thin-bedded gray fossilif. ls. grading upward into thin-bedded dark-gray somewhat cherty ls.; (2) *Alamogordo memb.*, consisting of massive black very cherty poorly fossilif. cliff-forming ls.; (3) *Nunn memb.*, consisting of soft blue-gray marls and nodular crinoidal ls. beds; (4) *Tierra Blanca memb.*, consisting of medium- to thin-bedded gray to brown criquina beds containing light-colored chert nodules. *Arcente* and *Dona Ana membs.* retained as originally defined.

Type locality and section: See under various members.

Name: From town of Lake Valley, Sierra Co.

Lamar limestone member (of Bell Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Lamar ls. memb. of Delaware Mtn. fm.*—Black calc. bed, 25 to 30 ft thick, forming top memb. of Delaware Mtn. fm. in Delaware Basin. Within the basin it is a carb. and highly calc. ss. As basin rim is approached, the rock grades into ls. and finally becomes pale-gray ls. at base of the escarpment. In places it is overlain by additional Delaware Mtn. beds, of ls. and ss., of variable thickness up to probably 100 ft. Underlies Castile anhyd. Type loc. is escarpment N. of Lamar Canyon, where the canyon is crossed by the Western Gas pipeline, about 15 mi due E. of Guadalupe Point. This ls. previously was called *Frijole ls.* by Blanchard and Davis, from Frijole Post Office, but the similar dark ls. that occurs at Frijole Post Office is an older ls.; the name Frijole ls., therefore, is abandoned, to avoid confusion.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Lamar ls. memb. of Bell Canyon fm.* —Essentially same as Lamar ls. memb. of Lang. Delaware Mtn. fm. now classified as gp., with Bell Canyon fm. as upper fm. *Lamar memb.* lies near top of Bell Canyon fm.

Type locality: On escarpment NE of the El Paso Natural Gas Co.'s road across Lamar Canyon, about 15 mi E. of El Capitan, S. Guadalupe Mtns., Culberson Co., Texas.

Name: From Lamar Canyon, S. Guadalupe Mtns.

Lampasan.

A time term used by some geologists to cover the epoch during which the Lower Penn. Lampasas series was deposited. R. C. Moore et al. (GSA Bull., v. 55, 657-706, 1944) recognized Lampasan as a division of the Penn. period in the midcontinent region.

Lampasas series.

Term used by geologists to indicate strata of the same age as the Lower Penn. Lampasas series of central Texas.

M. G. Cheney, 1940 (AAPG Bull., v. 24, 65-118) defined Lampasas series.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 26). Although the term Lampasas series probably can serve an excellent purpose in the subsurf. classification of the Penn. rocks of central and north central Tex., this series is not considered sufficiently well defined for long-range usage in N. Mex. and other areas of N. America. Faunal collections and other information concerning the Lampasas series indicate that it includes rocks which should be classified as of Des Moines age. Also, the definition of that series is dependent largely on subsurf. rocks which are not available to most geologists for detailed study.

R. G. Moore et al., 1944 (GSA Bull., v. 55, 657-706) recognized the Lampasas series as a subdivision of the Penn.

R. C. Spivey and T. G. Roberts, 1946 (AAPG Bull., v. 30, 181-186) proposed the name *Atoka series* for beds of the same age as those designated Lampasas series by Cheney. This name has received wide acceptance as a division of the Penn.

Las Cruces formation.

Mississippian (Meramecian): Central southern New Mexico and western Texas.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 17). *Las Cruces fm.*—Name proposed for the hard dense black sublithographic even-bedded gray-weathering sparsely fossilif. ls. beds that rest unconf. on the black "Percha" sh. (Canutillo fm. of Nelson, 1940) and are unconf. overlain by Rancheria fm. in Franklin Mtns. Distinguished by relatively thin, remarkably even beds, from 4 to 16 in. thick (aver. about 10 in.). Free of chert in the type sec. Thickness 60 ft in Franklin Mtns.

Type locality and section: SW. side of small S. fork of the shallow canyon that leaves the W. slope of the Franklin Mtns. almost directly E. of Vinton, Texas (SW¼ sec. 67, S. Blk. 82, El Paso Co., Texas).

Name: From city of Las Cruces, New Mexico.

La Tuna member (of Magdalena group).

Pennsylvanian: South central New Mexico and western Texas (Franklin Mountains).

L. A. Nelson, 1940 (AAPG Bull., v. 24, 166-171). *La Tuna memb.*—Largely massive light- to dark-gray semicoarse-grained ls., with thin beds of massive dark-gray ls. and thin-layered cherty ls. at top. Lies on Helms sh.; conf. overlain by Berino memb. of Magdalena gp. Thickness 360 ft.

Type locality and section: Franklin Mtns., opposite Vinton, Texas.

Name: From town of La Tuna, Texas.

Leadville limestone.

Mississippian (Middle?): Colorado, southeastern Utah, subsurface in northeastern Arizona, and north central and northwestern New Mexico.

G. H. Eldridge, 1894 (USGS Anthracite-Crested Butte folio, n. 9). *Leadville ls.*—Upper third, massive blue and cavernous ls.; lower two-thirds, bedded gray to brown lss., somewhat dolo. and carrying a few beds of dark-gray or black chert, and sometimes separated by bands of calc. sh. Thickness 400 to 525 ft. Carries sub-Carbf. (Miss.) fossils. Unconf. underlies Weber ss. (Penn.); overlies Yule ls. (Ord.). Known to miners as "Blue" ls.

E. Kirk, 1931 (Am. Jour. Sci., 5th ser., v. 22, 222-240). *Leadville ls.* here restricted to Miss. lss. of Colo., and the new name *Chaffee fm.* is introduced for the Dev. rocks of Colo. in areas N. and E. of SW. Colo., where the Dev. ls. will continue to be called Ouray ls. and the underlying Dev. fm. will continue to be called Elbert fm. The Miss. part of Ouray ls. of SW. Colo. hereafter to be called Leadville ls. The typical Leadville ls. rests unconf. on Dev. lss., which overlie the Dev. Parting qtzite.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 65). *Leadville ls.*—In Animas Canyon section, N. of Durango, Colo., G. K. Elias (personal communication, Mar. 1955) has reported the occurrence of Meramec fossils in ls. correlated by Bass and others with the Leadville ls. The correlation of the Leadville ls. in the Four Corners area proper is open to question, since the type section cannot be traced SW. into this area because of the intervening Uncompahgre uplift. The Animas Canyon section is not greatly dissimilar to the type Leadville; it is younger, however, which can logically be explained by a regressive deposition with younger beds lying to the SW. The Leadville terminology has been retained in this paper because it is so well entrenched in the literature. The Leadville ls., ranging from 0 to 370 ft, underlies a great portion of the Four Corners area as a stable shelf deposit. The fm. consists of massive white, cream, yellow to chalky commonly oölitic ls., which often contains crinoidal fragments. The texture ranges from dense, fine to coarsely crystalline to fossil-fragmental. Some red clayey sh. streaks occur in uppermost 100 ft of the fm., apparently as filling from the Penn. Molas sh. above. The Leadville is unconf. overlain by the Molas sh.; underlain with transitional conf. contact by the Madison fm.

E. H. Baltz and G. O. Bachman, 1956 (New Mex. Geol. Soc. Guidebook, 7th Field Conf., 99). Lower ls. memb. of Sandia fm. correlated with Leadville on lithologic grounds by Read and Wood (1947), in southeastern Sangre de Cristo Mtns.

Type locality: Leadville, Colorado.

Name: From Leadville dist., Colorado.

Leonardian.

A time term used by many geologists to indicate the epoch during which the middle Perm. Leonard series of western Texas was deposited. An approved subdiv. of Perm. time.

Leonard series.

Permian (a division of the Permian of North America).

J. E. Adams et al., 1939 (AAPG Bull., v. 23, 1673-1681). The Leonard fm. of western Tex. is raised to series rank and designated the second div. of the Perm. of N. Am., above the basal Perm. Wolfcamp series.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). In this paper the terms Wolfcamp, *Leonard*, Guadalupe, and Ochoa series are considered to be provincial terms.

F. E. Kottlowski et al., 1956 (N. Mex. Bur. Mines Mem. 1, 47). Noteworthy is a decision by the Geologic Names Committee of USGS, dated July 28, 1955, here quoted in part: "The Chief Geologist has approved [that] . . . the use of provincial series be continued as subdiv. of the Perm. system in preference to lower, middle, and upper."

Thus, the term Leonard series has been extended to include those strata deposited at the same time as the middle Perm. Leonard series of western Tex.

Type locality: On the S. face of Leonard Mtn., Hess Canyon quad., in Glass Mtns., Brewster Co., Texas.

Name: From Leonard Mtn.

Lobo formation.

Triassic(?): Southwestern New Mexico (Deming region).

N. H. Darton, 1916 (USGS Bull. 618, 19, 39). *Lobo fm.*—Largely reddish and gray sh. and gray to pinkish impure ls., but includes much cgl. at base. Unconf. underlies Sarten ss. (Lower Cret.); unconf. overlies Gym and older lss. in Deming quad. Thickness at Lobo Draw, on E. slope of Florida Mtns., 350± ft. In its overlap on granite SE. of Capitol Dome, there is some basal arkosic ss. No fossils. May be Penn., Perm., Triassic, or even earliest Cret. Is tentatively classified as Triassic(?).

H. L. Jicha, Jr., 1954 (N. Mex. Bur. Mines Bull. 37, 24-26). *Lobo fm.*—The Lobo fm. was classified by Darton (1916) as Triassic(?) on little evidence other than its position above the supposed "Chupadera equivalent" (Gym. ls.) and below the Lower Cret. Sarten ss., and the widespread occurrence of red beds in the Triassic. The Lobo fm. is probably the equiv. of the Perm. Abo fm. This conclusion is based not only on the resemblance of the Lobo fm. to the Abo in other areas, but also on its position directly above the Penn. beds in Cooks Range.

Type section: Outcrops in Lobo Draw, on NE. slope of Florida Mtns.

Name: From Lobo Draw.

Log Springs formation.

Pennsylvanian (Morrowan?): Northern New Mexico.

A. K. Armstrong, 1955 (N. Mex. Bur. Mines Circ. 39, 5). *Log Springs fm.*—Name proposed for 10 to 75 ft of ferruginous deep-red shs. and sss. lying unconf. on Miss. strata in the Sandia, Jemez, Nacimiento, and San Pedro Mtns. Overlain locally by 40 ft of aren. ls. containing *Schizophoria oklahomae*. Log Springs fm. is sim. lithologically, and probably in origin, to the Molas fm. of Colo. and the lowest part of the Naco fm. of southeastern Ariz.

Type locality and section: Penasco Canyon, Nacimiento Mtns., in NW¼ SE¼ sec. 5, T. 16 N., R. 1 E.

Name: From Log Springs in Penasco Canyon.

‡Lone quartzite.

Upper Cambrian: Southwestern New Mexico (Silver City region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 8). *Lone qtzite.*—Late Camb. section of alternating qtzites and metamorphosed lss. well displayed in Lone Mtn., near Silver City. Thickness 300 ft.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1209). The Upper Camb. qtzite of Silver City region has for many years been called *Bliss ss.* by the USGS.

Type locality: Not designated.

Name: From Lone Mtn., Sierra Co.

Los Pinos granite.

Precambrian: Central New Mexico (Los Pinos Mountains).

J. T. Stark and C. E. Dapples, 1946 (GSA Bull., v. 57, 1121-1172). *Los Pinos granite.* —Medium coarse-grained pink rock composed largely of orthoclase, microcline, albite, and qtz. Biotite is the most prom. dark mineral. The granite has intruded, assimilated, and granitized the Sais, Blue Springs, White Ridge, and Sevilleta fms. Xenoliths of these rocks and many "knots" of gray sericitic schist occur throughout the granite. The granite is slightly schistose. In a few areas miarolitic cavities are common. Believed to be correlative with Priest granite of Manzano Mtns.

Type locality: Not designated.

Name: From Los Pinos Mtns.

Los Vallos member (of Yeso formation).

Permian (Leonardian): North central New Mexico (Lucero uplift).

V. C. Kelley and G. H. Wood, 1946 (USGS Oil and Gas Inv. Prelim. Map 47). *Los Vallos memb.*—Two membs. are mapped in Yeso fm., the lower, or Meseta Blanca ss. memb., and the upper memb., here named the *Los Vallos memb.* Los Vallos memb. constitutes the bulk of the Yeso fm. It is 1,000 to 1,400 ft thick. Lower part of memb. is dominantly a clastic unit, composed largely of yellow, pink, and gray silty shs., but contains several persistent thin ls. and thicker gyp. beds. In upper part, gyp. makes up about 50 percent of the section; thin sss., dark lss., and yellow and pink silty shs. make up the remainder. The base of the memb. is a thin, persistent ls. Lies on Meseta Blanca ss. memb.; overlain by Glorieta ss.

Type locality: Los Vallos, Lucero uplift. No type section designated.

Name: From Los Vallos, Lucero uplift.

Lovington sandstone member (of San Andres formation).

Permian (Leonardian): Southeastern New Mexico and western Texas.

J. M. Hills, in Bates et al., 1942 (N. Mex. Bur. Mines Bull. 18, 270-271). A ss. in upper part of San Andres fm. is here named Lovington ss. memb. Well log shows it to consist largely of brown to tan crystalline dol., with 10 to 20 percent gray sandy sh. and fine gray ss. Interval from top of San Andres to top of Lovington memb. in S. Lovington pool ranges from 90 ft, along the NE.-SW. axis of pool, to 150 ft, in wells on the N. and S. edges. Surface of San Andres is irregular; its roughness indicates erosion in post-San Andres, pre-Grayburg time. Lovington memb. can be traced throughout all of northern Lea Co., N. Mex., and recognized in Gaines, Andrews, and Yoakum Counties, Tex. In some places the extreme variation in the interval btw. top of this memb. and top of San Andres indicates considerable erosion and possibly development of karst topography before deposition of the Grayburg. Thickness 30 ft.

Type locality and section: Skelly No. 3-0 State, SW¼ SE¼ sec. 31, T. 16 S., R. 37 E., from -4,705 to -4,735 ft.

Name: From S. Lovington pool, Lea Co., New Mexico.

‡Lunasan (Lunasian) series.

Middle Carboniferous (Pennsylvanian): Central New Mexico (Manzano Mountains).

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 3, 8). *Lunasan series.*— Main ls. sequence in the Manzano Mountains.

Type locality: Not designated.

Name: From Los Lunas, Valencia Co.

McCombs limestone member (of Bell Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

N. D. Newell et al., 1953 (The Permian reef complex, 15, 53), mentions *McCombs ls. memb.* of Bell Canyon fm. The unit is not defined.

P. B. King and N. D. Newell, 1956 (AAPG Bull., v. 40, 386-387). *McCombs ls. memb.* of Newell et al. (1953) was left undefined by oversight. It is here defined as the same unit as the flaggy ls. bed of King (USGS Prof. Paper 215, 1948). Thickness about 10 ft. Lies btw. Rader and Lamar membs. of Bell Canyon fm.; separated from each by 100 to 200 ft of ss.

Type section: Bed 15 in King's (1948, p. 172) section 34, a short distance SE. of McCombs ranch and the present route of U. S. Highway 62.

Name: From McCombs ranch, S. of the mouth of McKittrick Canyon, where it is widely exposed and has been quarried at many places for its characteristic flagstones.

McCracken sandstone member (of Elbert formation).

Upper Devonian: Subsurface of southwestern Colorado, southeastern Utah, northeastern Arizona, and northwestern New Mexico (Four Corners area).

R. L. Knight and J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 56-58), redefined the Elbert fm. into 2 membs., an upper memb. and the underlying *McCracken ss. memb.* The type locality for the 2 membs. is the Shell Bluff No. 1 well, located on McCracken Mesa, in sec. 32, T. 29 S., R. 22 E., San Juan Co., Utah. The McCracken ss., logged from 8049 to 8161 ft (thickness 112 ft), consists of glauconitic sands, with some minor dol. streaks.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 63). *McCracken ss. memb.* —The McCracken ss., ranging from 0 to 580 ft, underlies a great portion of the Four Corners area. To the W., in central Utah, this unit passes into the Elbert fm. undiff. The McCracken ss. consists predom. of white, light-gray to red ss., fine- to medium-grained, some coarse, generally poorly sorted, commonly glauconitic, with a few streaks of sandy dol. The McCracken ss. grades upward into the sandy dol. of the upper memb. of the Elbert fm. The Aneth fm. underlies the McCracken ss., probably unconf. The McCracken ss. is believed to be equiv. to the Ignacio ss. as exposed at Baker's Bridge, Colo., which in the past has been assigned an Upper Camb. age (see Barnes, 1954, under Ignacio qtzite). Additional well information is needed to correlate definitely the Ignacio ss. with the McCracken ss.

Type locality: Shell Bluff No. 1, sec. 32, T. 29 S., R. 22 E., San Juan Co., Utah.

Name: From McCracken Mesa, near Bluff, San Juan Co., Utah.

McKee sandstone member (of Tulip Creek formation).

Middle Ordovician: Subsurface of western Texas and southeastern New Mexico.

T. Cole, C. D. Cordry, and H. A. Hemphill, 1942 (AAPG Bull., v. 26, 279-282). *McKee ss. memb.*—53 ft of coarse gray and brown ss., silty ss., and sandy sh. Most sands have rounded, frosted grains. Upper part green to greenish gray. Top 305 ft below 1st red sh. break in the Simpson, 840 ft above top of Ellenburger. Same as bed 12, zone D of Powers. Consists of (ascending): (1) Gray-

brown coarse ss., with abund. frosted sand grains, 10 ft; (2) coarse green ss., with abund. rounded frosted sand grains, 22 ft; (3) green calc. sand, with streaks of sandy green sh., 8 ft; (4) greenish silty ss., 2 ft; (5) green sh., 2 ft; (6) coarse green sand, with abund. frosted sand grains, 11 ft. At base of Tulip Creek fm.

Type section: Magnolia Petrol. Co. J. S. McKee No. 1-A, sec. 24, Blk. 9, H. & G. N. Surv., Pecos Co., Texas.

Name: From well name.

***McLish formation.**

Middle Ordovician (Chazy): Central southern Oklahoma (Arbuckle and Wichita Mountains) and subsurface of western Texas and southeastern New Mexico.

C. E. Decker, 1930 (AAPG Bull., v. 14, 1493-1505). *McLish fm.*—Chiefly lss.; some sh.; ss. (8 to 200 ft thick) at base, and some sss. higher up. Contains limited but very distinctive fauna. Thickness 300 to 500+ ft. Underlies Tulip Creek fm.; overlies Oil Creek fm. Same as Falls fm.; latter name abandoned.

C. E. Decker and C. A. Merritt, 1931 (Okla. Geol. Surv. Bull. 55, 12, 98). A 7-partite div. of Simpson gp. has been used during part of this study; the 2 additional fm. names used temporarily are *Falls Creek* and *Criner*. These 2 fm. names later were discarded.

E. O. Ulrich, 1933 (GSA Bull., v. 44, 105) . Falls fm. is an older unit than McLish. It is confined mainly to SW. half of Arbuckle uplift, and McLish to NE. half; the 2 fms. occur one above the other in a few intermediate localities. *Simpson gp.* divided into 8 fms. [See this entry under *Simpson fm.*]

C. E. Decker, 1933. (See this entry under *Simpson fm.*).

C. E. Decker, 1941 (AAPG Bull., v. 25, 650-667). The subdiv. of the Simpson gp. into 5 formations is retained as used in Okla. Geol. Surv. Bull. 55.

T. Cole, C. D. Cordry, and H. A. Hemphill, 1942 (AAPG Bull., v. 26, 279-282), proposed the name *Waddell ss. memb.* for the basal ss. of the *McLish* in the subsurf. of western Tex.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038). Since, on paleontological grounds, all the formational units of the Okla.-type Simpson can be shown to be represented in the subsurf. of western Tex., and since the gp. in western Tex. can also be subdivided on lithologic grounds, not in conflict with the former, it is proposed that the Okla. formational names be applied to the recognized subdivisions of the subsurf. Simpson.

Type locality: Exposures on McLish Ranch, T. 1 S., R. 7 E., Johnston Co., Oklahoma.

Name: From McLish ranch.

McNutt zone (of Salado formation).

Permian (Ochoan): Southeastern New Mexico (Eddy County).

G. A. Kroenlein, 1939 (AAPG Bull., v. 23, 1682-1693). *McNutt zone.*—In the U. S. Potash Co. deposit, 11 beds of soluble potash are present in a zone 250 ft thick. This is called the McNutt zone and was first detailed in the potash core test drilled by the Snowden-McSweeney gp. on the V. H. McNutt potash permit. The potash beds of the McNutt zone are separated by thin beds of halite, which contain disseminated inclusions and very thin beds of polyhalite, anhyd., and red and green clay. A white polyhalite and anhyd. bed 75 ft above the base of the McNutt zone is a marker bed. The four potash beds below the marker have sufficient potassium content and thickness to be minable.

Type locality and section: Snowden-McSweeney well, sec. 4, T. 21 S., R. 30 E., Eddy Co.

Name: From V. H. McNutt potash permit.

Madera limestone. (Of Magdalena group.)

Pennsylvanian (Desmoinesian-Virgilian): Central New Mexico.

C. R. Keyes, 1903 (Ores and Met., v. 12, 48). The upper Carbf. blue to gray beds, the superior part of the great ls. fm., are called *Madera ls.* in Sandia Mtns. They overlie Middle Carbf. lss.

C. R. Keyes, 1904 (Am. Jour. Sci., 4th ser., v. 18, 360-362). *Madera fm.* consists of 300 ft of lss. underlying Bernalillo shs. and overlying Sandia lss., 300 ft thick, which rest on Lake Valley ls.

C. H. Gordon, 1907 (Jour. Geol., v. 15, 810-816). *Madera ls.*—Dark-blue ls., 300 to 700 ft thick. Top fm. of Magdalena gp. Overlies Sandia fm.; unconf. underlies Manzano gp.

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 22). The term Madera has been applied to different portions of the massive lss. of the Penn. of central N. Mex., ranging in age from lower Des Moines series to upper Virgil series. Since the term Madera was so poorly defined originally by Keyes, and apparently has been used in so many different senses by Keyes and others, it is proposed that the term Madera be dropped from the Penn. nomenclature of N. Mex.

V. C. Kelley and G. H. Wood, 1946 (USGS Oil and Gas Inv. Prelim. Map 47) divide the *Madera ls.* of the Lucero uplift area into (ascending) Gray Mesa, Atrasado, and Red Tanks membs.

R. H. Wilpolt et al., 1946 (USGS Oil and Gas Inv. Prelim. Map 61). The *Madera ls.* is divided in ascending order into a lower, gray ls. memb. and an arkosic ls. memb. The lower, gray ls. memb. consists of massive to thin-bedded cherty medium- to dark-gray ls., with minor amounts of gray and green sh., ss., and cgl. The arkosic ls. memb. consists of thin- to thick-bedded medium- and light-gray ls. that generally contains much less chert than the underlying memb.; gray, black, and red sh.; and green, brown, and gray ss. and arkosic ss. Fresh pink feldspars are invariably present in the basal sss. and cgls. of this memb.; one or two thin beds of distinctive yellow-weathering ls. are omnipresent in this unit.

E. H. Baltz and G. O. Bachman, 1956 (New Mex. Geol. Soc. Guidebook, 7th Field Conf., 99-100). *Madera ls.* in southeastern Sangre de Cristo Mtns. consists of two lithologically distinct units: (1) Lower memb. of interbedded gray fossilif. crystalline to granular ls., black sh., siltstone, and thin ss.; (2) upper memb. of arkosic cgl. ss, fossilif. gray ls., thin beds of purple and red sh., and thick beds of gray and olive siltstone and sh. Thickness 0 to over 3,000 ft.

Type locality: E. slope of Sandia Mtns.; no type section designated.

Name: From the village of La Madera.

‡Maderan series.

Middle Carboniferous (Pennsylvanian?): Central New Mexico (Sandia Mountains).

C. R. Keyes, 1903 (Rpt. Gov. N. Mex. to U. S. Sec. Interior) and 1915 (Conspectus of geol. fms. of N. Mex., 3, 8). *Maderan series.*—A series of the middle Carbf. (Penn.?) including Oscuro, Hueco (upper), and Bernalillo shs.

Type locality: Not designated.

Name: Derivation not indicated.

***Madison limestone.**

Mississippian (Lower): Montana (widespread), Wyoming (rather widespread), Idaho, northern Utah, Four Corners region (subsurface).

A. C. Peale, 1893 (USGS Bull. 110). *Madison ls.*—Consists of (descending): Massive jaspery lss., 575 ft; light bluish-gray massive lss., 350 ft; dark compact laminated lss., 325 ft. Fossils listed. Rests on Dev. Threeforks sh.; overlain by Quadrant fm.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 59-65). In southwestern Colo., southeastern Utah, and northwestern N. Mex., the Miss. rocks of Meramec-Osage age have been called in descending order the Leadville ls. and the Ouray dol. As Ouray dol. is a Dev. fm. in type area, it is proposed that the Miss. rocks in the Four Corners area be called Leadville ls. for the upper ls. unit, and *Madison fm.* for the underlying dol. The Madison fm. can be traced southward from the type loc. to Utah. In San Rafael swell, unit is entirely dol. This dol. can be traced to Four Corners area, where it has erroneously been called Ouray ls. But Ouray ls. is Dev. Joseph Clair (1952) substantiates Miss. age for this fm. from well data. The Madison fm., ranging from 0 to more than 800 ft in the area, consists of massive brown, gray, tan, buff, and some pink dol. characterized by a texture ranging from fine to coarsely crystalline, commonly with good intergranular and vuggy porosity. Locally the dol. is somewhat anhydritic. Chert commonly occurs near the top of the fm. and can be traced for great distances. The chert is generally white and tripolitic and increases to the NW. In the upper part of the fm., thin beds of ls. occur, which appear to be transitional with, and probably represent interfingering with, the overlying Leadville ls. The Madison fm. is overlain conf. with transitional contact by the Leadville ls.; underlain with conf. contact by the Ouray ls.

Type locality: Madison Range, center of old Threeforks quadrangle, Montana.

Name: From Madison Range, Montana.

Magdalena group (limestone).

Pennsylvanian: New Mexico (widespread) and western Texas.

C. H. Gordon, 1907 (Jour. Geol., v. 15, 807-816). *Magdalena gp.*—Divided into (descending) Madera ls. (300 to 700 ft of dark-blue ls.) and Sandia fm. (500 to 700 ft of alternating beds of blue and black clay sh., compact earthy ls., and cgl., vitreous ss. or qtzite; sh. and ls. predominate). In Magdalena Mtns. overlies Kelly ls. (Miss.).

P. B. King, 1934 (GSA Bull., v. 45, 687-798) extended *Magdalena ls.* into Tex. (where he identified the fm. in Hueco and Franklin Mtns. and in a small area in the Sierra Diablo) and restricted Hueco ls. to beds of Perm.(?) age, unconf. overlying the Magdalena.

C. B. Read and G. H. Wood, 1947 (Jour. Geol., v. 55, 220-236), in spite of proven Perm. age of some of the beds, apply the term *Magdalena gp.* to all marine beds btw. Miss. below and Perm. nonmarine Abo fm. above. The upper limit of the Magdalena group is not a time line but represents the limit of marine sedimentation in the area. This was Gordon's original definition.

It would seem better to restrict Magdalena gp. to beds of Penn. age, as the term has become synonymous with Penn. in N. Mex.

Type locality: Magdalena Mtns.; no type section designated.

Name: From Magdalena Mtns., Socorro Co., New Mexico.

Magenta dolomite member (of Rustler formation).

Permian (Ochoan): Southeastern New Mexico and western Texas.

J. E. Adams, 1944 (AAPG Bull., v. 28, 1596-1625). *Magenta dol. memb of Rustler fm.*—W. B. Lang, 1938 (N. Mex. State Eng., 12th and 13th Bien. Rpt., 84), measured Rustler fm. in central Eddy Co., N. Mex. His section is as follows (descending): (1) 30 ft gyp.; (2) 30 ft gypsif. dol.; (3) 100 ft gyp.; (4) 30 ft red beds; (5) 20 ft gyp.; (6) 35 ft dol.; (7) 30 ft red beds; (8) 70 ft gray ss.; (9) 35 ft red beds; (10) 130 ft gyp.; (11) 5 ft red beds. First 5 membs. of foregoing section belong to upper Rustler and others to the lower part of the fm. The 30-ft

gypsif. dol., no. 2 in the sequence, is a persistent marker in the N. half of the Delaware Basin. For this stringer, Lang favors name *Magenta dol. memb. of Rustler fm.*

Type locality and section: Not designated.

Name: From Magenta Point, N. of Laguna Grande de la Sal, central Eddy Co., New Mexico.

‡Mangas quartzite.

Upper Cambrian: Southwestern New Mexico (Silver City region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 9). *Mangas qtzite.*—Basal silic. memb., 100 ft thick, of Middle Camb. section exposed near Silver City. (According to E. Kirk and others, the Middle Camb. is absent in N. Mex. This probably refers to the *Bliss ss.*)

Type locality: Not designated.

Name: From village of Mangas, Catron Co.

‡Manzanan series.

Pennsylvanian: New Mexico.

See under *Mosca ls.*

Manzanita limestone member (of Cherry Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Manzanita ls. memb.*—Buff earthy ls. in rather thick beds, with many geode cavities. Beds weather to characteristic orange brown. Several 1-ft beds of volcanic ash, locally altered to green chert, occur in the section. This ls. is only a few ft below top of Cherry Canyon fm. Thickness 25 to 100 ft.

P. B. King, 1948 (USGS Prof. Paper 215, 36-38). *Manzanita ls. memb.*—Several hundred ft above the South Wells ls. memb., near the top of the Cherry Canyon fm., are the persistent calc. layers of the Manzanita ls. memb. Thickness 75 to 150 ft. Consists of straight-bedded ledges, a few in. to a ft thick, of dense greenish-gray earthy ls., which weathers to a striking orange brown or yellow. The ls. beds generally are separated by partings and thin beds of soft fine-grained greenish ss. Locally the lss. are divided in the middle by massive green-gray ss. as much as 50 ft thick. Most distinctive feature of Manzanita memb. is its intercalated beds of altered volcanic ash. These beds appear generally as pale apple-green silic. shs. or cherts, but in places are waxy green bentonitic clays. The volcanic ash forms beds as much as 2 ft thick, which occur at various positions within the memb.

Type locality and section: Nipple Hill, E. of Manzanita Spring, S. Guadalupe Mtns., Texas.

Name: From Manzanita Spring, three-quarters of a mi E. of Frijole Post Office, Culberson Co., Texas.

Manzano group.

Permian: (Wolfcampian-Leonardian): New Mexico (widespread).

C. L. Herrick, 1900 (Am. Geol., v. 25, 337; Jour. Geol., v. 8, 112-126; N. Mex. Univ. Bull., v. 2, pt. 2, fasc. 3, p. 4). *Manzano series.*—Large series of coarse red qtzites and sss. interbedded with dark earthy lss. and shs. Rests on large series of massive gray silic. lime (which separates it from underlying Coyote ss.); overlain by 500 ft of reddish ls., ss., and gyp. containing Perm. fossils near base.

G. H. Gordon, 1907 (Jour. Geol., v. 15, 810-816). *Manzano gp.* divided into descending): (1) gray ls., 0 to 500 ft; (2) alternating yellow, pink, and white ss. and shs., with lenses of gyp. and subordinate ls., 500 to 1,000 ft.; (3) dark-red ss. interstratified with red sandy shs. and some thin beds of bluish drab earthy ls., 400 to 800 ft. Overlies, with unconf., Madera ls., top fm. of Magdalena gp.

W. T. Lee, 1909 (USGS Bull. 389). *Manzano gp.* is here divided into 3 fms. (descending): (1) *San Andreas ls.*, 150± ft; (2) *Yeso fm.*, 610± ft; and (3) *Abo ss.*, 300± ft. The Abo rests unconf. on Madera ls., the upper fm. of Magdalena gp., and the Manzano is separated from overlying fms. by an unconf. It is clear, from Herrick's original definition of *Manzano gp.*, as well as from his other writings, that he included in his Manzano gp. only: (1) the lower (red) ss., here named *Abo ss.*, with which he associated the overlying gyp.; (2) the middle (chocolate-colored) sediments; and (3) the upper (vermilion) beds. The present writer has combined nos. 2 and 3 and has named them Yeso fm. The massive San Andreas ls. is not described in any of the literature of the Rio Grande region, although Herrick includes it in his sections. It contains an abund. fauna, which clearly allies it with the red beds in the Penn. (now called Perm.); it is included, therefore, in Manzano gp., although originally it was not so included by Herrick. So far as known, the San Andreas ls. is uppermost memb. of Manzano gp., but it cannot be asserted at present that there are no younger Penn. (Perm.) beds in the Rio Grande region, or that no Triassic occurs there. The red sediments near Carthage, which apparently are above San Andreas ls., are the only ones known that may represent Perm. or Triassic time. They differ considerably in general appear. from known Manzano, and nothing was found to indicate whether they belong in Manzano gp. or represent a younger fm.

Current usage includes four, or perhaps five fms. in the Manzano gp. which has long been recognized as Perm. These are (ascending): Bursum fm., Abo fm., Yeso fm., Glorieta ss., and San Andres ls. (presently approved spelling of Lee's San Andreas ls.). Bursum fm. has also been included by some in underlying Magdalena gp., in spite of its Perm. age.

Type section and locality: Not designated.

Name: Derivation not indicated; presumably from Manzano Mtns.

‡Martinian series.

Devonian: Southwestern New Mexico and southeastern Arizona.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 3, 9). *Martinian series.*—Late Devonic ls. sequence (Berenda ls.). Occurring at Bisbee, Ariz. and Silver City and Lake Valley, N. Mex.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1312). In 1922 Keyes applied the Martinian series to the lower part of the Upper Devonian in Ariz.

Type locality: Not designated.

Name: Derivation not indicated.

***Meramec group.**

Mississippian (Upper): Type area only.

Meramecian.

A time term used by many geologists to cover the epoch during which the Middle Miss. Meramec gp. of the Miss. Valley was deposited. A recognized subdivision of the Miss. period (J. M. Weller et al., GSA Bull., v. 59, 91-196, 1948).

Meramecian (Meramec) series.

Term used by many geologists to indicate strata deposited at the same time as the Middle Miss. Meramec gp. of the Miss. Valley region.

Meseta Blanca sandstone member (of Yeso formation).

Permian (Leonardian): Central New Mexico.

G. H. Wood and S. A. Northrup, 1946 (USGS Oil and Gas Inv. Prelim. Map 57). Yeso fm. is divided into the massive *Meseta Blanca ss. memb.* and the overlying thin-bedded San Ysidro memb. Meseta Blanca memb., 0 to 400± ft thick, consists of light-orange to red tangentially crossbedded ss. and weathers to rounded and overhanging cliffs. Overlies Abo fm. to S., tongues with Abo fm. to N., and then tongues with Cutler fm. in vicinity of Señorito Canyon. Conf. overlain by San Ysidro memb. in Nacimiento Mtns.; in other localities overlain (conf.) by various other membs. of Yeso fm.

Type locality and section: Near Cañon, New Mexico, in sec. 3, T. 16 N., R. 2 E., and in area immediately to N. of this sec., in Cañon de San Diego Grant.

Name: From Meseta Blanca, Nacimiento Mtns.

‡†Mimbres limestone.

Silurian and Ordovician: Southwestern New Mexico.

C. H. Gordon, 1907 (Sci., n. ser., v. 25, 824-825; Jour. Geol., v. 15, 91-92). *Mimbres ls.*—900 to 1,200 ft thick. Underlies Dev. Percha sh.; overlies Upper Camb. Shandon qtzite (Bliss ss.). The greater part of these lss. contains Richmond fauna, but upper 100+ ft has yielded Sil. fauna.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1378). Now separated into Fusselman ls. (Niagaran), Montoya ls. (Richmond), and El Paso ls. (Canadian), and name abandoned.

Type locality: Not designated.

Name: From Mimbres Mtns., W. part of Sierra Co.

‡Mimbresian (Mimbresan) series.

Ordovician (Late): New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 9). *Mimbresan series.*—Term restricted to Late Ordovicic section in Mimbres, Caballos, and Franklin Ranges that carries the Richmond fauna.

Type locality: Not designated.

Name: From Mimbres Mtns.

‡Mimbres series.

Carboniferous (Mississippian?): New Mexico.

C. R. Keyes, 1903 (Rpt. Gov. N. Mex. to Sec. Interior, 337-341). A time term used to cover 150 ft of ss. and ls., divided into the Placitos ss. and Lake Valley lss.

Type locality: Not designated.

Name: From Mimbres Mtns.

***Missouri group.**

Pennsylvanian (Upper): Midcontinent only.

Missourian.

A time term used by many geologists to indicate the epoch during which the Upper Penn. Missouri series of the midcontinent region was deposited. A recognized subdivision of the Penn. (R. C. Moore et al., GSA Bull., v. 55, 657-706, 1944).

Missouri series.

Term used by many geologists to indicate strata deposited at the same time as the Upper Penn. Missouri series (Missouri gp.) of the midcontinent region.

‡Moencopie shales.

See under Cimarronian series of C. R. Keyes.

Molas formation.

Pennsylvanian (Morrowan, Atokan): Southwestern Colorado, southeastern Utah, and subsurface of northeastern Arizona and northwestern New Mexico.

W. Cross and E. Howe, 1905 (USGS Silverton folio, n. 120, 4; GSA Bull., v. 16, 470-496). *Molas fm.*—Red calc. shs. and sss. with chert, ls., and qtzite pebbles and thin fossilif. ls. lenses. The ls. lenses contain Penn. fossils. The chert and ls. pebbles often contain fossils from Miss. part of underlying Ouray ls. with which it is unconf. Thickness 75 ft. Conf. overlain by Hermosa fm. The Molas is absent in area where Hermosa fm. was first defined; was not included, therefore, in original Hermosa.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1397). The Miss. part of Ouray ls. as first defined is now called Leadville ls., and *Ouray ls.* is restricted to the Upper Dev. part. [The unit conf. overlying the Molas is now named the Pinkerton Trail ls. (Wengerd and Strickland, AAPG Bull., v. 38, 2168-2169, 1954).]

N. W. Bass, 1944 (USGS Oil and Gas Inv. Prelim. Chart 7). *Molas fm.* of Penn. age unconf. overlies the Leadville ls. in subsurf. of N. Mex. and Ariz.

S. A. Wengerd and J. W. Strickland, 1954 (AAPG Bull., v. 38, 2166-2168). *Molas fm.*—Lower memb. is a section of varicolored claystone, predom. red, containing many solution-rounded ls. fragments of Miss. age., which appear to be a ls.-chert regolith cemented by calc. silty claystone. Middle memb. is highly variable siltstone and sh., with some intraformational cgl. The upper section, not everywhere present, is marine red and green sh.-ss. sequence, with abundant brachiopods, pelecypods, trilobites, and fusulinids of Des Moines age. Thickness 0-200 ft. Morrowan, Atokan, Desmoinesian(?) in age.

Type locality: Molas Lake, Needle Mtns. quadrangle, Colorado.

Name: From Molas Lake, Needle Mtns. quadrangle, Colorado.

Monte Largo granite.

Precambrian: Central New Mexico (Southern Manzano Mountains).

J. T. Stark, 1956 (N. Mex. Bur. Mines Bull. 34). *Monte Largo granite.*—A small stocklike mass of granite, qtz monzonite, and diorite approx. 1½ mi sq. Intrudes Blue Springs schist and Sais qtzite. The rock appears sim. to the Ojito granite. The granite is coarse to medium coarse grained and composed almost entirely of saussuritized feldspar, qtz, and chloritized biotite and hornblende. It shows schistose structure, schist inclusions more or less parallel to the schistosity, and numerous short lens-shaped qtz-filled vugs, which aver. 2 to 4 in. long and 1 in. wide. The feldspars are albite-oligoclase, orthoclase, microperthite. Qtz is 20 to 25 percent of the rock.

Type locality: Monte Largo Canyon, secs. 26, 27, 34, 35, T. 5 N., R. 5 E., W. Torrance Co.

Name: From Monte Largo Canyon.

‡Montosa limestone.

See under *Mosca ls.* A part of Madera ls. (Penn.), N. Mex.

Montoya group (limestone).

Upper Ordovician: Western Texas and southern New Mexico.

G. B. Richardson, 1908 (Am. Jour. Sci., 4th ser., v. 25, 476-479). *Montoya ls.*—Upper part, which carries Richmond fossils, according to E. O. Ulrich, is prevailingly gray ls., characteristically mag., in places seamed with conspicuous bands of chert a few in. thick; some beds are almost white, others are dark. Lower part is commonly marked, in El Paso quad., Tex., by massive dark-colored ls., containing little or no chert and carrying characteristic Galena fossils, according to E. O. Ulrich. The two parts cannot always be distinguished lithologically. Thickness 250 ft. In Van Horn quad. the base of the Montoya commonly is marked by presence of thin-bedded earthy yellow and reddish ls.; otherwise, in both quads, the contact with underlying El Paso ls. is apparently conf. Overlain by Fusselman ls. (Niagara).

M. G. Wilmarth, 1938 (USGS Bull. 896, 1411). Further studies of faunas contained in Montoya ls. have resulted in assigning the *lower* fauna to pre-Richmond Upper Ordovician.

L. P. Entwistle, 1944 (N. Mex. Bur. Mines Bull. 19, 16-19), divided the Montoya into 3 membs. (ascending): *Second Value memb., Par Value memb.,* and *Raven memb.*

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 56-66), raised the *Montoya* to a *gp.*, including 4 fms. (ascending): *Cable Canyon ss., Upham dol., Aleman fm.,* and *Cutter fm.,* the last named being Darton's (1917) lower memb. of Fusselman ls., which is shown to be of Ord. age.

L. C. Pray, 1953 (AAPG Bull., v. 37, 1907). Kelley and Silver have extended the term Montoya of Richardson to include strata called lower Fusselman by Darton. The Cutter fm. probably should not be included in the Montoya gp., as its inclusion expands the original definition of Montoya fm.; the Cutter probably is more correctly related to the Fusselman dol.

Type locality: At S. end of the Franklin Mtns., above Scenic Drive, El Paso, Texas.

Name: From Montoya station on A.T.&S.F. Ry., about 10 mi N. of El Paso, Texas.

Montoyan series.

Ordovician (Middle): Southern New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 9). *Montoyan series.*—Mid Ordovicic section of the Franklin, Caballos, and Mimbres Mtns.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1411). A time term employed by C. R. Keyes to cover a part of Montoya ls.

Type locality: Not designated.

Name: From Montoya station on A.T.&S.F. Ry.

***Morrow group.**

Pennsylvanian (Lower): Midcontinent only.

Morrowan.

A time term used by many geologists to indicate the epoch during which the Lower Penn. Morrow series of the midcontinent region was deposited. A recognized subdivision of the Penn. period (R. C. Moore et al., GSA Bull., v. 55, 657-706, 1944).

Morrow series.

A term used by many geologists to indicate strata deposited at the same time as the Lower Penn. Morrow series of the midcontinent region.

‡Mosca limestone.

Pennsylvanian: New Mexico.

C. R. Keyes, 1906 (Jour. Geol., v. 14, 147-154), divided his *Manzanan series* (not same as Manzano group, but older) into (descending) *Mosca lss.*, Coyote sss., *Montosa lss.*, and Sandia shs.

Type localities: Not designated.

Names: (Manzanan series) from Manzano Mtns.; (Mosca limestone) from Mosca Peak; (Montosa limestone) derivation not indicated.

Mountain Home shale.

Pennsylvanian: Southwestern New Mexico (Santa Rita mining district).

H. Schmitt, 1933 (AIME Contr. 39, 2, 4, 13). (See under *Humboldt fm.*)

This is the lower 100 to 130 ft of Syrena fm. (Penn.) of Santa Rita mining dist.

Type locality: Vicinity of Mountain Home mine, Santa Rita mining district, Grant County.

Name: From Mountain Home mine, Santa Rita mining district, Grant County.

Moya formation. (Of Keller group.)

Pennsylvanian (Virgilian): Central New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 71, 72-73). *Moya fm.*—At type loc. 51 ft, largely massive to massively bedded ls., with a few thin beds of irregularly bedded to nodular ls. In Los Pinos Mtns. and Mud Springs Mtns., and at Abo Canyon and Mockingbird Gap, sss. and shs. are interbedded with the lss. of the Moya fm. Beds thicken to N. and S. of type section. Type section (ascending): (1) ls., fine-grained, dense and hard, fossilif., forms one massive cliff, 25 ft; (2) ls., light-gray, algal, evenly bedded, poorly exposed in upper part, 7 ft; (3) ls., light-gray, dense, massive, fusulinids, 12 ft; (4) ls., light-gray, dense, massive, sections of shells common, 7 ft. Fusulinid fauna: *Triticites*. Lies conf. on Del Cuerto fm.; conf. overlain by Bruton fm.

Type locality and section: N. end of Oscura Mtns., in NE¼ sec. 31, T. 5 S., R. 6 E., and W. central part of sec. 32, T. 5 S., R. 6 E.

Name: From Moya Spring on E. slope of Oscura Mtns., 8 mi S. of N. end of range.

Mud Springs group.

Pennsylvanian (Derryan): Southern and central New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 36-39). *Mud Springs gp.*—Name for all Derry strata btw. top of Green Canyon gp. and base of Des Moines

series. At type section 114 ft thick, consisting of 2 fms.: *Hot Springs fm.*, 86 ft of dark-gray to light-gray massive to nodular highly cherty ls. and thick sh. beds; overlain by *Cuchillo Negro fm.*, 28 ft of light-gray massive to nodular cherty ls., with thin greenish to brownish coarse-grained ss. at base. Fusulinid fauna: *Millerella, Ozawainella(?), Eoschubertella, Pseudostaffela,* and *Fusulinella.* Lies conf. on Apodaca fm. of Green Canyon gp.; unconf.(?) overlain by Des Moines series.

Type locality and section: W. end of Whiskey Canyon, Mud Springs Mtns., in SW¼ sec. 1, T. 3 S., R. 5 W.

Name: From Mud Springs Mtns., west of Truth or Consequences, Sierra Co., New Mexico.

***Naco limestone.**

Pennsylvanian and Permian: Southern Arizona and extreme southwestern New Mexico (Hidalgo County).

F. L. Ransome, 1904 (USGS Prof. Paper 21, 44-46). *Naco ls.*—Chiefly light-colored regularly stratified fossilif. beds, consisting essentially of $CaCO_3$; compact nearly aphanitic, splintery fracture; granular crinoidal beds not uncommon. Beds range in thickness from a few in. to 10 ft. Chert not uncommon; occurs in irregular bunches and nodules. Rests conf. on Escabrosa ls.; is unconf. overlain by basal Cret. Thickness 1,500 to 2,000 ft.

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 15-30). *Naco gp.*—Naco is retained as a group term, as it is thought that a name for the entire assemblage of post-Miss. Paleozoic rocks will long be useful. The Naco gp. is subdivided into six fms. (fundamental map units) for this area. These are, in ascending order, the Horquilla ls., the Earp fm., the Colina ls., the Epitaph dol., the Scherrer fm., and the Concha ls.

W. L. Quaide, 1935 (Geology of the Central Peloncillo Mountains, Hidalgo County, New Mexico, Univ. of Calif., unpub. Master's thesis, 34-42). *Naco fm.*—Gray fine-grained cherty fetid fossilif. ls., with interbeds of sh. and minor amounts of qtz ss. Lower 700 ft, gray or blue-gray medium-bedded medium- to fine-crystalline ls., chert erratically distrib., fetid fossilif.; fusulinids and *Chaetetes* reefs abund. Middle 1,400 ft of 30% gray-green sh. and 70% fine- to medium-grained crinoidal lss., with chert replacement common. Upper 1,100 ft, medium- to thick-bedded fine- to medium-grained cherty fossilif. lss., sandy lss., and calc. sss., lithic units interbedded and intergrading laterally. Fusulinids and solitary corals abund. Thickness 3,100 ft. Age: 70 ft above base, *Fusulinella* of middle to late Atokan; in succeeding 2,500 ft faunal assemblages of Des Moines, Missouri, and Virgil age; top 500± ft carries fusulinids of Wolfcamp and Leonard age. Overlies Paradise fm. with appar. conf.; underlies Cret. rocks unconf.

Type locality: Naco Hills; no type section designated.

Name: From Naco Hills, near W. edge of Bisbee quadrangle, Arizona.

‡Naiad limestone.

Silurian(?): Southwestern New Mexico (Silver City region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 3, 10). *Naiad ls.*—Main ore-bearing fm. at Georgetown, Silver City, and elsewhere in these districts. Thickness 250 ft. Overlies Cibola ls., both of which comprise Santa Ritan series. Assigned to Sil.

Type locality: Not designated.

Name: Derivation not indicated.

Nakaye formation.

Pennsylvanian (Desmoinesian-Missourian?): South central New Mexico (Caballo Mountains).

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 92-93). *Nakaye fm.*—419 ft, dominantly thick to massive ledges of ls., which often contain abund. bands, lenses, or nodules of gray chert. Precipitous outcrop of 15 to 20 distinct ledges, ranging from 10 to 25 ft in thickness. The ledges are separated from each other by bedding planes, sh. intervals 1 to 2 ft thick, or thin- to medium-bedded ls. 5 to 10 ft thick. The ls. is medium gray to dark gray and very fine grained to fine grained in most places. Many of the beds weather to light tan-brown; others weather light gray to medium gray. No ss. occurs in the section. Some of the massive ls. beds contain only fine lacy chert intimately intergrown with calcite. Lies conf. on Red House fm. (Penn.); is conf.(?) overlain by Bar B fm. (Penn.).

Type locality and section: South Ridge, Caballo Mtns., in sec. 10, T. 15 S., R. 4 W.

Name: From Nakaye Mtn., in southern Caballo Mtns., where it is prominently exposed.

‡Ninos schist.

Precambrian: Central northern New Mexico (Las Vegas region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 10). *Ninos schists.*—Lower and principal schistose section above Azoic gneisses in Solitario Mtn. region, NW. of Las Vegas. Thickness 1,000 ft.

Type locality: Not designated.

Name: Derivation not indicated.

‡†Nogal formation.

Permian: Southeastern New Mexico (Roswell artesian basin).

A. G. Fiedler and S. S. Nye, 1933 (USGS Water-Supply Paper 639). *Nogal fm.*—A lithologic unit consisting chiefly of red beds, gyp., and anhyd., but including interbedded ls. in thick beds, dolo. ls., ss., sh., and salt. Thickness 1,000 to 2,000+ ft; 1,000± ft thick in vicinity of Nogal Canyon. Underlies, apparently conf., Picacho ls.; rests on Abo ss. In SE. part of basin it gives place laterally to a thick ls. section, which is tentatively included in Picacho ls. The Nogal fm. differs from the younger Pecos fm. in that it is usually much more thickly bedded and includes but a small proportion of red beds. The Nogal fm. is considered by geologists working in SE. N. Mex. to be Yeso fm. of Lee and Girty, and it forms lower part of Chupadera fm. of Darton in this region. The Picacho ls. of this rpt. is considered by geologists working in this region to be the San Andres ls. of Lee and Girty.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-896). Picacho ls. is here abandoned for San Andres ls. memb. of Chupadera fm., and *Nogal fm.* is here abandoned, being replaced by Hondo ss. memb. of Chupadera fm. (above) and Yeso memb. of Chupadera fm. (below). [As originally defined and heretofore used, San Andres ls. rested on Yeso. The recognition of Hondo ss. involves slight redefinition of the San Andres and Yeso.]

Type locality and section: W. side of ridge separating Nogal Canyon from Tularosa Basin, about 10 mi ENE. of Tularosa, Otero Co.

Name: From Nogal Canyon.

Nunn member (of Lake Valley formation).

Mississippian (Osagian): Southern New Mexico.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 13). *Nunn memb.*—At type section 65 ft of nodular blue-gray criquina and soft blue-gray crinoidal marl. The upper part is interbedded with brown and gray criquina and contains the prolific Lake Valley crinoid fauna. Thickness varies from 100 ft in Santa Rita area to 1 ft in Sacramento Mtns. Rapid lateral variation in thickness is common in the Sacramento Mtns., where biohermal structures occur. Lies conf. on Alamogordo memb.; conf. and gradationally overlain by Tierra Blanca memb.

Type locality and section: Apache Hill, near Lake Valley, in NE¼NW¼ sec. 21, T. 18 S., R. 7 W.

Name: From Pryor Nunn ranch, on Tierra Blanca Creek, Sierra Co.

Ochoan.

A time term used by many geologists to indicate the epoch during which the upper Perm. Ochoa series of southeastern New Mexico and western Texas was deposited. An approved subdiv. of Perm. time.

Ochoa series.

Permian (uppermost division of Permian of North America).

J. E. Adams et al., 1939 (AAPG Bull., v. 23, 1673-1681). The writers of this note propose to call the fourth and uppermost div. of Perm. of N. Am. the *Ochoa series.* In the deep basin underlying this vicinity, almost continuous deposition took place during Ochoa time. The Ochoa series, which is designed to include all of upper Perm. sediments of post-Guadalupe age, consists largely of evaporites and attains a subsurf. thickness of considerably more than 4,000 ft. Four distinct subdiv. are recognized, which, at present, are designated (ascending) as Lower Castile, Upper Castile, Rustler, and Dewey Lake.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). In this paper the terms Wolfcamp, Leonard, Guadalupe, and *Ochoa* series are considered to be provincial terms.

F. E. Kottlowski et al., 1956 (N. Mex. Bur. Mines Mem. 1, 47). Noteworthy is a decision by the Geologic Names Committee of the USGS, dated July 28, 1955, here quoted in part: "The Chief Geologist has approved [that] . . . the use of provincial series be continued as subdiv. of the Perm. system in preference to lower, middle, and upper."

Thus, the term Ochoa series has been extended to include strata deposited at the same time as the upper Perm. Ochoa series of southeastern N. Mex. and western Tex.

Type locality and section: Subsurf. section in deep basin underlying vicinity of Ochoa Post Office, in T. 24 S., R. 34 E., Lea Co., New Mexico; represented by samples and cores on file at the Bureau of Economic Geology, Austin, Texas.

Name: From Ochoa Post Office.

Ocotillo silt member (of Tansill formation).

Permian (Guadalupian): Southeastern New Mexico and western Texas.

R. K. Deford and G. D. Riggs, 1941 (AAPG Bull., v. 25, 1713-1728). *Ocotillo silt memb.*—Thin silts, mag. ls., sand, and marl in upper part of Tansill fm. At some places prevailing color is gray; at others, red. Thickness 13.5 ft at type loc. This unit can be traced over a wide area in surface outcrops and in the subsurf.

Type locality and section: On Carlsbad-Artesia highway (U. S. 285), 3.7 mi N. of Eddy Co. courthouse, in W½ sec. 26, T. 21 S., R. 26 E.

Name: From Ocotillo Hills, near type loc. of Tansill fm., Eddy Co., New Mexico.

***Oil Creek formation.**

Middle Ordovician (Chazy): Central southern Oklahoma (Arbuckle Mountains) and subsurface of western Texas and southeastern New Mexico.

C. E. Decker, 1930 (AAPG Bull., v. 14, 1498-1505). *Oil Creek fm.*—Consists chiefly of dols. and lss., with some sh. and ss. beds, and at base a ss. from 8 to 200 ft thick. Underlies McLish fm.; overlies Joins fm. Thickness of fm. 1,600 to 2,300± ft. Of Chazy age.

C. E. Decker and C. A. Merritt, 1931 (Okla. Geol. Surv. Bull. 55). The *Simpson* is here raised to a *gp.*, divided into 5 fms. (ascending): Joins, *Oil Creek*, McLish, Tulip Creek, and Bromide. Oil Creek is of lower Chazyan age.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038), proposed the name *Connell ss. memb.* for the basal ss. of the *Oil Creek* in the subsurf. of western Tex. Since, on paleontological grounds, all the formational units of the Okla.-type Simpson can be shown to be represented in the subsurf. of western Tex., and since the gp. in western Tex. can also be subdivided on lithologic grounds, not in conflict with the former, it is proposed that the Okla. formational names be applied to the recognized subdivisions of the subsurf. Simpson.

Type locality: Exposures on Oil Creek, W. Johnston Co. and SE. Murray Co., Oklahoma.

Name: From Oil Creek.

Ojito granite.

Precambrian: Central New Mexico (North Manzano Mountains).

P. Reiche, 1949 (GSA Bull., v. 60, 1183-1212). *Ojito granite.*—Light-gray massive medium-grained granite, locally gradational to qtz monzonite. Extent 7 mi N.-S., 2.75 mi E.-W. Discordant contact with intruded earlier Precamb. rocks Faulted off on W. Apart from silic., contact alteration of adjacent sediments is very slight.

Type locality: Not designated.

Name: From El Ojito Canyon, N. Manzano Mtns.

Oklan.

A time term proposed by R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302), to cover the epoch during which the Oklan series (Middle Penn.) was deposited.

Oklan series.

A term proposed by R. C. Moore and M. L. Thompson, 1949 (AAPG Bull., v. 33, 275-302) as a substitute for Middle Penn. (Atokan and Desmoinesian). Atokan and Desmoinesian are designated as stages in the Oklan series.

Onate formation.

Middle(?) or Late(?) Devonian: Southern New Mexico (Sacramento and San Andres Mountains).

F. V. Stevenson, 1945 (Jour. Geol., v. 53, 217-245). *Onate fm.*—The Onate fm. consists of a gray-brown to buff variable and intergradational series of sh.,

siltstone, fine ss., and ls. Identification of these sediments for correlation purposes is complicated by lateral intergradational changes, a lack of sufficient index fossils, and the absence of strong color contrasts between the beds. The base of the Onate is located easily. The older Paleozoic fms., which are massive lss. and silic. dols., are separated by an erosional unconf. from the relatively thin-bedded clastic units of the superjacent Onate fm. The top of the Onate is not marked by any disconf. readily detectable in the field. An outstanding difference btw. the Onate and the overlying Sly Gap fm., however, is the gray-brown color of the former and the tan to light-yellow color of the latter. *Leiorhynchus* sp. occurs in Onate but not in Sly Gap. Thin shaly beds containing ribbonlike bryozoa (*Sulcoretepora anomalotruncata*) occur within 3 or 4 ft of the top of the Onate in most sections. Weathers to steplike outcrop. Thought to be at least a partial correlative of the Canutillo fm. Thickness 86 ft at type loc.; aver. 35 ft in Sacramento Mtns.

Type locality and section: N. slope of San Andres Canyon, sec. 18, T. 18 S., R. 4 E., San Andres Mtns.

Name: From Onate Mtn., San Andres Mtns.

***Ophir formation.**

Middle Cambrian: Central Utah and subsurface of southeastern Utah and northwestern New Mexico (Four Corners area).

G. F. Loughlin, 1919 (USGS Prof. Paper 107, 25-27). *Ophir fm.*—Name proposed by B. S. Butler for the shs. (locally slates), with a little ss. and intercalated ls. beds, overlying Tintic qtzite, as here restricted, and underlying Teutonic ls. in the ranges of central Utah. Thickness 159 to 475± ft. Well exposed at Ophir, eastern Tooele Co. Lower part of these beds (100 to 190 ft) was included in Tintic qtzite as originally defined, but Tintic is herein restricted to the massive qtzites.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 59-65). The *Ophir fm.*, which can be traced into the Four Corners area by a few scattered wells, ranges from 0 to 375 ft. This unit, which has been penetrated by 12 wells, consists predom. of thin-bedded gray-green and red micaceous sh., which is commonly sandy. The sh. generally contains numerous, intercalated, thin beds of cream and red silty micaceous dol. and ls., which often carry glauconite. The Ophir fm. commonly contains thin beds of red and green glauconitic ss., especially near the base. To the NW., in Utah, the fm. grades to a gray to brown glauconitic micaceous siltstone, with numerous sh. and dol. interbeds, as above. The Ophir fm., which is equiv. to the Bright Angel sh. of Grand Canyon, overlies the Tintic ss. with a transitional contact; is overlain conf. by the Bowman-Hartman ls. undiff. To the E., where Upper Camb. rocks have been either beveled by erosion or not deposited, the Ophir fm. is overlain by Dev. rocks.

Type locality: At Ophir, eastern Tooele Co.

Name: From mining town of Ophir, in the Oquirrh Mtns.

Ortega formation.

Precambrian: Central northern New Mexico (Picuris Range and Petaca area).

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 6-21). *Ortega fm.*—Consists of lower qtzite, at least 2,500 ft thick; *Rinconada schist memb.*, 1,800 ft thick; and *Pilar phyllite memb.*, at least 2,300 ft thick. The lower qtzite is coarse grained, with thin beds of sillimanite-kyanite gneiss. The rock is glassy and mostly massive; locally slabby. Ordinarily gray to gray white but may be pale brown, with streaky or mottled appearance due to iron-oxide staining. Other colors

are milky white, dark-smoky or nearly gray black, and (rarely) pale bluish green. Very minor dark grains, tourmaline, hematite, or ilmenite, and minute kyanite or sillimanite. Rinconada schist is made up of andalusite-biotite hornfels, staurolite gneiss and schist, qtzite, and muscovite-qtz-biotite-garnet phyllite. Pilar phyllite is gray-black carb. qtz-mica phyllite with a slaty cleavage. Ortega fm. is oldest Precamb. fm. in the Picuris Range.

Type locality: Not designated.

Name: From Ortega Mtns.

Ortega quartzite.

Precambrian: Central northern New Mexico (Petaca area and Picuris Range).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13). *Ortega qtzite.*—Bluish-gray qtzite and cgl. qtzite, and gray to buff qtz-muscovite schist (Rinconada schist memb. in Picuris range, Petaca schist in Petaca area). Thickness 1 to 5 mi. Lies on Hopewell series.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 6), calls the *Ortega qtzite* of Just a member of the Ortega fm., which includes basal qtzite, Rinconada schist memb., and Pilar phyllite memb. (Hondo slate of Just). Ortega fm. is oldest Precamb. fm. in Picuris Range and is overlain by Vadito fm., which is at least partly equiv. to Hopewell series of Just.

Type locality: Not designated.

Name: From Ortega Mtns.

Osagean (Osage) series.

Term used by many geologists to indicate strata deposited at the same time as the Middle Miss. Osage gp. of the Miss. Valley region.

Osagean (Osagian).

A time term used by many geologists to cover the epoch during which the Middle Miss. Osage gp. of the Miss. Valley region was deposited. A recognized subdivision of the Miss. period (J. M. Weller et al., GSA Bull., v. 59, 91-196, 1948).

‡Oscuro limestone.

Pennsylvanian: Rio Grande region, New Mexico.

C. R. Keyes, 1909 (Iowa Acad. Sci. Proc., v. 16, 159-163). A name applied to Penn. lss. unconf. overlying the Mosca ls. in Rio Grande region, N. Mex.

Type locality: Not designated.

Name: From Oscuro Peak, Socorro Co.

Oswaldo formation. (Of Magdalena group.)

Pennsylvanian: Southwestern New Mexico (Santa Rita district).

A. C. Spencer and S. Paige, 1935 (USGS Bull. 859, 22-26). *Oswaldo fm.*—Aver. thickness 400 ft. In ascending order: (1) basal sh., 20 to 30 ft; (2) massive blue ls., 80 to 90 ft; (3) thin-bedded blue ls., with rare sh. partings, 210 ft; (4) thin-bedded banded ls., with sh. partings, 80 ft. Is used as lower fm. of Magdalena gp. Underlies conf. Syrena fm.; overlies, probably unconf., the Lake Valley ls.

R. M. Hernon, W. R. Jones, et al., 1955 (Geologic map of the Central mining district, Grant County, New Mexico, USGS, open file). *Oswaldo fm.*—Predom. blue-gray thick-bedded cherty ls. beds with sh. partings from a few in. to as much as 10 ft. Small to large lenses of coarse-grained ss. locally at 70 to 125 ft

above base. A 20- to 40-ft gray or reddish sh. (the "Parting sh. memb." at base). Top 3 to 5 ft dense cherty but pure ls.; otherwise, top 50 to 80 ft of thin alternating beds of pure ls., partly crinoidal, and silty ls. These beds, upon weathering, form a banded or striped zone of light-gray and tan beds. The ls. btw. basal parting sh. and a persistent qtz diorite sill (80 to 100 ft above sh.) is called the "middle blue ls." Above sill, but below striped beds, is the "upper blue ls." Thickness 330 to 420 ft.

Type locality and section: Not stated.

Name: From Oswaldo patented mining claim, 1± mi S. of Hanover Post Office.

‡Otero limestone.

Permian: Western Texas and southeastern New Mexico.

C. R. Keyes, 1936 (Pan-Am. Geol., v. 65, 39, 42, 46). A name applied to "upper black ls." of Shumard and Girty (later called "Frijole ls." by some geologists), which forms top memb. of Delaware Mtn. fm. (Perm.) in Guadalupe Mtns., western Texas.

Type locality: Not designated.

Name: Probably from Otero Co., New Mexico.

***Ouray limestone.**

Upper Devonian: Southwestern Colorado and subsurface of southeastern Utah, northeastern Arizona, and northwestern New Mexico (Four Corners area).

A. C. Spencer, 1900 (Am. Jour. Sci., 4th ser., v. 9, 125-129). *Ouray ls.* is name proposed for only memb. of pre-Carbf. section of San Juan region, SW. Colo., which is definitely shown by its fossils to be of Dev. age. Named for prom. occurrence in vicinity of Ouray, at junction of Cañon Creek with Uncompahgre River. The fm. consists of 100 to 300 ft of massive ls. In places it is one massive unit; in other places it consists of 2 or 3 massive beds separated by greenish crumbling marls. The ls. is usually white but sometimes is stained red or pink. Certain strata are somewhat coarsely crystalline, but as a rule the ls. is fine grained. The Dev. fossils (identified by G. H. Girty) were found a short distance below top. Neither the top nor the basal layers have yielded fossils. Rests on 0 to 100 ft of Dev. sh., and, in places, on Algonkian; underlies, apparently conf., rocks containing Upper Carbf. fossils a few ft above Ouray ls. The Lower Carbf. appears to be absent, but possibly a few ft of unfossilif. ls. above the true Dev., and not differentiated from it, may be of Lower Carbf. age.

A. C. Spencer, 1900 (USGS 21st Ann. Rpt., pt. 2, 37-78). *Ouray ls.* (Dev.) is overlain by Hermosa fm. (Penn.). The sh. on which Ouray ls. rests may be pre-Dev.

W. Cross, 1904 (Am. Jour. Sci., 4th ser., v. 18, 245-252). *Ouray ls.* of San Juan region is a lithologic unit and contains Miss. fossils in upper part and Dev. fossils in lower part. It overlies Elbert fm. (Dev. sh.).

W. Cross and E. Howe, 1905 (GSA Bull., v. 16, 470-496). *Ouray ls.* of SW. Colo. is unconf. overlain by Molas fm. (Penn.).

W. Cross, A. C. Spencer, and F. L. Ransome, 1905 (USGS Rico folio, n. 130). *Ouray ls.*, 100 to 300 ft thick, is of Miss. and Dev. age. When defined by Spencer, it was supposed to be all Dev. It is a lithologic unit, and the Miss. and Dev. cannot be separated. The Miss. fauna is found also in Leadville ls.

W. S. Burbank, 1930 (Colo. Sci. Soc. Proc., v. 12, n. 6). The *Ouray ls.* is chiefly of Miss. age, the Dev. part being 65 to 70 ft thick, and the Miss. part 180 to 235 ft thick. Fossils 15 to 30 ft above base are pronounced by Kirk to be Upper Dev. No other fossils found in Dev. part of the ls. The Dev. part is chiefly gray, buff,

or white lss. of medium grain; the Miss. part is largely gray or brownish-gray crystalline ls., alternating with beds of ls. breccia containing red shaly seams. The top of the Dev. part in Ouray dist. is drawn at base of a blue-gray thin-bedded ls. that commonly contains nodules of black chert. An inconspicuous ls. breccia occurs at places in overlying beds. At Box Canyon the dark-colored chert-bearing beds and the breccia are both absent, but base of Miss. ls. seems to be marked by ss. layers containing calc. cement.

E. Kirk, 1931 (Am. Jour. Sci., 5th ser., v. 22, 224). *Ouray ls.* here restricted to the Dev. part of Ouray ls. as previously used; the Miss. part hereafter to be called Leadville ls. It is understood that *Ouray* will not be applied outside of SW. Colo.

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 63). *Ouray ls.*—The Ouray ls. ranges from 0 to 238 ft in the Four Corners area, thickening gradually to the NW. The unit consists of a massive dense argil. ls., ranging from buff, tan, and cream to gray, with some thin streaks of waxy gray-green clayey shs. In Utah the ls. is locally slightly sandy, and in places the basal portion carries ss. Brachiopod and crinoid fragments occur in some of the wells. Dev. fossils have been reported in one test. The Ouray ls. is overlain unconf. by the Miss. Madison fm.; underlain probably unconf. by the Elbert fm.

Type locality: Vicinity of Ouray at the junction of Cañon Creek with the Uncompaghre River.

Name: From mining town of Ouray, southern Colorado.

Panther Seep formation.

Pennsylvanian (Virgilian): South central New Mexico (San Andres Mountains).

F. E. Kottlowski et al., 1956 (N. Mex. Bur. Mines Mem. 1, 7, 42-47). *Panther Seep fm.*—Silty brown shs., dark carbonaceous shs., dark argil. lss., massive biostromal lss., silty calcarenites, and calc. siltstones. Near Ash Canyon, two gyp. beds in upper part; near Rhodes and Hembrillo Canyons, numerous biohermal reefs. Owing to the distinctiveness of the lithology from other Virgilian units in surrounding areas and the possibility that upper portions may be Wolfcampian, the unit is here given a formational name. It can be mapped from Mockingbird Gap to the S. end of the San Andres Mtns., and in the N. end of the Franklin Mtns. Thickness 1,458 to 2,390 ft; thickens to S. Lies unconf. on Missourian strata; unconf. overlain by Bursum fm. (Perm.).

Type locality and section: Along Rhodes Canyon, San Andres Mtns., in SE¼ sec. 14, T. 13 S., R. 3 E. (lower part), and center sec. 12, T. 13 S., R. 2 E. (upper part).

Name: From Panther Seep, Bearden Canyon, San Andres Mtns.

***Paradise formation.**

Mississippian (Upper): Southeastern Arizona and adjoining extreme southwestern New Mexico (Hidalgo County).

A. A. Stoyanow, 1926 (Am. Jour. Sci., 5th ser., v. 12, 316-320). *Paradise fm.*—Consists of black and gray moderately thick- and thin-bedded crystalline ls. that weathers olive and yellow, alternating with ss., sh., oölite, cross-bedded calc. ss., and aren. ls. Preponderant color of fm. is yellow. Fossils indicate an Upper Miss. age (late Meramec and early Chester). Underlies Naco ls.; overlies Escabrosa ls. Thickness 134 ft.

R. M. Hernon, 1935 (Jour. Pal., v. 9, 653-694), divided Paradise fm. of Stoyanow into 8 lithologic membs.; gave detailed sections of fm.; described, listed, and figured its fauna; and correlated its membs. with Miss. Valley, Ark., and Okla. fms. ranging in age from St. Louis(?) ls. up to Glen Dean ls. of Chester gp.

A. A. Stoyanow, 1936 (GSA Bull., v. 47, 509-511), gave very detailed section of his Paradise fm. and listed its fossils.

W. L. Quaide, 1953 (Geology of the Central Peloncillo Mountains, Hidalgo County, New Mexico, Univ. of Calif., unpub. Master's thesis, 31-34). *Paradise fm.*—Black and brown calc. sh., brown-weathering argil. ls., and coarse clastic ls. interbedded. Base drawn at first appear. of sh. or argil. ls.; calc. shs. and siltstone increase in amount upward. Near top a distinctive calcirudite. Thickness 120 ft. Overlies the Escabrosa conf. with transitional contact; underlies the Naco fm. with appar. conf.

R. A. Zeller, 1956 (Prelim. composite stratigraphic section, Big Hatchet Peak quad., Hidalgo County, New Mexico, N. Mex. Bur. Mines, unpub. manuscript). *Paradise fm.*—Thin-bedded gray to black crystalline ls., clastic; some beds oölitic or ls. cgls., crossbedded. Weathers brown. Fossilif. Thickness 270± ft.

Type locality and section: On E. face of Chiricahua Mtns., a few miles E. of the old mining camp of Paradise, Arizona.

Name: From Paradise, an abandoned mining camp 45 mi NE. of Bisbee, Arizona, and 10 mi W. of New Mexico line.

Paradox formation (Paradox member of Hermosa formation).

Pennsylvanian (Lampasan-Desmoinesian): Southeastern Utah, western Colorado, and subsurface of northwestern New Mexico.

A. A. Baker, 1933 (USGS Bull. 841, 13-18). *Paradox fm.*—Salt, gyp., and anhydrite, with interbedded black and brown sh. and some ls. Exposed in a few small areas in Moab dist., Utah, where overlying rocks were relatively thin and have been ruptured by upward movement of the plastic salt and gyp. Base not exposed. In Moab dist., Utah, it underlies Hermosa fm. of SW. Colo., although its lithology is totally different from Hermosa lithology. It is believed to be younger than Molas ls. of SW. Colo.

N. W. Bass, 1944 (USGS Oil and Gas Inv. Prelim. Chart 7). *Paradox memb.*—The Paradox memb. (of Hermosa fm.), which has been designated as a fm., is a widespread unit of sh., salt, and gyp. The age of this fm. is given as Lampasan-Demoinesian by Henbest. The salt sequence at McElmo (Colo.), which lies on the SE. margin of the salt basin as previously shown, is reported to exceed 1,300 ft in thickness in a well drilled there in 1944. This great thickness suggests that the salt basin extends a considerable distance SE. beyond the McElmo loc., and probably extends into NW. N. Mex. (As shown on the chart, the Paradox memb. is located in lower part of Hermosa fm.)

S. A. Wengerd and J. W. Strickland, 1954 (AAPG Bull., v. 38, 2169-2173). *Paradox fm.* as here defined lies on Pinkerton Trail fm. (formerly lower memb. of Hermosa fm.) and underlies Hermosa fm. Consists of 3 membs.: (1) Lower, 0 to 200 ft, thick, predom. anhydrite, gyp., black sh., and minor dol., locally highly dolo.; gradational contact with middle memb. Lower memb. not distinguishable outside salt area. (2) Middle, gyp., salt, and interbedded black shs., dark calc. siltstone, and black argil. ls., up to 4,500 ft thick. (3) Upper, abundant black silty calc. sh., grayish-brown finely crystalline argil. dol., white anhydrite, gray to white finely crystalline gyp., and brown argil. fine-grained ls., 200 to 500 ft thick. Base is top massive salt; top is uppermost thick black sh. associated with stringers of gyp. or, at first appear., of anhydrite. The total depositional thickness of the Paradox fm. is about 5,000 ft; flow thickness up to 12,000 ft.

The Paradox was first described as an "intrusive" fm. because of the mobile qualities of the salt section under tectonic stress.

Type locality: Paradox Valley, Montrose Co., SW. Colorado; no type section designated.

Name: From Paradox Valley, Colorado.

Par Value member (of Montoya limestone).

Middle Ordovician: Southwestern New Mexico (Silver City area).

L. P. Entwistle, 1944 (N. Mex. Bur. Mines Bull. 19, 16-19), divided the Montoya into 3 membs. (ascending): Second Value memb., *Par Value memb.*, and Raven memb. Overlying the Second Value member is a persistent unit composed of alternating bands of red chert and gray dol. The proportions are about one-third chert and two-thirds dol. This unit has been found in many other areas in the SW. part of N. Mex. The base of the Par Value memb. is a very distinctive horizon. Thickness 65 ft on Par Value claim.

Type locality and section: Par Value claim, Boston Hill subdist., Silver City dist., Grant Co.

Name: From Par Value claim.

Pecos Canyon sandstone.

Permian: Northeastern New Mexico (Santa Rosa to Tucumcari).

J. K. Knox, 1920 (AAPG Bull., v. 4, 99-101). *Pecos Canyon ss.*—A massive ss. which divides the red beds overlying Magdalena gp. into two gps., the *upper "Red Beds"* and the *lower "Red Beds,"* in the Santa Rosa-Tucumcari region.

Type locality: Not designated.

Name: From Pecos Canyon.

‡†Pecos formation.

Permian: Southeastern New Mexico (Roswell artesian basin).

A. G. Fiedler and S. S. Nye, 1933 (USGS Water-Supply Paper 639, 44-53). *Pecos fm.* —A lithologic unit, consisting chiefly of red beds, gyp., anhyd., impure ls., light-colored fine sand, and intercalated thin beds of mag. or dolo. ls. and dol. Unconf. underlies the Triassic E. of Pecos River; overlies Picacho ls., with unconf. locally. Base of fm. varies considerably in strat. position, being lower N. of Salt Creek and notable higher a few mi S. of mouth of Seven Rivers than it is within the artesian basin. Near top, in Seven Rivers region, it is penetrated laterally by Carlsbad ls. tongue of Capitan ls., which is underlain by Seven Rivers tongue of Pecos fm., which to S. becomes laterally replaced by Capitan ls. Upper part of Pecos fm. has been eroded away W. of Pecos River, but lower part extends a few mi W. of river. Thickness of fm. 1,066 ft in one section. The strata constituting the Pecos fm. are represented on Darton's 1928 geol. map of N. Mex. as Chupadera fm., N. of Lake McMillan, and as Castile fm., SE. of Lake McMillan.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Pecos fm.* abandoned, being here divided into (descending): Pierce Canyon red beds, Rustler fm., Salado halite, Castile anhyd. (thin lateral extension of upper part of Castile anhyd. of Delaware Basin), and Chalk Bluff fm. Latter fm. includes equiv. of (descending): Seven Rivers gypsif. memb., Queen ss. memb., and underlying beds that are equiv. to Dog Canyon ls. Picacho ls. is here abandoned for San Andres ls. The Pierce Canyon red beds are classified now as Triassic.

Type locality: Bluffs paralleling Pecos River on E. side of river, Chavez and Eddy Cos., New Mexico.

Name: From Pecos River.

‡Pecos shale.

Permian(?): New Mexico.

C. R. Keyes, 1909. (See under *Cimarronian series.*)

‡†Pecos Valley red beds.

Permian and Triassic: Southeastern New Mexico and western Texas.

J. W. Beede, 1910 (Am. Jour. Sci., 4th ser., v. 30, 131). *Pecos Valley red beds.*—Thin lss. and covered slopes, appar. composed of soft sss. or clays. Overlies Guadalupian series in Carlsbad region.

C. L. Baker, 1920 (Am. Jour. Sci., 4th ser., v. 49, 99-126). The *Pecos Valley red beds* crop out along foot of E. flank of Sacramento Mtns. and underlie alluvium in lower Pecos Valley. The N. limit of outcrop is not known at present. They extend S. into Toyah Basin, Tex., and E. under Llano Estacado. Near E. base of Guadalupe Mtns., the Capitan ls. changes along strike into *Pecos Valley red beds.* The transition is well seen in walls of Rocky Arroyo, 20 mi W. of Carlsbad. On E. flank of Sacramento Mtns. and N. flank of Guadalupe Mtns., the Pecos Valley red beds lie on San Andres ls.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1623). Includes Pecos fm. (Perm.) and overlying Triassic red beds.

Type locality: Not designated.

Name: From Pecos Valley.

‡Penasco quartzite.

Precambrian: Central northern New Mexico (Santa Fe region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 10). *Penasco qtzite.*—Main body of silic. section exposed near Picuris, N. of Santa Fe. Thickness 400 ft.

Type locality: Not designated.

Name: From town of Penasco, Taos Co.

Percha shale.

Upper Devonian: Southern New Mexico and southwestern Texas.

C. H. Gordon, 1907 (Am. Jour. Sci., 4th ser., v. 24, 58-64; Sci., n. ser., v. 25, 824-825; Jour. Geol., v. 15, 91-92). *Percha sh.*—Sh. underlying Lake Valley ls., overlying Mimbres ls., and carrying an Upper Dev. fauna in lower part. 200 ft thick in Sierra Co., N. Mex. and 500 ft thick in Grant Co., N. Mex. At Lake Valley it consists of 60 ft of grayish-yellow and blue shs. underlain by 100 ft of black fissile sh.

F. V. Stevenson, 1942 (N. Mex. Bur. Mines Bull. 18, 23-24). The Dev. strata of N. Mex. are divided into 3 fms., all of late Dev. age. The divisions are based on sed. and faunal breaks, and to a certain extent on superposition. The formations are named (ascending): Canutillo, Sly Gap, and *Percha.* The *Percha sh.* is divisible readily into 2 parts. The lower unit, which makes up two-thirds of the total thickness, consists of black carb. fissile sh. without fossils. The upper unit consists of gray and green sh., with lenses and nodules of ls. Fossils are generally confined to the ls. lenses and nodules in the sh.

F. V. Stevenson, 1945 (Jour. Geol., v. 53, 217-245), divided the *Percha sh.* into Ready Pay memb. (lower) and Box memb. (upper). Designates type loc. for Percha sh. as 2½ mi SE. of Hillsboro, near Percha Creek, in SW¼SW¼SE¼ sec. 14, T. 16 S., R. 7 W.

M. A. Stainbrook, 1947 (Jour. Pal., v. 21, 297-328), suggested that the Percha might be of Miss. age, on the basis of brachiopods in Box memb.

A. K. Miller and C. Collinson, 1951 (Am. Jour. Sci., v. 249, 600-603), describe a clymenid ammonoid in the Box memb. of the Percha.

G. A. Cooper, 1954 (Jour. Pal., v. 28, 325-332). *Syringospira prima* Kindle from the Percha closely related to *Sphenospira alta* (Hall) from the Chagrin formation, Conewango gp., of New York and Pa.

Type locality: 2½ mi SE. of Hillsboro, Sierra Co., New Mexico, near Percha Creek, in SW¼SW¼SE¼ sec. 14, T. 16 S., R. 7 W. (designated by Stevenson).

Name: From Percha Creek.

‡Perchan series.

Devonian (Middle): Southwestern New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 3). *Perchan series.*—Middle Devonic sh. sequence. (Silver shs. overlain by Bella shs.) Occurring in the vicinity of Lake Valley.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1312). In 1922 Keyes applied the term *Perchan series* to the upper part of the Upper Dev. in Ariz.

Type locality: Not designated.

Name: From Percha Creek.

Petaca schist member (of Ortega quartzite).

Precambrian: Central northern New Mexico (Petaca area).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 43). *Petaca schist.*—As in the Picuris area, the Ortega qtzite contains a minor qtz-muscovite schist phase, which is here named the Petaca schist. The Petaca schist is nearly restricted to Mesa la Jarita. Locally the schist contains qtzite membs.; in places it is cgl. Along the strike it grades into typical Ortega qtzite. In places the schist is quite feldspathic.

Type locality: Not designated.

Name: From town of Petaca.

‡Picacho limestone.

Permian: Southeastern New Mexico (Roswell artesian basin).

A. G. Fiedler and S. S. Nye, 1933 (USGS Water-Supply Paper 639, 55-70). *Picacho ls.*—A lithologic unit consisting dominantly of ls. and dolo. ls. but including minor amounts of ss., sh., gyp., and anhyd., whose upper and lower limits are variable with respect to strat. position and time. Throughout most of Roswell artesian basin, the Picacho ls. is underlain, appar. conf., by Nogal fm. In SE. part of basin, however, the Nogal gives place laterally to a thick ls. section, which is tentatively included in Picacho ls.; here the Picacho rests on older Abo ss. Thickness of fm. 800 to 1,200 ft where it underlies Pecos fm. and overlies Nogal fm., but top of fm. is locally eroded away. The beds here named Picacho ls. are "believed by geologists working in this region to be the strat. equiv. of the San Andres ls. of Lee and Girty, and have been referred to by that name for years. In 1922, Darton assigned them to the Chupadera fm."

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Picacho ls.* here abandoned for *San Andres ls. memb. of Chupadera fm. Nogal fm.* also abandoned, being replaced by Hondo ss. memb. of Chupadera fm. (above) and Yeso memb. of Chupadera fm. (below). As originally defined and heretofore used, San Andres ls. rested on Yeso. The recognition of Hondo ss. involves slight redefinition of both Yeso and San Andres.

Type locality and section: In Rio Hondo Valley, on E. side of a ravine entering the valley opposite Sunset ranch, and on N. slope of same valley, NE. of Sunset ranch, 3.9 mi by highway E. of Picacho.

Name: From town of Picacho, in Rio Hondo Valley, Chavez Co.

Picuris basalts.

Precambrian: Central northern New Mexico (Picuris and Petaca areas).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 23-24, 44). *Picuris basalts.*—The Picuris basalts comprise a series of basalt flows that occur principally interspersed with the sed. schists of the Hopewell series. The basalts could be grouped as part of the Hopewell series, except that they persist up into the Ortega qtzite. Therefore, the basalt extrusives have been given a distinctive name. Most of the dark hornblende schists of the Hopewell series probably belong to the Picuris basalts, but the development of schistosity has destroyed their original textures. The best exposure of the Picuris basalts observed in the Picuris area is near the mouth of Picuris Canyon. Here, although the basalts are schistose, their egneous nature is established by the presence of lath-shaped phenocrysts of plagioclase. The phenocrysts are oriented parallel to the flows and show typical flow-band structure. Most of the Hopewell series in the Petaca area consists of dark hornblende-chlorite schists that are metamorphic derivatives from basalt and andesite flows.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 21). The Vadito fm. consists of metasedimentary rocks that are interbedded with flows and contain sills of various types of metaigneous rocks. It seems best to describe all these rocks under the Vadito fm.

Type locality: Not designated.

Name: From the town of Picuris.

‡Picurisan (Pecurisan) series.

Precambrian: New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 10). *Picurisan series.*—A thick section of highly tilted sediments of Archeozoic age widely exposed on the W. side of the Rocky Mtns. N. of Santa Fe. They strike NW. and SE., and are best exposed near the village of Picuris.

Type locality: Not designated.

Name: From village of Picuris.

Pilar phyllite member (of Ortega formation).

Precambrian: Central northern New Mexico (Picuris Range).

E. Just, 1937. [See entry under Hondo slate.]

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 19-21). Ortega fm. consists of lower qtzite, Rinconada schist memb., and *Pilar phyllite memb.* The Pilar phyllite, or Hondo slate of Just, is the youngest rock of the Ortega fm. and the most distinctive horizon marker in the Picuris Range. The old name *Hondo* had been applied to other rocks prior to Just's usage, and hence is abandoned. The rock is carb., dense, homogeneous, hard, gray black to black, with a gray sheen on cleavage surfaces. Muscovite flakes on cleavage surfaces are discernible with a hand lens. Cleavage is irregular, slabby, some corrugated. Commonly contains many qtz veins; large veins follow joints, and thin veins parallel cleavage. Large veins contain limonite masses and may be stained yellow. Close folding prohibits accurate determination of thickness, but Pilar phyllite appears to be 2,300 ft in min. thickness as exposed in the Picuris Range.

Type locality: Not designated.

Name: From village of Pilar.

Pinery limestone member (of Bell Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico (Guadalupe Mountains).

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Pinery ls. memb.*—Dark-gray somewhat cherty ls. in thin, straight beds, with several thicker, lighter colored, more granular layers toward base. Lies approx. 30 ft above base of Bell Canyon fm. Thickness 25 to 150 ft. Thins and becomes sandier to SE.

P. B. King, 1948 (USGS Prof. Paper 215, 55-56). *Pinery ls. memb.*—In SW. part of area (S. Guadalupe Mtns.), Pinery memb. consists of 25 ft of thin-bedded dark-gray fine-grained ls., with a few sparingly fossilif., more granular, thicker beds, and much interbedded platy ss. It lies about 75 ft above Hegler ls. memb. (basal memb. of Bone Canyon) and crops out less prom. than that memb. The Pinery lies below Capitan ls. along reef escarpment. There the memb. reaches 150 ft in thickness and consists of fine-grained ls. in beds a few in. to a ft thick, containing small nodules and sheets of brown chert. Interbedded with the the thinner bedded lss. are lighter gray quite granular thick-bedded to massive layers 5 to 10 ft thick. At this loc. the memb. is separated from the Capitan above by about 100 ft of interbedded ss. and ls. These beds gradually become limy, and the Pinery intergrades with Capitan ls.

Type locality and section: Slopes above Pine Spring, S. Guadalupe Mtns., Texas.

Name: From "The Pinery," old stage station on Butterfield trail, 2½ mi E. of Guadalupe Peak.

Pinkerton Trail formation.

Pennsylvanian (Atokan and earliest Desmoinesian): Southwestern Colorado, southeastern Utah, and subsurface of northwestern New Mexico (Paradox salt basin).

S. A. Wengerd and J. W. Strickland, 1954 (AAPG Bull., v. 38, 2168-2169). *Pinkerton Trail fm.*—Equiv. to lower memb. of Hermosa fm. of Bass (1944; see under Hermosa fm.). Widespread throughout the Paradox salt basin region as dark-gray fine to coarsely crystalline crinoidal and fusulinid-bearing ls., with some dark sh. Contains an anomalous detrital section in Monument upwarp area. Thickness ranges from a wedge edge to more than 200 ft where the intraformational detrital section is best developed, in the Cedar Mesa anticline of the Monument upwarp, SE. Utah. Merges with and is indistinguishable from Hermosa fm. where Paradox fm. is absent.

Type locality and section: Pinkerton Trail, 12 mi N. of Durango, Colorado, on W. side of U. S. Highway 550.

Name: From Pinkerton Trail, Colorado.

‡†Pinos Altos limestones.

Ordovician: Southwestern New Mexico.

C. R. Keyes, 1904 (Am. Jour. Sci., 4th ser., v. 18, 360-362). *Pinos Altos fm.*—400 ft of lss. of Ord. age, underlying Dev. Chloride fm. (lss.) and overlying Camb. sss.

Probably includes Fusselman ls. (Sil.) and Montoya and El Paso lss. (Ord.).

Type locality: Not designated.

Name: Probably from village of Pinos Altos in Grant Co.

‡Placitos limestone.

Pennsylvanian: Central New Mexico.

C. R. Keyes, 1903 (Ores and Met., v. 12, 48). *Placitos ls.*—lower black ls. in Sandia Mtns., of middle Carbf. age. Overlies Sandia qtzites.

Type locality: Not designated.

Name: Derivation not indicated.

Powwow conglomerate member (of Hueco limestone).

Permian (Wolfcampian): Western Texas and southeastern New Mexico.

P. B. and R. E. King, 1929 (AAPG Bull., v. 13, 909-911). Above the beds of Strawn age are lss. containing Canyon and Cisco fossils. *Chaetetes* is absent, and a zone of *Fusulinella meeki* occurs at base. Uppermost beds contain Cisco fusulinids (identifications of C. O. Dunbar). Near top is a memb. of cgl. and red beds, which is folded with the rest of the Carbf. The red beds are well exposed from 2 to 5 mi S. of Hueco Canyon, along main escarpment of Hueco Mtns.; for them the name *Powwow* is proposed.

P. B. King, 1934 (GSA Bull., v. 45, 743). *Powwow cgl. memb. of Hueco ls.*, unnamed then, was placed correctly above the unconf. (btw. Perm. and Penn.) by J. W. Beede (Tex. Univ. Bull. 1852, 14, 1920), but was grouped erroneously with the strata below the unconf. by P. B. and R. E. King in publication cited above.

L. C. Pray and C. Otte, Jr., 1954 (GSA Bull., v. 65, 1269). *Powwow cgl. memb. of Hueco ls.* correlates with basal part of Abo fm. of central N. Mex.

Type locality: Outcrops exposed along main escarpment of Hueco Mtns., 2 to 5 mi S. of Hueco Canyon, Texas.

Name: From Powwow Canyon, 3½ mi S. of Hueco Canyon.

Priest granite.

Precambrian: Central New Mexico (Southern Manzano Mountains).

J. T. Stark and E. C. Dapples, 1946 (GSA Bull., v. 57, 1121-1172). *Priest granite.*—A coarse-grained rock composed chiefly of pink feldspar, qtz, and biotite. At many localities there are irregular areas of pegmatite, with gradational borders into the finer grained granite. Feldspar crystals are commonly 3 in. long. The rock weathers readily to rounded knobby surfaces. The granite contains many xenoliths of schist, which increase in size and number near the contacts; xenoliths of qtzite are less common. Both types of inclusions are more resistant than the granite and stand out above the eroded surface as knobs. The rock is made up of 60 to 65 percent feldspar; orthoclase, microcline, and albite, partly saussuritized, kaolinized, and epidotized. Qtz makes up 35 percent of the rock; biotite most of the remainder. Believed to be correlative with Los Pinos granite.

Type locality: Vicinity of Priest Peak, S. Manzano Mtns.

Name: From Priest Peak.

‡†Pueblo quartzite.

Precambrian: Central northern New Mexico (Taos County).

J. W. Gruner, 1920 (Jour. Geol., v. 28, 731-742). *Pueblo qtzite.*—As a whole is yellow, but southern end becomes reddish and purplish gray.

Type locality: Exposures at head of Pueblo Creek (T. 26 and 27 N., R. 14 and 15 E.), Taos Co.

Name: From Pueblo Creek.

Queen formation (sandstone, sandstone member [of Chalk Bluff formation]). Permian (Guadalupian): Southeastern New Mexico and western Texas.

F. S. Prout, 1929 (AAPG Bull., v. 13, 656). *Queen sand zone* to N., toward Carlsbad, is in top of San Andres ls.(?), and Seven Rivers gyp. is above it.

K. H. Crandall, 1929 (AAPG Bull., v. 13, 929, 940). *Queen sand*—Brown and buff ss., 100 ft thick, underlying Seven Rivers gyp.

W. G. Blanchard, Jr. and M. J. Davis, 1929 (AAPG Bull., v. 13, 972, 983, 987). A sandy ls. and sand zone, 0 to 500 ft thick, notable near old post office at Queen, Eddy Co., N. Mex., is often referred to by N. Mex. geologists as *"Queen ss."* The "Queen ss." consists primarily of reddish-brown and gray sss. interbedded with hard gray lss. that are locally sandy. These ss. lenses lie in uppermost part of San Andres ls.(?), and *Queen sand zone* is considered the top of that fm. Because there are several of these lenses within 200 ft or more of section, the term *zone* is applicable. These sss. have been traced from their type loc. SW. to El Paso Gap, through Dog Canyon to Bush Mtn. (a high mass in the Guadalupes), and S. to approx. 5 mi S. of N. Mex. line and 1 mi NE. of El Capitan. The upper lenses of Queen zone are strat. within 300 ft of top beds of El Capitan. Several mi E. of Queen P. O., the Queen outcrop dips steeply N. and NE. and is at base of gyp. beds in Carlsbad memb. (In pl 11, Queen ss. is shown underlying Carlsbad fm., and in one place it is said to be very close to strat. position of Frijole ls. *Queen sand zone* and *Queen ss.* as here used include much more than the Queen sand of Crandall, which crops out in vicinity of Queen, Eddy Co., N. Mex., is 100 ft thick, and, according to W. B. Lang, can be traced in outcrop for 20 or more mi.)

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *Queen ss. memb. of Chalk Bluff fm.* is a brown and buff ss., 100 ft thick, exposed on Queen Mesa, in upper Dark Canyon and along N. slope of Hess Hills in Guadalupe Mtns. It underlies Seven Rivers gypsif. memb. of Chalk Bluff fm. and overlies Dog Canyon ls. (According to Lang (personal communication), his Queen ss. memb. corresponds to the Queen sand of Crandall, and is the upper ss. of the thick series of sss. and lss. which has been called *Queen sand, Queen ss.,* and *Queen sand zone* by the oil geologists, and which includes the Dog Canyon ls. of Lang. This is approved definition of the USGS.)

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14). *Queen ss.* is a distinct fm. and memb. of Whitehorse gp. of western Tex. and southeastern N. Mex.

W. C. Fritz and J. Fitzgerald, Jr., 1940 (AAPG Bull., v. 24, 15-28), named *Yoakum dol. memb. of Queen fm.*

R. I. Dickey, 1940 (AAPG Bull., v. 24, 37-51), notes that *Queen sand zone* of Blanchard and Davis corresponds more closely with subsurf. Queen than Queen sand as used by Lang.

N. D. Newell et al., 1953 (The Permian reef complex, etc., 43-45). *Queen fm.* was named (Crandall, 1929) from outcrops in the vicinity of the old Queen P. O., but the thickness of the fm. at type loc. was not given, and the definition of the fm. is rather vague. Whiteman's investigations near type loc. indicate that the outcrops form only part of a distinctive rhythmically bedded unit, each cyclothem of which consists of reddish-brown fine-grained ss., which grades upward through sandy, platy dol. to fine-grained unfossilif. dol. Top of dol. is irregular and is overlain abruptly by the basal ss. of succeeding cyclothem. This rhythmic sequence extends through about 300 ft of beds along S. side of Queen Mesa. Only lower half of fm. is exposed at type loc. At Devil's Den, on Shattuck Valley escarpment, fm. consists of 6 cyclothems, in which ss. comprises 65 percent of the total. Queen fm. extends from dols. at top of Grayburg fm. to the Seven Rivers fm. above. Lower boundary used here is essentially that selected by Crandall on Queen Mesa, but top of fm. is drawn above *Shattuck memb.*

(new), a prominent ss. approximately 100 ft thick over much of shelf area in Guadalupe Mtns., except near the reef, where it thins rapidly. Shattuck memb. is probably the red "sand" zone at top of subsurf. Queen. If this correlation is correct, the surface and subsurf. characteristics of the fm. are now similar.

W. R. Moran, 1954 (GSA Bull., v. 65, 1288). The suggested type section for the *Queen fm.* is 5 mi S. 75° E. from site of Queen P. O., on W. wall of Dark Canyon, in SW¼ sec. 36, T. 24 S., R. 22 E., Eddy Co., N. Mex., where 421 ft of alternating ss. and sandy dol. is exposed. Here Queen fm. underlies Seven Rivers fm. and overlies Grayburg. The Shattuck memb. of Queen fm. proposed by Newell et al. (1953) has been recognized as uppermost 100 ft of this section.

Type locality: Vicinity of Queen Post Office, sec. 30, T. 24 S., R. 22 E., Eddy Co., New Mexico.

Type section: As redesignated by Moran, W. wall of Dark Canyon, SW¼ sec. 36, T. 24 S., R. 22 E., Eddy Co., New Mexico.

Name: From Queen Post Office.

Rader limestone member (of Bell Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico (Guadalupe Mountains).

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *Rader ls. memb.*—At type loc., 225 ft above base of Bell Canyon fm. Massive light-gray ls. and a few layers of thinner, darker ls. Thickness 100 ft to SE.; thins to 15 ft.

P. B. King, 1948 (USGS Prof. Paper 215, 56-57). *Rader ls. memb.*—In SE. part of area (S. Guadalupe Mtns.), memb. is 15 ft thick and lies 30 to 40 ft above Pinery memb. Consists of several layers, as much as 3 ft thick, of gray granular ls., with numerous rounded pebbles, and of interbedded, thinner, darker gray ls. At several places in this region, it contains a bed, as much as 2 ft thick, of apple-green silic. volcanic ash. To NW. the memb. is 30 to 100 ft thick and consists of rounded ledges of very massive granular or dense light-gray or white ls. Some of beds contain angular ls. cobbles. Occasional lenses of ss. and dark-gray slabby ls. are found in depressions on the undulatory upper surfaces of the massive beds. Though separated from Capitan ls. by several hundred ft of ss. and thin-bedded ls. at type loc., the memb. merges with Capitan ls. a few mi to the W.

Type locality and section: Rader Ridge, Guadalupe Mtns., Texas.

Name: From Rader Ridge.

Rancheria formation.

Mississippian (Meramecian): Central southern New Mexico and western Texas.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 17). *Rancheria fm.*—Name proposed for sequence of cherty fm. (Miss.) and are unconf. overlain by green shs. of Helms fm. (restricted) in Franklin Mtns. At type section, 250 ft thick; there basal beds are distinctive and sharply set off from rest of fm. Basal few in. consists of black detrital sandy sh. with small chert pebbles, phosphatic concretions, and a few fish teeth. Above the basal sh. is a black detrital qtz ss. with numerous plant fossils and considerable carbonaceous material. This is followed by 8 ft of soft yellow to brown sandy siltstone containing *Leiorhynchus carboniferum*. Above siltstone is massive black bituminous crinoidal detrital ls. Remaining 235 ft is typical medium-bedded dense black silty ls. beds that weather brown, with large amounts of peculiar brown-weathering porous chert,

nodular or occurring in thinly laminated layers and streaks through the ls., giving weathered outcrop appearance of woodpile. Bedding planes btw. ls. beds are made of thin laminations of soft gray silty sh., locally 6 in. to several ft thick. Thins to N. in San Andres and Sacramento Mtns.

Type locality and section: SW. side of small S. fork of shallow canyon that leaves W. slope of Franklin Mtns. almost directly E. of Vinton, Texas (SW¼ sec. 67, blk. 82, El Paso Co., Texas).

Name: From Rancheria Peak in Hueco Mtns., Texas, where it is well exposed.

Raven member (of Montoya limestone).

Middle Ordovician: Southwestern New Mexico (Silver City district).

L. P. Entwistle, 1944 (N. Mex. Bur. Mines Bull. 19, 18), divided the Montoya into 3 membs. (ascending): Second Value memb., Par Value memb., and *Raven memb.* The upper (Raven) memb. of the Montoya dol. is essentially a thick-bedded gray dol. with some red chert. The base is a shell ls. with abund. fossils of Richmond age. The overlying beds are in general nonfossilif. but in some places contain colonial corals. The upper part of the Raven memb. is thick-bedded gray cherty dol. The top is not clearly defined. A bed of nodular chert a few in. thick is considered to be the base of the overlying Fusselman ls. Thickness 120 ft.

Type locality and section: Raven claim, Boston Hill subdist., Silver City dist., Grant Co.

Name: From Raven claim.

Ready Pay member (of Percha shale).

Upper Devonian: Southern New Mexico and western Texas.

F. V. Stevenson, 1945 (Jour. Geol., v. 53, 217-245), divided the Percha sh. into *Ready Pay memb.* (lower) and Box memb. (upper). The Ready Pay memb. is composed of black fissile nonfossilif. sh.; in most sections it comprises two-thirds of the thickness of the Percha sh. The Ready Pay memb. grades without any marked break into the Box memb. above. 120 ft thick at type locality. Lies unconf. on Fusselman ls. (Sil.) at many localities.

Type section: 2½ mi SE. of Hillsboro, SW¼SW¼SE¼ sec. 14, T. 16 S., R. 7 W., Sierra Co., New Mexico.

Name: From Ready Pay Gulch, near "The Box" on Percha Creek.

Red House formation.

Pennsylvanian (Derryan and Desmoinesian): South central New Mexico (Caballo Mountains).

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 91-92). *Red House fm.*—Lower third of Magdalena gp. in Caballo Mtns. At type section, 362 ft dominantly thin-bedded ls. and sh. or claystone, with ls. nodules and lenses. It is gray to dark gray and usually slope forming. Massive ls. beds, which are commonly very cherty, are locally present. A thin ss. bed locally marks the base of the fm., and a coarse-grained and conglomeratic ss. ledge is widely present in the N. part of the mtns. near the middle of the section. Ls. cgl. and calcarenite occur in many places in the lower part of the fm. Lies unconf. on Ord. and Dev. fms.; overlain conf. by Nakaye fm.

Type locality and section: South Ridge, Caballo Mtns., in sec. 10, T. 15 S., R. 4 W.

Name: From Red House Mtn., at S. end of Caballo Mtns.

Red Tanks member (of Madera limestone).

Permian(?) or (less likely) Pennsylvanian(?): North central New Mexico (Lucero uplift).

V. C. Kelley and G. H. Wood, 1946 (USGS Oil and Gas Inv. Prelim. Map 47). *Red Tanks memb.*—200 to 300 ft, lower part consisting of dark red-brown siltstone, ss., and sh. Locally base contains buff ss. and ls. cgl. Upper part mostly cement-gray thin-bedded nodular ls. and gray sh. The ls. is marine and contains an abund. well-preserved fauna. There is some intertonguing of the marine seds. of the Red Tanks memb. with the continental beds of the overlying Abo fm. The contact with the Abo fm. is at the top of the uppermost marine ls. in the memb. conf. underlain by Atrasado memb. of Madera ls.

R. L. Bates et al., 1947 (N. Mex. Bur. Mines Bull. 26, 26). The Bursum fm. (Perm.) is approx. equiv. to the *Red Tanks memb.* of the Madera ls. named by Kelley and Wood (1946) in the Lucero uplift.

Type locality and section: West side of Red Tanks Arroyo, NW¼ sec. 4 and NE¼ sec. 5, T. 3 N., R. 3 W., 1 mi W. of Salaido ranch, Valencia Co.

Name: From Red Tanks Arroyo.

‡Rican series.

A term applied by C. R. Keyes to Carbf. deposits in Colo. (and northern N. Mex.?) stated by him to be older than his Moenkopian series and younger than his Aubreyan series; probably applied to Rico fm. (Penn. and Perm.) of other geologists.

Rico formation.

Permian and Pennsylvanian: Southwestern Colorado, southeastern Utah, and northwestern New Mexico.

W. Cross, 1899 (USGS Telluride folio, n. 57, 2). In Rico quad. an invertebrate fauna has been found in lower 200 to 300 ft of red beds, which is assigned by G. H. Girty to Permo-Carbf., in the sense of a transition series. The complex of strata characterized by this fauna will be described as *Rico fm.* In absence of fossil evidence, the red strata btw. the Rico Permo-Carbf. and the overlying beds containing Triassic remains are grouped with the latter, here named *Dolores fm.*

W. Cross, 1899 (USGS La Plata folio, n. 60, 8). (See 1st entry under *Hermosa fm.*)

A. C. Spencer, 1900 (USGS 21st Ann. Rpt., pt. 2, 59). It is here proposed to apply the name *Rico* to a fm. assumed to be about 300 ft thick, occurring btw. the Hermosa or characteristic Penn. Carbf. and strata assigned to the Triassic of San Juan region (the *Dolores fm.*). The Rico is composed of sss. and cgls. with intercalated shs. and sandy fossilif. lss. In Rico region is conf. on Hermosa and is followed by Dolores with seemingly perfect parallelism of stratification. The boundary btw. Rico and Dolores fms. is at present entirely artificial, being based upon highest known occurrence of Rico fossils. (In 1905 the Dolores fm. as first defined was divided into Cutler fm. below and Dolores fm. (restricted) above. The fm. that overlies Rico fm. is therefore now called *Cutler fm.*, instead of *Dolores.*)

W. Cross, 1905 (USGS Rico folio, n. 130, 3-4). *Rico fm.*—Consists of 300 ft of sss. and cgls. with intercalated sandy shs. and thin fossilif. sandy lss.; color chocolate or dark maroon. Rests conf. on Hermosa fm.; conf. overlain by Cutler fm., which comprises lower 1,600 ft of Dolores fm. as originally defined. Base of Rico fm. usually can be very accurately located in field by its lowest fossil-bearing stratum. The boundary btw. Rico and Cutler fms. is, however, quite arbitrary, being based on highest known occurrence of Rico fossils. The former

is made to include only that part of the section characterized by the Permo-Penn. fauna, whereas the Cutler comprises the apparently unfossilif. red beds of this region, extending to horizon at which Triassic fossils are known to occur. The fm. was named by A. C. Spencer.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1812). Where the lss. of Rico fm. are absent in SE. Utah, the red beds corresponding to Rico fm. are now included in Cutler fm. (See C. H. Dane, USGS Bull. 863, 1935.)

N. W. Bass, 1944 (USGS Oil and Gas Inv. Prelim. Chart 7). *Rico fm.*—In Animas River Valley the lower boundary of Rico fm. is drawn at the top of a ledge-forming crinoidal ls. bed which is placed in the Hermosa fm. On E. side of Animas River Valley, Rico fm. is 110 ft thick. There it consists, from the base upward, of 49 ft of green to greenish-gray finely micaceous sh., in part sandy, 7½ ft of nodular shaly ls., and 4 ft of greenish-gray limy sh. that weathers reddish-brown, capped by a 1-ft bed of dark-gray nodular ls. These beds are overlain by about 6 ft of greenish-gray micaceous sandy sh., which, in turn, is overlain by about 4 ft of greenish-gray very fine-grained micaceous ledge-forming ss. that weathers brown. The uppermost 39 ft of the fm. consists mainly of fossilif. greenish-gray shaly ls. and limy sh. The upper boundary of the Rico fm. was drawn at the top of the highest ls. bed below the thick cliff-forming beds of red ss. and purplish-red grit of the Cutler fm. The character of the fm. is variable. According to J. S. Williams (personal communication), the available faunal evidence indicates that at least part of the Rico fm. in the Animas River Valley is of Missouri (Penn.) age. Data revealed by examination of well samples indicate that the Rico fm. represents beds of widely different age from well to well, if the upper boundary is drawn at the base of the beds that are dominantly red. For example, SW. from McElmo to Rattlesnake, and particularly S. from Rattlesnake to Toato, the upper part of the supposed Hermosa sequence changes rapidly from dominantly gray ls. to mainly red sh. containing minor units of ls.

S. A. Wengerd and J. W. Strickland, 1954 (AAPG Bull., v. 38, 2174). The *Rico facies*, first mentioned as a fm. differentiated from the overlying Cutler by the presence of marine fossils (Cross, 1899), is here considered to be a transitional memb. btw. Cutler continental strata above and Hermosa marine strata below. For convenience, and because of its closer affinities with the Cutler fm., it is here considered the basal memb. of that fm. It is distinctly not a mappable unit over a wide area and cannot be called a fm. This usage follows to some extent that of Dane (1935), who placed in the Cutler fm. the red beds of southwestern Colo. corresponding to the Rico fm. in southeastern Utah.

Type locality and section: Scotch Creek, a tributary of the Dolores River, at the southern base of the Rico Mtns., Colorado.

Name: from Rico Mtns., Colorado.

Rinconada schist member (of Ortega formation).

Precambrian: Central northern New Mexico (Picuris Range).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 21-22). *Rinconada schist memb.*—The qtzite and qtz schist fm. that succeeds the Hopewell series is divisible into qtzitic and schistose phases. The schistose phase, called the Rinconada schist in this area, is gray to buff qtz-muscovite schist, which in many places has interbedded qtzite membs. Some of the qtzite membs. are quite thick; N. of Copper Mtn., qtzite composes about half the total mass of the Rinconada schist. Although most of the schist is more or less even in texture, in places it contains porphyroblasts of garnet ranging from pinhead to marble size, or of staurolite up to 1 in. long. Many of the staurolite crystals are twinned. Some of the schist is cgl.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 6, 12-19). The Ortega fm. consists of a lower qtzite member, the *Rinconada schist memb.*, and the Pilar phyllite memb. The *Rinconada schist memb.* consists of 4 distinctive mappable units (ascending): (1) Andalusite-biotite hornfels bed, 200 to 350 ft thick; (2) staurolite schist and gneiss bed, 200 to 500 ft thick; (3) qtzite bed; gray-white qtzite with slabby cleavage, containing some interbedded layers of staurolite and garnet schist a few in. thick; thickness 200 to 600 ft; (4) muscovite-qtz-biotite-garnet phyllite, with thin beds of hornblende granulite, hornblende-garnet hornfels, calc. granulite, and others; thickness 200 to 400 ft. Thickness of Rinconada schist memb. 1,800 ft.

Type locality and section: Not designated.

Name: From town of Rinconada, in eastern Rio Arriba Co.

‡†Rio Grande series.

Pennsylvanian: New Mexico.

C. R. Keyes, 1903 (Rpt. Gov. N. Mex. to U. S. Sec. Interior, 337-341). A time term used to cover 500 ft of Penn. lss. called Madera terrane.

Type locality: Not designated.

Name: From the Rio Grande River.

‡Rociada (Rociado) limestone.

Precambrian: Central northern New Mexico (Las Vegas region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 10). *Rociada lss.*—Main body of Archeozoic lss. in Solitario Mtn. dist., NW. of Las Vegas. Thickness 250 ft.

Type locality: Not designated.

Name: From village of Rociada.

Rustler formation (limestone).

Permian (Ochoan): Western Texas and Peocs Valley of southeastern New Mexico.

G. B. Richardson, 1904 (Tex. Univ. Min Surv. Bull. 9, 44). *Rustler fm.*—Fine-textured white mag. ls. and less abund. ss. Thickness 200 ft. In southern outcrops there is no ss., and hills are capped by 150 ft of massive gray ls. In Horseshoe Draw the fm. consists of 100 ft of calc. buff ss. overlain by 50 ft of ls. Overlies Castile gyp.; clearly older than "Red Beds" but may be contemp. with part of Capitan ls. [Now considered to be much younger than Capitan. See 1931 entry under *Castile gyp.*]

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898), discriminated Rustler fm. much farther N. in Pecos Valley of southeastern N. Mex., where it also rests on Salado halite and is overlain by Pierce Canyon red beds.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1858). In Delaware Basin of southeastern N. Mex. and western Tex. there occurs, btw. the Rustler ls. and Castile gyp. of Richardson, an unexposed series of salt beds (1,400 ft thick in well borings) known as upper salt series, in contradistinction to lower salt series or Castile fm. To these unexposed rocks W. B. Lang (AAPG Bull., v. 19, 262-270, 1935) applied the name *Salado halite.* Neither the Castile nor the Rustler fm. is restricted by the introduction of Salado, because in all surface exposures the Rustler rests upon the Castile. [See under *Salado halite.*] Lang also applied *Pierce Canyon red beds* to the fm. overlying the Rustler.

J. E. Adams, 1944 (AAPG Bull., v. 28, 1596-1625). In subsurf., where complete *Rustler* section is preserved, it can readily be divided into 2 main parts, an

upper 150- to 175-ft bed of anhyd. or gyp., and a lower gp. of dol., anhyd., sand, and sh. membs. W. B. Lang (N. Mex. State Eng. 12th and 13th Bien. Rpt., 84, 1938), measured Rustler fm. in central Eddy Co., N. Mex. Section (descending) as follows: (1) 30 ft gyp.; (2) 30 ft gypsif. dol.; (3) 100 ft gyp.; (4) 30 ft red beds; (5) 20 ft gyp.; (6) 35 ft dol.; (7) 30 ft red beds; (8) 70 ft gray ss.; (9) 35 ft red beds; (10) 130 ft gyp.; (11) 5 ft red beds. The first 5 membs. of the foregoing section belong to upper Rustler, and the others to lower part of fm. The 30-ft gypsif. dol. (no. 2 in the sequence), is a persistent marker in N. half of Delaware Basin. For this stringer Lang favors the name *Magenta dol. memb. of Rustler fm.* For the 35-ft dol. (no. 6 in the section), he favors the name *Culebra dol. memb. of Rustler fm.* This memb. is a good subsurf. marker.

Type locality: Exposures in the Rustler Hills, Culberson Co., Texas.

Name: From Rustler Hills, Culberson Co., Texas.

Sais quartzite.

Precambrian: Central New Mexico (Los Pinos and Southern Manzano Mountains).

J. T. Stark and E. C. Dapples, 1946 (GSA Bull., v. 57, 1121-1172). *Sais qtzite.*— Light- to dark-gray fine-grained qtzite with greenish and nearly white facies. Massive qtzose beds, 3 to 5 ft thick, alternate with thinner bedded zones, commonly sericitic, indicating argil. beds within the original ss. The E. boundary is faulted, no base being exposed. The thickest section measured is 600 ft, near Abo Pass. Near the top of the fm., the beds become increasingly sericitic, and no sharp boundary can be drawn between this fm. and the overlying Blue Springs schist fm.

Type locality: Not designated.

Name: From Sais station, on A.T. & S.F. Ry., near Abo Pass.

Salado formation (halite).

Permian (Ochoan): Delaware Basin and Pecos Valley of southeastern New Mexico and western Texas.

W. B. Lang, 1935 (AAPG Bull., v. 19, 262-270). In 1923 writer recognized that the salt section of Delaware Basin is divisible into 2 major units, orally introducing the terms "upper salt series" and "lower salt series." The basis for separation at that time was that the upper series is shaly, pinkish, and by analysis showed more than 1 percent of K_2O, whereas the lower series has a dull-grayish appearance and on analysis yields less than 1 percent of K_2O. The upper salt series is dominantly rock salt, with massive anhyd. beds, red beds, shaly sands, and prom. beds and lenses of polyhalite that are characteristic of this fm. only. Although this upper salt series underlies an area of over 60,000 sq mi, it has no known outcrop, the nearest approach to an outcrop being in eastern Culberson Co., where weathering has so deeply altered the anhyd. to gyp. that if the disrupted anhyd. of the upper series were present, they would be difficult to recognize. The name *Salado halite* is given to this upper salt series. The fm. has suffered pre-Rustler erosional truncation in Eddy Co., N. Mex., and in Reeves, Culberson, and western Loving Cos., Tex., and has also been affected in those areas where the more prom. reef masses accumulated. In Means well it extends in depth from 920 ft to 2,350 ft. The lower salt series crops out in Eddy Co., N. Mex., and Culberson Co., Tex. It is the fm. to which Richardson gave the name *Castile gyp.* as including all rocks btw. the Delaware Mtn. and Rustler fms. Richardson was not then aware of what took place in subsurf. As the outcropping gyp. is the lower salt series and but a surficial alteration by weather-

ing of the main mass of anhyd. in the subsurf., it seems fitting to apply to the lower salt series the name *Castile anhydrite*. The Castile anhyd. extends downward from 2,350 ft in depth to 4,990 ft, where it is unconf. on the Delaware Mtn. fm. The Castile in Delaware Basin consists of massive beds of gray anhyd., clean white rock salt, dolo. and crystalline lss. that are chemical precipitates, and some sss.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898), discriminated *Salado halite* farther N. in Pecos Valley of N. Mex., where it is overlain by Rustler fm. and rests on Castile anhyd.

W. B. Lang, 1939 (AAPG Bull., v. 23, 1569-1572). Because of conflict with usage and the difficulty of distinguishing K_2O content, *Salado fm.* is here redefined, such that it includes a basal anhyd. which is magnesitic, dense, and nonbanded, and which contains no calcite and is thus different from the typical underlying *Castile anhydrites*. Boundary placed at 3,300 ft in Means well. Castile fm. thereby restricted to Delaware Basin.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14). Lang's redefinition of *Salado fm.* makes it practical equiv. of the "Upper Castile" of older nomenclature.

W. B. Lang, 1942 (AAPG Bull., v. 26, 63-79). Lower anhyd. memb. of *Salado fm.* is named *Fletcher anhydrite* in Eddy Co., N. Mex.

Type locality and section: Pinal Dome Corp.'s Means well, SE¼ sec. 23, Blk. C-26, P. S. L. Survey, Loving Co., Texas, from –920 to –3,300 ft.

Name: From Salado (Spanish, "salted") Wash, northern Loving Co., Texas.

San Andres formation (limestone, limestone member [of Chupadera formation]).

Permian (Leonardian): Central and southeastern New Mexico.

W. T. Lee, 1909 (USGS Bull. 389). *San Andreas ls.*—Essentially massive ls., often cherty and poorly fossilif., although at several localities fossils are abund. Thickness 500 ft. This ls. was not included by Herrick in Manzano gp., but he refers to it, in his description of region E. of Socorro, as an unfossilif. ls. overlying Manzano red beds, and includes it in the illustrations of his section. Lee found in it fossils which are said to be unquestionably of Penn. (now Perm.) age, and which prove that San Andreas ls. should be included in Manzano gp. Typically developed at N. end of San Andreas Mtns. Until further information is available, the San Andreas ls. cannot be separated definitely from Yeso fm., except at its type loc. in San Andreas Mtns., where it is 500 ft or more thick and clearly separable from underlying beds. In Caballos and Fra Cristobal Mtns., to W., and at Carthage, to N., the uppermost ls. of the sections is correlated with some confidence, on lithologic evidence, with San Andreas ls. Since, however, the San Andreas fauna is apparently not sufficiently characteristic for purposes of correlation, it is not known whether the capping ls. shown in the sections from other localities is the San Andreas or one of the lss. within the Yeso fm. The large coiled shells of the genus *Euomphalus*, the long pencil-shaped scaphopods *Plagioglypta canna* and *Dentalium mexicanum*, and the genus *Aviculipinna* are conspicuous in uppermost lss. provisionally correlated with the San Andreas but are not entirely absent from the lower ones. The San Andreas ls. differs from the older fms. of Manzano gp. in having a more restricted geographic range. The beds provisionally correlated with it are well developed in S. part, but become less prom. northward and are not represented in N. part of region described.

N. H. Darton, 1922. (See under *Chupadera fm.*)

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). *San Andres ls. memb. of Chupadera fm.* is here applied to the rocks in Pecos Valley of N. Mex. that were named *Picacho ls.* in 1933; *Hondo ss. memb. of Chupadera fm.* (above) and *Yeso memb. of Chupadera fm.* (below) are here applied to the rocks designated as *Nogal fm.* in 1933. *Picacho ls.* and *Nogal fm.* are both abandoned. (The recognition of Hondo ss. involves a slight redefinition of both Yeso and San Andres.)

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1668). *San Andres ls.*—San Andres ls. was named by Lee in 1909, but no detailed section was included. New type section measured. Consists chiefly of calcitic ls. with some dol. beds. In subsurf. of NE. part of State, changes laterally to alternating lss., gypsif. sss., and red beds. Thickness 15 to 1,200 ft; thickest to SE. Lies conf.(?) on Glorieta ss. (separate fm.); unconf. overlain by Permian and other beds. The San Andres of the type loc. is thought to belong entirely to the upper part of the Leonard series.

C. B. Read and D. A. Andrews, 1944 (USGS Oil and Gas Inv. Prelim. Map 8). *San Andres fm.* is shown as consisting of: (1) upper memb., 0 to 80 ft thick, light-terra cotta to orange gypsif. siltstone and fine-grained ss.; (2) ls. memb., 1 to 20 ft thick, light-gray thick-bedded cavernous-weathering ls.; and (3) Glorieta ss. memb., 100 to 250 ft thick, light-gray crossbedded medium-grained ss. [This is a change in terminology from that given by Wilmarth (1938). Here the ss. of Glorieta Mesa is included as a memb. of San Andres fm., (not Yeso memb. of Chupadera fm.); in addition, San Andres fm. is raised again from memb. of Chupadera fm. to fm. status. No explanation of this change in terminology is given.]

J. W. Skinner, 1946 (AAPG Bull., v. 30, 1857-1874). *San Andres fm.* is of Word age (i. e., Guadalupian).

P. B. King, 1947 (AAPG Bull., v. 31, 774-777). If Skinner's correlation of *San Andres ls.* as Guadalupian is correct, interesting facies-faunal changes must take place along strike. Author considers these unlikely, but problem merits study.

G. O. Bachman, 1953 (USGS Oil and Gas Inv. Map. 137). In central N. Mex., *San Andres fm.* has in the past been considered to contain 3 membs. (ascending): (1) Glorieta ss. memb., (2) ls. memb., and (3) upper clastic memb. However, upper clastic memb. is now recognized as a separate fm. and is here named *Bernal fm.*

In many areas in N. Mex., the N. Mex. Bur. Mines recognizes Glorieta ss. as separate fm. This procedure has been followed by many other geologists in the area.

Type locality and section: Rhodes Canyon, San Andres Mtns., in sec. 29, T. 12 S., R. 2 E.

Name: From San Andres (formerly San Andreas) Mtns.

Sandia formation. (Of Magdalena group.)

Pennsylvanian (Lower and Middle): Central New Mexico.

C. L. Herrick, 1900 (Jour. Geol., v. 8, 112-126; Am. Geol., v. 25, 234-237; N. Mex. Univ. Bull., v. 2, pt. 3, 1-14). *Sandia series.*—Series of shs., sss., and cgls., with occasional bands of sandy ls. Thickness 150 ft. Separated from overlying Coyote ss. by thick series of dark conchoidal lss. and shs. Rests on qtzite of unknown age. Present in Sandia, Manzano, and San Andreas Mtns.

C. R. Keyes, 1904 (Am. Jour. Sci., 4th ser., v. 18, 360-362). *Sandia fm.*—Consists of 300 ft of lss. underlying Madera ls. and overlying Lake Valley ls.

C. H. Gordon, 1907 (Jour. Geol., v. 15, 810-811). *Sandia fm.*—Alternating beds of blue and black clay sh., compact earthy ls. and cgl., vitreous ss. or qtzite; sh.

and ls. predom. Includes Incarnacion fire clay of Herrick at base. Thickness 500 to 700 ft. Underlies Madera ls. Is lower fm. of Magdalena gp. In Magdalena Mtns. rests on Kelly ls. (Miss.).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 22, 49-50). Name *Sandia* should be retained for the lower 127 ft of coarse-grained ss., cgls., and variegated shs. at the base of the Penn. in the Sandia Mtns. In the Sandia Mtns., the Sandia fm. as here interpreted corresponds in age to the lower part of type section of Armendaris gp. (Desmoinesian). The Sandia is about 127 ft thick in the N. end of the Sandia Mtns. and is composed largely of crossbedded ss., aren. to highly calc. shs., and highly argil. and aren. dark gray to black ls. The Sandia fm. is confined to the general region of the Sandia Mtns. S. of the Sandia Mtns., the Sandia sss. and aren. beds change laterally into the lower lss. of the Elephant Butte fm. N. from the Sandia Mtns., the Sandia fm. overlaps against the Precambrian.

R. H. Wilpolt et al., 1946 (USGS Oil and Gas Inv. Prelim. Map 61). The oldest rocks of Penn. age in the area (Los Pinos Mtns. and Chupadera Mesa) belong to the Sandia fm. The Sandia fm. is divided into two membs., a lower ls. and an upper clastic unit, in some parts of N. Mex. In the mapped area only the upper clastic unit is present.

C. B. Read and G. H. Wood, 1947 (Jour. Geol., v. 55, 220-236). Sandia fm. is of Morrow and Lampasas age in central N. Mex.

R. H. Baltz and G. O. Bachman, 1956 (New Mex. Geol. Soc., Guidebook, 7th Field Conf., 99). The Sandia fm. recognized through the southern Sangre de Cristo Mtns. Composed of a lower ls. memb. referred to Dev.(?) and Miss. and an upper memb. of thick beds of cgl. ss., siltstone, carb. sh., lenses of impure coal, and some thin ls. Local unconf. and rapid facies change common. Upper memb., of Morrowan age, is unconf. on lower memb., but conf. and intertonguing with overlying Madera ls. Thickness 0 to over 2,000 ft; increases to the N.

It should be noted that the term *Sandia fm.* is still in use in N. Mex. as defined by Gordon.

Type locality: S. end of Sandia Mtns.; no type section desginated.

Name: From Sandia Mtns., central New Mexico.

‡Sandia quartzites.

Middle Carboniferous: New Mexico (Sandia Mountains).

C. R. Keyes, 1903 (Ores and Met., v. 12, 48). A name applied to the "basal cgl. and associated ss." of the Middle Carbf., in Sandia Mtns., N. Mex., "which probably corresponds to the coal measures of Miss. Valley."

M. G. Wilmarth, 1938 (USGS Bull. 896, 1907). Probably refers to Sandia fm. of other geologists.

Type locality: Not designated.

Name: From Sandia Mtns.

‡†Sandia series.

Carboniferous: New Mexico.

C. R. Keyes, 1903 (Rpt. Gov. N. Mex. to U. S. Sec. Interior, 337-341). A term used to cover what appears to be Manzano terrane, a black carbf. ls.

Type locality: Not designated.

Name: From Sandia Mtns.

‡Sandoval granite.

Precambrian: Central New Mexico (Magdalena and Sandia Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 11). *Sandoval granites.*—Red granites penetrating all Precamb. rocks of Sandia, Magdalena, and other ranges.

Type locality: Not designated.

Name: From Sandoval Co.

Sangre de Cristo formation.

Pennsylvanian (Middle or Upper) and Permian (Lower): Central southern Colorado and central northern New Mexico (Sangre de Cristo Range).

R. C. Hills, 1899 (USGS Elmoro folio, n. 58, 1). The exposures in neighboring mtns. to W. indicate that it was not until near end of Carbf., when *Sangre de Cristo cgl.* was formed, that any considerable accumulation of sediments took place.

R. C. Hills, 1900 (USGS Walsenburg folio, n. 68). In Sangre de Cristo Range the strat. section corresponds very nearly to that at S. extremity of Greenhorn Mtns. (in this quad.) except in respect to thickness of the cgl. Below Morrison fm. there is in each case about same thickness of capping red ss., but the coarse cgl. and ss. on which it rests attain in the Sangre de Cristo a thickness of several thousand ft. In that locality the beds yielded an upper Carbf. fauna and flora. Evidence of similar character from Fountain fm. on E. slope of Rocky Mtns. is meager and contradictory, and it is still a question whether it should be classed as Perm. or Triassic. As Fountain and *Sangre de Cristo* fms. have not sufficient geologic importance to warrant separation on areal geol. sheet, they are grouped together under name *Badito fm.* and referred to upper Carbf. The upper part of the Badito consists of 100 ft of massive or thick-bedded brick-red ss., sometimes shaly on weathered surface, and apparently corresponds to some part of Fountain fm. The lower part consists of coarse brownish red cgl. (In chart in back of folio, Fountain fm. is shown as overlying *Sangre de Cristo fm.*, and both as equal to Badito fm.)

R. C. Hills, 1901 (USGS Spanish Peaks folio, n. 71, 2). A few mi W. of the dist. (Spanish Peaks quad.), there are extensive exposures of reddish-brown coarse cgl. (*Sangre de Cristo fm.*) which attains an enormous thickness and is regarded as of upper Carbf. age. It was the erosion of this cgl. that furnished bulk of of material composing Huerfano beds of Spanish Peaks area.

F. A. Melton, 1925 (Jour. Geol., v. 33, 807-815). *Sangre de Cristo cgl.*—Cgls., arkoses, and shs., noteworthy for red color throughout nearly entire fm. Most characteristic development and greatest thickness is in central part of Sangre de Cristo Range near village of Crestone (Saguache Co., Colo.), where it is probably at least 13,000 ft thick, and where it forms backbone of the range. From this place it thins irregularly in both directions until it is 6,000 ft at Culebra Range, near S. border of Colo. To N. of Crestone it thins to 4,300 ft in valley of Arkansas River, SE. of Salida. Near Crestone it is divisible into 2 groups of strata: *Upper Sangre de Cristo cgl.* (Perm.), consisting of 5,500± ft of very coarse red cgls.; and *Lower Sangre de Cristo cgl.* (Penn.), consisting of 7,500± ft of finer cgls. and arkoses, of darker color than Upper Sangre de Cristo cgl., and containing at base the Veta Pass ls. memb. Rests on Leadville ls. (Miss.). Though an angular unconf. was not seen btw. the Upper and Lower Sangre de Cristo cgls., it is believed that further search in this area may reveal such a break. The coarse cgl. beds in Upper Sangre de Cristo cgl. are "here named *Crestone cgl. phase of the Upper Sangre de Cristo cgl.*"

J. H. Johnson, 1929 (Colo. Sci. Soc. Proc., v. 12, 3-18). There is distinct unconf. btw. *Upper Sangre de Cristo fm.* and *Lower Sangre de Cristo* at some localities.

C. B. Read and G. H. Wood, 1947 (Jour. Geol., v. 55, 224, 234-235). *Sangre de Cristo fm.*—Highly variable succession of arkosic and red beds; conf. or unconf. overlies Magdalena gp. Possibly lower portion of this unit is, at some localities, Penn. in age. The middle and upper parts have been dated, on basis of fossil plants, as Permian(?). At Lamy, N. Mex., a thin sequence of the Sandia fm. and the lower memb. of the Madera are overlain by arkose of the Sangre de Cristo fm.

E. H. Baltz and G. O. Bachman, 1956 (N. Mex. Geol. Soc. Guidebook, 7th Field Conf., 100). *Sangre de Cristo fm.*—Composed of coarse cgl. arkosic ss.; red, green, and gray sh. and siltstone; a few gray or pink earthy lss., carbonaceous shs., and thin impure coal beds in lower part; also several beds of granite wash. Some lss. contain marine fossils; others are unfossilif. and may be of fresh-water origin. Thickness increases to N. from less than 500 ft, in S. part of Creston Range, to at least 4,000 ft, near Coyote. Ranges in age from Des Moines or Missouri, in N. to Virgil and Wolfcamp, in S. to N., upper part of fm. is laterally replaced by Yeso and thus is of Leonard age.

Type locality: In central part of Sangre de Cristo Range, near village of Crestone, Colorado; no type section designated.

Name: From Sangre de Cristo Range, central southern Colorado and central northern New Mexico.

‡Santa Rita limestone.

Silurian: Southwestern New Mexico (Sierra County).

C. R. Keyes, 1908 (AIME Bull. 19, 7-21). *Santa Rita ls.*—Dark-drab compact lss., 0 to 10 ft thick, containing Sil. fossils. Underlies Silver sh. (Dev.) unconf.; overlies El Pasan series (Ord.).

Type locality: Santa Rita, Grant Co.

Name: From the Santa Rita mine.

‡Santa Ritan series.

Silurian: New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 3, 11). *Santa Ritan series.*—Mid Siluric section as represented around Fort Bayard, and in the Franklin and Caballos Ranges.

Type locality: Not designated.

Name: From Santa Rita, Grant Co.

San Ysidro member (of Yeso formation).

Permian (Leonardian): North central New Mexico (Nacimiento Mountains).

G. H. Wood and S. A. Northrup, 1946 (USGS Oil and Gas Inv. Prelim. Map 57). Yeso fm. is divided into the massive Meseta Blanca ss. memb. and the overlying thin-bedded *San Ysidro memb.* San Ysidro memb. of Yeso is thin- to medium-bedded light orange-red to dark-red ss. and siltstone, with a few thin ls. beds. This memb. conf. overlies Meseta Blanca ss. memb. In the area from San Miguel Canyon N. to Señorito Canyon, the San Ysidro memb. tongues with the underlying Mesita Blanca ss. memb. It is thought that erosion prior to Upper Triassic time removed the upper part of San Ysidro memb. in this region. Thickness 0 to 200 ft.

Type locality and section: Near Cañon, N. Mex., in sec. 3, T. 16 N., R. 2 E., and in area immediately to N. of this sec., in Cañon de San Diego Grant.

Name: From San Ysidro Arroyo, Nacimiento Mtns.

‡Sapello quartzite.

Precambrian: Central northern New Mexico (Las Vegas region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 11). *Sapello qtzites.*—Main body of Archeozoic qtzites below the thick ls. section in Solitario Peak region, NW. of Las Vegas. Thickness 300 ft.

Type locality: Not designated.

Name: Derivation not indicated.

***Scherrer formation.**

Permian (Leonard): Southeastern Arizona and extreme southwestern New Mexico (Hidalgo County).

J. Gilluly, J. R. Cooper, and J. S. Williams, 1954 (USGS Prof. Paper 266, 27-29, 42). Scherrer fm.—Base is an easily identified plane beneath a bright-red siltstone memb. about 65 ft thick, and rests directly on dark lss. assigned to the Colina ls. Above the siltstone there are, in turn, about 30 ft of fine-grained gray ls., 270 ft of ss., 165 ft of gray ls., and 150 ft of ss. The ss. is nearly white on fresh fracture but generally weathers rusty brown; beds are 2-18 in. thick, a few are cross-bedded and ripple-marked. Exposed surfaces are commonly hardened to qtzite. The thick upper ls. memb. is a conspicuous feature; ls. is fine grained, relatively thin bedded, prevalent color light gray; nodules of white to rusty-brown chert are sparse to abundant. Well-preserved echinoid spines are the only fossils generally seen. Top of fm. is drawn at base of dark-gray ls. or calc. ss. of overlying Concha ls. Thickness of type section, 687 ft.

Elliot Gillerman, 1958 (N. Mex. Bur. Mines Bull. 57, 39-41). *Scherrer fm.*—About 50 ft of thick-bedded well-cemented dusky-red siltstone, capped by a thick ledge of white well-cemented ss.; overlies Colina ls. and is overlain by Chiricahua ls. (Concha ls. of USGS).

R. A. Zeller, Jr., 1958 (unpub. Ph. D. thesis, Univ. Calif., Los Angeles, 104-107). *Scherrer fm.*—5 to 20 ft thick in Big Hatchet Mtns.; characterized by medium- and fine-grained subrounded quartz sand in a ls. matrix. Basal contact of the orthoquartzite with underlying Epitaph dol. is sharp and interpreted as an unconformity. Upper contact with Concha ls. is less distinct and is chosen where quartz grains disappear. Probably of Leonard age, as grades upward into the Concha ls. of Leonard age.

Type locality and section: Scherrer Ridge and Concha Ridge, Gunnison Hills, NW. of Walnut Gap, Dragoon quad. Lower part of section on W. face of Scherrer Ridge, NE¼NE¼ sec. 29, T. 15 S., R. 23 E.; top of section along crest of Concha Ridge, SW¼NW¼ sec. 28, T. 15 S., R. 23 E.

Name: From Scherrer Ridge, Gunnison Hills, 5 mi N. of Dragoon, Arizona.

Second Value member (of Montoya limestone).

Middle Ordovician: Southwestern New Mexico (Silver City district).

L. P. Entwistle, 1944 (N. Mex. Bur. Mines Bull. 19, 16-19), divided the Montoya into 3 membs. (ascending): *Second Value memb.*, Par Value memb., and Raven memb. The *Second Value memb.* is the basal memb. of Montoya dol. at Boston Hill. Consists of purplish-gray sandy dol. The sand grains are grouped in wormlike aggregations, which in places simulate filled fossil molds. Locally thin

crossbedded sands, with red and black chert fragments. The sand is more prom. near the base. Upper part contains fossils of Galena age. The member is locally lenticular. Thickness at type loc. 90 ft.

Type locality and section: Second Value claim, Boston Hill subdist., Silver City dist., Grant Co.

Name: From Second Value claim.

‡Serna schist.

Precambrian: Central northern New Mexico (Santa Fe region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 11). *Serna schists.*—Basal part of Archeozoic section near Picuris, N. of Santa Fe, on W. flank of Rocky Mtns. Thickness 1,500 ft.

Type locality: Not designated.

Name: Derivation not indicated.

Seven Rivers formation (gypsiferous member [of Chalk Bluff formation]).

Permian (Guadalupian): Southwestern New Mexico and western Texas.

O. E. Meinzer, B. C. Renick, and Kirk Bryan, 1926 (USGS Water-Supply Paper 580A, 6-7, 13-15, and map). *Seven Rivers gypsif. memb. of Chupadera fm.*—The upper 60 ft or more consists of interbedded greenish limy sh. and ls., which in places changes laterally into ls. breccia; W. of A. T. & S. F. Ry. tracks, the breccia becomes a persistent bed. Lower part of Seven Rivers memb. consists of an undetermined thickness; at least 100 ft of thick beds of gyp. and associated red sand and sh. The Seven Rivers is basal memb. of Chupadera fm. as exposed in Carlsbad region, where it underlies Carlsbad ls. memb. of the Chupadera.

A. G. Fiedler and S. S. Nye, 1933 (USGS Water-Supply Paper 639). *Seven Rivers tongue of Pecos fm.*—Underlies Carlsbad ls. tongue of Capitan ls.; underlain by basal deposits of Pecos fm.; in places, rests on Picacho ls.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898), made following changes: (1) Divided the rocks formerly called *Pecos fm.* into several fms. (see under *Pecos fm.*); (2) abandoned *Pecos*; (3) introduced *Chalk Bluff fm.* for the beds overlying San Andres ls. memb. of Chupadera fm. and underlying Castile anhyd. in Pecos Valley, where the Castile is only the upper attenuated part of the Castile of Delaware Basin; (4) redefined *Seven Rivers gypsif. memb.* by removing its upper part, which he named *Three Twins memb.* of Chalk Bluff fm.; (5) showed Seven Rivers and Three Twins membs. as composing upper part of Chalk Bluff fm.; (6) introduced *Azotea tongue of Carlsbad ls.* for the tongue of ls. that separates the Seven Rivers and Three Twins membs. [This is present approved classification of USGS.] At Rocky Arroyo, *Seven Rivers memb.* is a series of sss., anhydritic sss., and red beds, with intercalated anhyds. and thin dolo. lss. from an in. to a few ft in thickness. Interfingers with Carlsbad ls.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14), raised *Seven Rivers gypsif. memb.* to status of fm. in Whitehorse gp.

N. D. Newell et al., 1953 (The Permian reef complex, etc., 42-46), redefined Queen ss. in such a way that *Seven Rivers fm.* of surface outcrops would be considerably thinner than previously indicated. No redefinition necessary in subsurf.

Type locality: Bluff S. of Seven Rivers (a river), in sec. 17 and 18, T. 20 S., R. 26 E., Eddy Co., New Mexico.

Name: From Seven Rivers.

Sevilleta metarhyolite.

Precambrian: Central New Mexico (Los Pinos and Manzano Mountains).

J. T. Stark and E. C. Dapples, 1946 (GSA Bull., v. 57, 1121-1172). Sevilleta rhyolite.—4,500 ft of acid flows in 2 facies. The lower 500 ft is more or less compact sericitic rhyolite, which grades downward into highly sheared and recrystallized White Ridge qtzite. The light-buff to reddish-brown schistose rhyolite is extremely fine grained and compact, and abund. sericitic. Usually the flows contain phenocrysts of pink orthoclase, which range from 1 to 15 mm in length, but where no phenocrysts occur, it is difficult to distinguish the schistose rhyolite from the underlying qtzite. The basal schistose facies grades up into progressively less metamorphosed rhyolite, which varies from dark red to black. Phenocrysts of orthoclase and qtz are abund. in a black aphanitic groundmass. In a few places a light silvery sheen indicates the development of sericite, but for the most part the upper flows show only slight alteration. In the upper part of the section, the flow character is apparent from an abundance of flow lines and chilled borders marking the tops of flows.

J. T. Stark, 1956 (N. Mex. Bur. of Mines Bull. 34), calls this fm. *Sevilleta metarhyolite.*

Type locality: N. of Los Pinos Arroyo.

Name: From the Sevilleta Grant, in which it is well exposed.

†Shandon quartzite.

Upper Cambrian and Lower Ordovician (Canadian): Southwestern New Mexico.

C. H. Gordon, 1907 (Jour. Geol., v. 15, 91-92). *Shandon qtzite.*—Qtzites, ss., and shs., with occasional ls. beds. Thickness 50 to 1,100 ft. Underlies Mimbres ls.

M. G. Wilmarth, 1938 (USGS Bull. 896, 1966). *Bliss ss.* has replaced this name in N. Mex. usage.

Type locality: Not designated.

Name: From Shandon, E. Sierra Co.

Shattuck member (of Queen formation).

Permian (Guadalupian): Southeastern New Mexico and western Texas.

N. D. Newell et al., 1953 (The Permian reef complex, etc., 43-45). Whiteman's investigations near type loc. of Queen fm. indicate that the outcrops form only a part of distinctive, rhythmically bedded unit, each cyclothem of which consists of reddish-brown fine-grained ss., which grades upward through sandy platy dol. to fine-grained unfossilif. dol. The top of the dol. is irregular and is overlain abruptly by basal ss. of the succeeding cyclothem. This rhythmic sequence extends through about 300 ft of beds on the S. side of Queen Mesa. Only the lower half of the fm. is exposed at type loc. At Devil's Den, on the Shattuck Valley escarpment, the fm. consists of cyclothems in which ss. comprises about 65 percent of the total. The Queen fm. extends from the dols. at top of Grayburg fm. to Seven Rivers fm. above. The lower boundary used here is essentially the same selected by Crandall (1929) on Queen Mesa, but top of fm. is drawn above the *Shattuck memb.* (new), a prom. ss. which is approx. 100 ft thick over much of shelf area in Guadalupe Mtns., except near the reef, where it thins rapidly. *Shattuck memb.* is probably the red "sand" zone at top of subsurf. Queen. If this correlation is correct, the surface and subsurf. characteristics of the fm. are now similar.

Type locality: Devil's Den, Shattuck Valley escarpment, Eddy Co., New Mexico.

Name: From Shattuck Valley escarpment.

Sierra limestone.

Mississippian: Southwestern New Mexico (Sierra County).

C. R. Keyes, 1908 (AIME Bull. 19, 7-10). *Sierra ls.*—Compact massively bedded gray lss., 50 ft thick. Contains upper Burlington and lower Keokuk fauna. Overlies Lake Valley ls. (restricted) at Lake Valley. The latter ls. consists of 150 ft of shaly highly fossilif. lss. containing a lower Burlington fauna.

L. R. Laudon and A. L. Bowsher, 1941 (AAPG Bull. 25, 2109-2110). The Grande, Lake Valley, and Sierra lss. of Keyes are definitely recognized facies of the Alamogordo memb. of the Lake Valley fm. as used in this paper. The Geologic Names Committee of the USGS recognizes only the Lake Valley formation.

Type locality: Not designated.

Name: From Sierra Co.

Sierrite limestone. (Of El Paso group).

Lower Ordovician (Canadian): Southern New Mexico.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 42-45). The El Paso ls. is raised to a gp., consisting of 2 fms., the *Sierrite ls.* (lower) and Bat Cave fm. (upper). The Sierrite is a medium-gray thin-bedded ls., with thin crenulated chert laminae. Crops out as cliff or slabby ledgy slope. Chert laminae form reticulating brown masses on broken surfaces parallel to bedding. When fresh, medium gray to dark gray. Most beds are microgranular, but fine- to medium-grained textures are present. Almost entirely calcitic at type locality but may be a dolo. ls. elsewhere. The chert is light gray to white on fresh surfaces. Thickness 127 to 167 ft. Essentially conf. with Bliss ss. (below) and Bat Cave fm.

Type locality and section: N. side of Cable Canyon, Caballo Mtns., sec. 10, T. 16 S., R. 4 W., Sierra Co.

Name: From Sierrite iron mine, S. side of Cable Canyon.

Silver-pipe limestone.

Mississippian: Central New Mexico.

C. L. Herrick, 1904 (Am. Geol., v. 33, 310-312). (See under †*Graphic-Kelly ls.*)

Name: Miners' description term; not a geographic name.

‡Silver shales.

Upper Devonian: Southwestern New Mexico (Grant County).

C. R. Keyes, 1908 (AIME Bull. 19, 7-21). *Silver shs.*—Black argil. shs., nonfossilif., 100 ft thick. Underlie Bella shs.; unconf. overlie Santa Rita ls. (Sil.). Assigned to Dev., from strat. position. Appears to correspond to lower part of Percha sh.

Type locality: Silver City, Grant Co.

Name: From Silver City.

*Simpson group.

Lower(?) and Middle Ordovician: Central southern Oklahoma (Arbuckle Mountains) and subsurface of western Texas and southeastern New Mexico.

J. A. Taff, 1902 (USGS Atoka folio, n. 79). *Simpson fm.*—Sss. and fossilif. ls., with interbedded greenish clay shs. and marls, separable into several quite distinctive members. Thickness 1,600 ft. In Tishomingo quad. and Arbuckle Mtns., where fm. is completely exposed, it varies in thickness from 1,200 to 2,000 ft. Underlies Viola ls. through transition; overlies Arbuckle ls.

J. A. Taff, 1903 (USGS Tishomingo folio, n. 98). According to E. O. Ulrich, the fauna of lower part of Simpson fm. has decided similarities to that of Chazy, of N. Y. and Canada, and fauna of upper part has close relations with that of upper div. of Stones River gp. in Tenn. and Ky.; certain species, however, indicate an age equiv. to that of Black River fauna of Minn., though these forms may have appeared earlier in Tishomingo region.

E. O. Ulrich, 1911 (GSA Bull., v. 22, pl. 27), assigned *Simpson fm.* (restricted) wholly to Stones River (early Chazyan) and an older "unnamed epoch"; allocated the overlying beds, of late Chazy and Black River age, to a new fm., which he called *Bromide;* and designated the overlying beds of Trenton age as Viola ls.

E. O. Ulrich, 1927 (Okla. Geol. Surv. Bull. 45, 30), showed *Simpson fm.* as of upper, middle, and lower Chazy age, and as including at top "typical Bromide (of late Chazy age)," whereas the overlying beds of Black River age he "provisionally referred to the Bromide fm."

F. C. Edson, 1927 (AAPG Bull., v. 11, 967-975), suggested that *Simpson fm.* be divided into (descending): (1) Bromide gp. (all "post-Wilcox" beds, of lower Black River age, underlying Viola ls., of upper Black River and Richmond age); (2) "Wilcox" sand, of upper Chazy age; and (3) Simpson fm. (restricted), of lower Chazy or Stones River age.

E. O. Ulrich, 1930 (U. S. Nat. Mus. Proc., v. 76, art. 21, 73), showed *Simpson fm.* as including at top the lower part of Bromide (which part he assigned to Black River), and divided the rest of the Simpson into several new but undefined fms. (descending): Criner, Tulip Creek, Falls, McLish, Oil Creek, and Joins, all of Chazy age.

C. E. Decker, 1930 (AAPG Bull., v. 14, 1498-1505), divided Simpson fm. into (descending): Bromide (including Criner), Tulip Creek, McLish (same as Falls, dropped), Oil Creek, and Joins fms.

C. E. Decker and C. A. Merritt, 1931 (Okla. Geol. Surv. Bull. 55, 11-13). The *Simpson* is here raised to a *gp.*, divided into 5 fms. (ascending): Joins, Oil Creek, McLish, Tulip Creek, and Bromide. These fms. represent 5 more or less complete sed. cycles, with a basal sand at bottom of each of 4 upper ones and a cgl. at base of lowest one.

E. O. Ulrich, 1933 (GSA Bull., v. 44, 105). *Simpson gp.* is divided into 8 fms.: Bromide fm. (correlates with Lowville); Criner fm.; Cool Creek fm.; Tulip Creek fm.; McLish and Falls fms., of middle Chazy age; and Oil Creek and Joins fms., of lower Chazyan age.

C. E. Decker, 1941 (AAPG Bull., v. 25, 650-667), confirms 5-partite div. of *Simpson gp.* as given in Okla. Geol. Surv. Bull. 55. Joins fm. may be in part Lower Ord.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038). Since, on paleontological grounds, all the formational units of the Okla.-type Simpson can be shown to be represented in the subsurf. of western Tex., and since the gp. in western Tex. can also be subdivided on lithologic grounds, not in conflict with the former, it is proposed that the Okla. formational names be applied to the recognized subdivisions of the subsurf. Simpson, with the McKee, Waddell, and Connell sss. as basal sands of the Tulip Creek fm., McLish fm., and Oil Creek fm., respectively.

Type locality: See individual formations.

Name: From former village of Simpson, just N. of Pontotoc, Johnston Co., Oklahoma.

Sly Gap formation.

Upper Devonian: South central New Mexico.

F. V. Stevenson, 1942 (N. Mex. Bur. Mines Bull. 18, 22, 23). *Sly Gap fm.*—Late Dev. Consists chiefly of thin alternating layers of sh. and siltstone, with a few

beds of ls. A zone 8 to 10 ft thick at the base is more massive than the rest of the fm. In outcrop its characteristic red-brown color contrasts sharply with the lighter colors of the sediments above and below. Contains many fragments of crinoids and brachiopods. The shs. range from black, fissile, and carb. to light buff or tan; the siltstones and lss. are, in general, buff. Thickness 0 to 135 ft. Rests unconf. on Fusselman ls. or Canutillo fm.; overlain conf. by Percha sh.

Type locality and section: S. side of Sheep Mtn., in Sly Gap, San Andres Mtns., sec. 25, T. 11 S., R. 5 E. (F. V. Stevenson, Jour. Geol., v. 53, 217-245, 1945).

Name: From Sly Gap, San Andres Mtns.

‡Socorran series.

Mississippian: New Mexico.

C. R. Keyes, 1906 (Sci., n. ser., v. 23, 921). A term applied to 300 ft of Miss. lss. in SW. N. Mex. said to underlie his Ladronesian series (shs.) and to overlie Dev. lss.

Type locality: Not designated.

Name: From town of Socorro.

‡Solitario slate.

Precambrian: Central northern New Mexico (Las Vegas region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 11). *Solitario slates.*—Extensive section of tilted Archeozoic beds lying above the main ls. exposed on Solitario Mtn., NW. of Las Vegas. Thickness 800 ft.

Type locality: Not designated.

Name: From Solitario Mtn.

South Wells limestone member (of Cherry Canyon formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). *South Wells ls. memb.*—Middle ls. memb. of Cherry Canyon fm. At type loc., several thin black or gray fossilif. ls. beds in an interval 75 ft thick. To NW., near base of reef, these change into buff or drab sandy dolo. lss. Lies 600 ft above base Cherry Canyon fm. Locally absent.

P. B. King, 1948 (USGS Prof. Paper 215, 36). *South Wells ls. memb.*—About 200 ft above Getaway memb. is another, less prom., less continuous group of ls. ledges, which is named the South Wells ls. memb. At type loc., memb. consists of several ls. beds, as much as 20 ft thick, interbedded with ss. and locally replaced by massive ss. beds. The lss. are gray, fine grained, and nondolo. and form beds a few in. to several ft thick, with some lenses and thin beds of dense black ls. In some places the ls. beds are replaced laterally by slabby reddish qtzites. The sss. beneath some of the ls. ledges are thick bedded and crop out in bare, rounded slopes. Farther N. the black ls. beds disappear, and the memb. contains beds, as much as 10 ft thick, of buff or drab fine-grained dolo. ls., in part sandy, which weathers into slabs or blocks. Overlying each bed is a few ft of slabby compact dolo. ls. The lss. are associated with thick beds of brown calc. ss. of a slightly coarser grain than the sss. above and below. In some places the ls. beds pinch out, and only the thick ss. beds remain to indicate the position of the memb. Thickness 0 to 175 ft.

Type locality and section: Near South Wells, D ranch, 11 mi SE. of El Capitan, Culberson Co., Texas.

Name: From South Wells, D ranch.

Staendebach member (of Tanyard formation).

Lower Ordovician (Canadian): Central Texas and subsurface of West Texas and southeastern New Mexico.

P. E. Cloud, Jr., V. E. Barnes, and J. Bridge, 1945 (Tex. Univ. Pub. 4301, 133-161), Named *Staendebach memb.* of *Tanyard fm.* [See this ref. under Ellenburger gp.]

P. E. Cloud, Jr. and V. E. Barnes, 1948 (Tex. Univ. Pub. 4621). *Staendebach memb.*—Upper memb. of Tanyard fm. Predom. fine- to coarse-grained commonly vuggy to porous light yellowish gray to wood-ash gray and pearl-gray, irregularly bedded dols., and sublith. pearl-gray to wood-ash gray and old-ivory thick- to thin-bedded lss. The dol. characteristically weathers rough or smoothly irregular to pitted, craggy, and medium gray to iron-gray with brownish tinges, or to yellowish shades of gray and brown. The ls. weathers reticulate to smooth, slabby or thick bedded, and to colors near wood-ash gray or pearl gray, old ivory, old silver, and cement gray. Gradation btw. ls. and dol. tends to be abrupt laterally and is of no apparent strat. significance. Characteristically contains an abundance of sparingly dolomoldic procelaneous to semiporcelaneous and chalcedonic to semichalcedonic chert. This weathers to solid, shiny, white or bluish-white masses, slabs, or chips; the semichalcedonic cherts are commonly oölitic to crypto-oölitic and pseudospicular. Correlated with Gasconade fm. of Mo. Thickness 230 ft at type loc.

Type section: 4.5 mi NE. of State Highway 16 on road from Cherokee to the San Saba-Chappel road, San Saba Co.

Name: From Staendebach survey.

Story formation. (Of Hansonburg group.)

Pennsylvanian (Missourian): Central New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 63-66). *Story fm.*—At type section, 57.5 ft; basal 19.5 ft reddish-brown sh., arkosic and micaceous ss., and gray sh.; upper 38 ft light-gray massive to massively bedded and highly fossilif. ls. Upper unit is composed of two massive thick beds of light-gray ls., separated by a thin bed of nodular to irregular ls. Type section (ascending): (1) sh., reddish-brown, mottled with light gray, interbedded in upper part with medium-grained purplish highly micaceous ss., 5 ft; (2) ss., medium-grained, highly crossbedded, lenticular, 6 ft; (3) ss., medium- to fine-grained, alternating indurated and soft layers, highly micaceous, 4.5 ft; (4) clay, light-gray to white, soft, greenish-gray in lower 1 ft, 4 ft; (5) ls., light-gray, dense and hard, massively bedded, beds to 5 ft thick, 17 ft; (6) ls., light-gray, granular, even-bedded, 4 ft; (7) ls., light-gray, coarse-grained, massively bedded, weathers rough, 17 ft. Fusulinid fauna: *Triticites, Dunbarinella*(?), and *Pseudostaffella*(?). Lies conf. on Burrego fm.; conf. overlain by Del Cuerto fm. of Virgil series.

Type locality and section: NE. side of Oscura Mtns., in SE¼ sec. 31, T. 5 S., R. 6 E., Socorro Co.

Name: From Story tank, 3 mi W. of Oscura Mtn. front.

Strawn.

A time term used by many geologists to cover the epoch during which the Strawn series of north central Texas was deposited.

***Strawn group.**

Pennsylvanian (Middle): Texas.

Strawn series.

Term used by many geologists to indicate strata deposited in central and western Texas and New Mexico at the same time as the Strawn series (M. G. Cheney, AAPG Bull., v. 24, 65-118, 1940) of north central Tex. Strawn series is equiv. to Des Moines series (Middle Penn.) of mid-continent region.

Syrena formation. (Of Magdalena group.)

Pennsylvanian: Southwestern New Mexico (Santa Rita district).

A. C. Spencer and S. Paige, 1935 (USGS Bull. 859, 22-26). *Syrena fm.*—Lower meb. consists of 100 to 130 ft of sh., with thin beds of nodular ls. in lower part; upper memb. consists of 260 ft of alternating ls. and sh. The lower memb. is locally called *Mountain Home sh.* by geologists of mining companies, in their company rpts., and the upper memb. is called by them *Don ls.* Upper fm. of Magdalena gp. The Syrena is overlain by Abo red beds; underlain conf. by Oswaldo fm.

R. M. Hernon, W. R. Jones, et al., 1955 (Geologic Map of the Central mining district, Grant County, New Mexico, USGS, open file). *Syrena fm.*—At the base, 35 to 40 ft of blocky to fissile black fetid silty ls., with long fossilif. gray ls. lenses 3 to 5 ft thick and/or lenses of ls. cgls.; overlain by 30 ft of 3- to 4-in. nodules of blue-gray ls. set in a dense dark-gray silty ls. matrix, whose weathered tan surface is porous silt leached of carbonate. Rest of fm. consists of alternating groups of beds of pure gray ls. (some crinoidal), silty ls., and brown, yellow, and red shs. Gray ls. nodules in tan matrix characteristic. Pronounced lateral variation in detailed lithology. Thickness 170 to 390 ft.

Type locality and section: Not stated.

Name: From Syrena patented mining claim, 1± mi S. of Hanover Post Office.

Tansill formation.

Permian (Guadalupian): Southeastern New Mexico and subsurface of western Texas.

R. K. DeFord and G. D. Riggs, 1941 (AAPG Bull., v. 25, 1713-1728). *Tansill fm.*—At type loc., 123.5 ft of yellowish, buff, gray, and brown thin-bedded fine-grained mag. lss., with about 16 ft of silty and sandy beds near the top (Ocotillo silt memb.). Type sec. (ascending): (1) brown mag. ls., 9.0 ft; (2) gray silty mag. ls., 1.0 ft; (3) silt and fine sand, 2.0 ft; (4) brown mag. ls., 55.5 ft; (5) buff mag. ls., 13.0 ft; (6) white chalky marl, 0.3 ft; (7) mag. ls., 4.5 ft; (8) sand and marl, 5.0 ft; (9) buff-gray mag. ls., 1.5 ft; (10) gray and yellow silt, 7.0 ft; (11) yellowish mag. ls., 17.2 ft; (12) silt and marl, 2.5 ft; (13) mag. ls., 5.0 ft. Units 8, 9, and 10 are Ocotillo silt memb. In subsurf. sections, Tansill lss. are commonly anhydritic, and some thin beds of anhyd. occur in top of section. Lies conf. on Yates ss.; unconf. overlain by Castile or Salado fm. Lang's (1937) Three Twins memb. of Chalk Bluff fm. appears to include both Tansill fm. and Yates sand; if so, the two units are described as intergradational, and the superposition of the Tansill on the Yates is not clearly recognized. Tansill fm. correlates with Capitan ls.; thickens basinward from 100-150 ft to 300 ft before it grades into upper part of Capitan ls.

Type locality and section: On Carlsbad-Artesia highway (U. S. 285), 3.7 mi N. of Eddy Co. courthouse, in W½ sec. 26, T. 21 S., R. 26 E., Eddy Co., New Mexico.

Name: From Tansill power dam, on Pecos River, New Mexico.

***Tanyard formation.** (Of Ellenburger group.)

Lower Ordovician (Canadian): Central Texas and subsurface of western Texas and southeastern New Mexico.

P. E. Cloud, Jr., V. E. Barnes, and J. Bridge, 1945 (Tex. Univ. Pub. 4301, 133-161), named *Tanyard fm.* See this ref. under Ellenburger gp.

P. E. Cloud, Jr. and V. E. Barnes, 1948 (Tex. Univ. Pub. 4621). *Tanyard fm.*—Extends from Camb. Ord. boundary to base of Gorman. Predom. fine- to coarse-grained commonly vuggy to porous light yellowish-gray to woodash gray and pearl-gray irregularly bedded dols. and sublith. pearl-gray to woodash gray and old-ivory thick- to thin-bedded lss. The ls. weathers reticulate to smooth, slabby to thick-bedded, and to colors near wood-ash gray or pearl gray, old ivory, old silver, and cement gray. Gradation btw. dol. and ls. tends to be abrupt laterally. Locally the fm. is dol. from top to bottom. On the basis of chert, supported by grain-size differences in the dols. or, in the W. part of the region, by a change from ls. to dol., the Tanyard fm. is divided into the Threadgill memb. (below) and the Staendebach memb. (above). The boundary between the membs. is transitional. Aver. thickness 590 ft.

Type locality and section: "The Tanyard," on E. bank of Buchanan Lake (Colo. River), opposite mouth of Jim John Creek, and 2 to 3 mi N. of the mouth of Fall Creek, in NW. Burnett Co., Texas.

Name: From "The Tanyard."

‡Taosan series.

Precambrian (Archeozoic): Northern New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 11). *Taosan series.*—Tilted Archeozoic sediments exposed in Solitario Peak. They strike N. 50 degrees W., across Taos Co., and dip about 60 degrees SW.

Type locality: Not designated.

Name: From Taos Co.

‡Tellera (Tellara) limestone.

Pennsylvanian(?): Central New Mexico (Sandia Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 3, 11. Uppermost gray ls. memb. of Maderan series, exposed on E. flank of Sandia Range. Thickness 300 ft.

Type locality: Not designated.

Name: Derivation not indicated.

***Threadgill member (limestone).** (Of Tanyard formation.)

Lower Ordovician (Canadian): Central Texas and subsurface of western Texas and southeastern New Mexico.

V. E. Barnes, 1944 (Tex. Univ. Pub. 4301, 37). *Threadgill ls.*—Lower ls. unit of Tanyard fm.

P. E. Cloud, Jr., V. E. Barnes, and J. Bridge, 1945 (Tex. Univ. Pub. 4301, 133-161). The lowest unit of the Tanyard fm. was revised to include equiv. dol. and called *Threadgill memb.* of Tanyard fm.

P. E. Cloud, Jr. and V. E. Barnes, 1948 (Tex. Univ. Pub. 4621). *Threadgill memb.*—Lss. and dols., abruptly transitional, fine- to coarse-grained, commonly vuggy, light yellowish-gray to woodash-gray and pearl-gray, irregularly bedded. Lss. sublith. On W., lss. have argil. films and minor silt. Dols. of Threadgill memb.

yield vuggy or spongy masses of highly dolomoldic or cellular chert interlaced with qtz druse. Lss. are generally noncherty. Thickness 91 ft in E. Llano region; 294 ft in W.

Type section: Threadgill and Mormon Creeks, S. of Lange's mill, NW. Gillespie Co., Texas.

Name: From Threadgill Creek.

Three Twins member (of Chalk Bluff formation).

Permian (Guadalupian): Southeastern New Mexico (Pecos Valley).

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898). North from Little McKittrick Canyon to Spencer Draw, the top of Carlsbad ls. grades into sss., which in turn are displaced by anhydritic sands, sandy red beds, anhyds., fine greenish sss., thin greenish-gray sandy shs., and dolo. lss. This sequence of beds is here named *Three Twins memb. of Chalk Bluff fm.* This memb. is top part of the fm. It is underlain by Azotea tongue of Carlsbad ls. or, where that is absent, by lithologically similar Seven Rivers memb. The Three Twins and Seven Rivers membs. represent greater part of Chalk Bluff fm. and are equiv. to Carlsbad and Capitan lss. of reef zone.

R. K. DeFord and G. D. Riggs, 1941 (AAPG Bull., v. 25, 1713-1728). *Three Twins memb. of Chalk Bluff fm.* of Lang is approx. equiv. to Yates and Tansill fms. of Whitehorse gp.

The terms Chalk Bluff fm. and Three Twins memb. are not used by the petroleum geologists in SE. N. Mex. Instead they use the terms "Whitehorse gp.," with 5 fms., the Grayburg, Queen, Seven Rivers, Yates, and Tansill making up the gp. However, the use of the terms Chalk Bluff fm., Three Twins memb., and other membs. of Chalk Bluff fm. has been continued by the USGS.

Type locality: Partial section at Three Twins Hills, Spencer Draw, 10 mi NE. of Carlsbad, Eddy Co.

Name: from Three Twins Hills, NE. of Carlsbad.

Tierra Blanca member (of Lake Valley formation).

Mississippian (Osagian): South central and southwestern New Mexico.

L. R. Laudon and A. L. Bowsher, 1949 (GSA Bull., v. 60, 13-14). *Tierra Blanca memb.*—The medium-bedded gray to brown criquina beds containing light-colored chert nodules that cap the Miss. section at Lake Valley and grade imperceptibly down into the soft blue-gray marls of the Nunn memb. Most of the basal beds of the Tierra Blanca memb. are interbedded with blue-gray marl, so that a definite line btw. the Nunn and Tierra Blanca memb. is difficult to draw. The upper part is invariably gray to brown criquina, with up to 50% light-colored chert. The Tierra Blanca memb. is a cliff former and in most places makes a vertical scarp along the mountain front. Its thickness ranges from 125 ft, in the Percha Creek area, to 10 ft, in parts of the Sacramento Mtns. Rapid lateral changes in thickness are common where biohermal structures are present.

Type locality and section: Apache Hill, near Lake Valley, in NE¼NW¼ sec. 21, T. 18 S., R. 7 W.

Name: From Tierra Blanca Creek, Sierra Co.

‡Tijeras quartzite.

Precambrian: New Mexico.

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 11). *Tijeras qtzites.*—Qtzite beds 250 ft thick, best exposed in great Tijeras arch of Precamb. rocks at S. end of Sandia Range.

Type locality: Not designated.

Name: From Tijeras Canyon, Bernalillo Co., New Mexico.

***Tintic quartzite.**

Lower Cambrian: Central Utah and subsurface of southeastern Utah and northwestern New Mexico (Four Corners area).

G. O. Smith, 1900 (USGS Tintic folio, n. 65). *Tintic qtzite.*—Clay slates and qtzites; the qtzites white, weathering brownish red, very pure, compact, and fine grained, with occasional beds of fine qtz pebbles. Several beds of green, yellow, and red clay slates occur near top. Underlies Mammoth ls. In mapping, the base of the lowest bed of ls. was taken as contact btw. the two fms., so that some slates are included in Mammoth ls. Exposed thickness about 7,000 ft, but base not found.

G. F. Loughlin, 1919 (USGS Prof. Paper 107), restricted Tintic qtzite to the massive qtzites, and transferred to his overlying Ophir fm. 100 to 190± ft of sh. or slate which were included in Tintic qtzite as originally defined. (This is present approved definition.)

J. C. Cooper, 1955 (Four Corners Geol. Soc. Guidebook, 59). *Tintic ss.*—The Tintic ss. has been correlated with a basal, transgressive, qtzose ss. in the Four Corners area ranging from 0 to 547 ft. Only 7 wells in the entire region have penetrated this unit completely. The Tintic ss., which thickens to the NW. into the Cordilleran geosyncline, consists principally of massive white, green, and maroon to pink ss., with fine to medium grains, which grade downward to a very coarse pebbly cgl. The basal 50 to 70 ft are nearly everywhere abundantly feldspathic. The ss., which locally carries some glauconite, contains minor, intercalated streaks of red and green micaceous clayey shs. The Tintic ss. unconf. overlies Precambrian rocks; conf. underlies the Ophir fm. To the E., where the Upper Camb. rocks have been either beveled by erosion or not deposited, the Tintic ss. is overlain by Dev. rocks. The Tintic is equiv. to the Prospect Mtn. qtzite, the Tapeats ss., and the Brigham qtzite.

Type locality: Exposures on Quartzite Ridge, between Eureka and Mammoth gulches.

Name: From Tintic Canyon, Juab Co., Utah.

‡Torrance shale.

Permian(?): Central New Mexico (Manzano Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 3, 11). *Torrance shs.*—Upper or vermilion section of Bernallillan series of Carbonic red beds in Manzano Mtns. Thickness 500 ft. Overlie Yeso fm.

Type locality: Not designated.

Name: From Torrance Co.

Torres member (of Yeso formation).

Permian (Leonardian): Central New Mexico.

R. H. Wilpolt et al., 1946 (USGS Oil and Gas Inv. Prelim. Map 61). Upper division of Yeso fm. includes (ascending): *Torres memb.,* Canas gyp. memb., and Joyita ss. memb. Type section of Torres memb. is given graphically. Torres memb. comprises the bulk of Yeso fm.; consists of alternating beds of orange-red and buff ss. and siltstone, gray ls., and gyp. Thickness ranges from 350 to 600 ft.

Type locality: Outcrops in tributary of Aqua Torres Canyon (on Sevilleta Grant), 7 mi S. of Black Butte, Socorro Co.

Name: From Aqua Torres Canyon, Socorro Co.

‡Truchas slate.

Precambrian: Central northern New Mexico (Santa Fe region).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 12). *Truchas slates.*—The upper slate section of the Archeozoic succession at Picuris, N. of Santa Fe. Thickness 900 ft.

Type locality: Not designated.

Name: From Truchas Peaks.

***Tulip Creek formation.** (Of Simpson group.)

Middle Ordovician: Central southern Oklahoma (Arbuckle Mountains) and subsurface of western Texas and southeastern New Mexico.

F. C. Edson, 1930 (AAPG Bull., v. 14, 947). *Tulip Creek fm.* is overlain with angular unconf. by Bromide fm.

C. E. Decker, 1930 (AAPG Bull., v. 14, 1498-1505). *Tulip Creek fm.*—Chiefly shs. and sss., with some lss. Usually a thick ss. at base. Thickness of fm. 0 to 600± ft. Underlies Bromide fm.; overlies McLish fm. Whether of early Black River or late Chazy age to be determined after further study of fossils. Occurs only in W., SW., and central parts of Arbuckle Mtns.

C. E. Decker and C. A. Merritt, 1931 (Okla. Geol. Surv. Bull. 55). The *Simpson* is here raised to a *gp.*, divided into 5 fms. (ascending): Joins, Oil Creek, McLish, Tulip Creek, and Bromide. A few fossils near the base of the Tulip Creek seem to be upper Chazy, but those in middle and near top are typical Black River forms.

T. Cole, C. D. Cordry, and H. A. Hemphill, 1942 (AAPG Bull., v. 26, 279-282), proposed the name *McKee ss. memb.* for the basal sand of the Tulip Creek in the subsurf. of western Texas.

R. H. Schweers, 1949 (AAPG Bull., v. 33, 2029-2038), formally proposed that the recognized subdivs. of the subsurf. Simpson in western Tex. have Okla. formational names applied, as they are the same on paleontological and strat. grounds.

See also 1933 and 1941 entries under *Simpson gp.*

Type locality: Exposures at headwaters of Tulip Creek, in Carter Co., N. of Springer, Oklahoma.

Name: From Tulip Creek.

Tusas granite.

Late Precambrian: Central northern New Mexico (Petaca area).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 44-46). *Tusas granite.*—Considered to be contemp. and possibly identical with the Dixon granite of the Picuris area. The Tusas granite varies greatly in composition and texture. In general it is composed of medium-sized grains and is nonporphyritic. The granite S. of Tusas Mtn. is pink and noticeably lacking in ferromag. minerals. N. of Tusas Mtn., the rock is gray, contains a good deal of biotite, and varies from monzonite to qtz monzonite in composition.

Type locality: Tusas Mtn., Rio Arriba Co.

Name: From Tusas Mtn.

Upham dolomite. (Of Montoya group.)

Upper Ordovician: Southern New Mexico.

V. C. Kelley and C. Silver, 1952 (N. Mex. Univ. Pub., geol. ser., n. 4, 59-60). *Upham dol.*—Massive-bedded medium-gray- to brownish-gray-weathering dol. Microcrystalline to coarsely crystalline and medium gray to dark gray when fresh. Basal beds sandy. Locally contains scattered, irregularly shaped nodules of chert as much as 12 in. in greatest dimension, or thin bands of chert. Fossils scarce. Thickness in Caballo Mtns. 20 to 80 ft. Lies conf. on Cable Canyon ss.; conf. overlain by Aleman fm.

Type locality and section: Cable Canyon, Caballo Mtns., NW¼ sec. 10, T. 16 S., R. 4 W., Sierra Co.

Name: From Upham station, on A.T. & S.F. Ry., E. of Caballo Mtns.

Vaca Triste sandstone member (of Salado formation).

Permian (Ochoan): Southeastern New Mexico and western Texas.

J. E. Adams, 1944 (AAPG Bull., v. 28, 1596-1625). *Vaca Triste ss. memb.*—Persistent and widespread 10-ft layer of fine-grained orange-red ss. lying just below anhyd. no. 12 of section given by G. A. Kroenlein (AAPG Bull., v. 23, 1682-1693, 1939).

Type locality and section: Continental Oil Co. King No. 1, sec. 26, T. 25 S., R. 32 E., Lea Co., New Mexico (btw. –1555 and –1565 ft).

Name: From Vaca Triste Draw, Lea Co., New Mexico.

Vadito formation.

Precambrian: Central northern New Mexico (Picuris Range).

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 8, 21-35). *Vadito fm.*—At least partial equiv. of Hopewell series of Just. The name Hopewell had been applied to other rocks prior to Just's usage, and the type area lies many mi NW. of the Picuris Range; consequently, the rocks younger than the Ortega fm. in the Picuris area are renamed. The best exposures of the Vadito occur within a 1-mi radius of the Harding mine. The fm. consists of a lower cgl. memb. and an upper schist memb. Cgl. memb. (ascending): (1) 750 ft of cgl. and qtzite, interbedded with felsites, metadacites, and metaandesites; (2) 500 ft of cgl. and qtzite, interbedded with amphibolites; (3) 750 ft of coarse qtz cgl. and fine-grained qtzite, with minute scales of muscovite. Schist memb. (ascending): (1) Qtz-muscovite schist, interbedded with flows of plagioclase amphibolites and containing sills of partly porphyritic plagioclase amphibolites, 1,250 ft; (2) qtz-muscovite schist, qtz-muscovite phyllite, and qtz-biotite granulite, 1,250 ft. The thickness of the Vadito fm. is est. to be 4,500 ft.

Type locality: Exposures for 1 mi NNW. of Harding mine, Taos Co.

Name: From town of Vadito, about 7 mi E. of Harding mine.

‡Valencian series.

Precambrian: New Mexico.

C. R. Keyes, 1915 (Conspectus of geol. fms. of N. Mex., 4, 12). *Valencian series.*—A term introduced to cover the "latest pre-Cambric succession of volcanics and granites."

Type locality: Not designated.

Name: From Valencia Co.

Vallecitos rhyolites.

Precambrian: Central northern New Mexico (Picuris Range and Petaca area).

E. Just, 1937 (N. Mex. Bur. Mines Bull. 13, 44). *Vallecitos rhyolites.*—The Hopewell series and the Ortega qtzite contain a number of flows of rhyolite and trachyte, which are named Vallecitos rhyolites. The flows range in thickness up to three-quarters of a mi. It is assumed that such thicknesses represent aggregates of flows, rather than single flows. In places the flows are somewhat schistose, but characteristically their original textures have been well preserved, and flow-banding is well developed. They range in color from deep pink to brick red, and all contain distinct phenocrysts up to a quarter of an in. in diameter. Trachyte is subordinate to rhyolite.

A. Montgomery, 1953 (N. Mex. Bur. Mines Bull. 30, 21), includes these in his Vadito fm.

Type locality: Not designated.

Name: From town of Vallecitos, Rio Arriba Co.

Valmont dolomite.

Upper Ordovician: Southern New Mexico.

L. C. Pray, 1953 (AAPG Bull., v. 37, 1906-1911). *Valmont fm.*—The strata consisting predom. of light-gray-weathering thin- to medium-bedded sublith. dol. lying btw. the underlying cherty memb. of the Montoya fm. and the generally massive, darker, and more coarsely crystalline dol. termed the "upper Fusselman dol." by Darton. Equiv. to "lower Fusselman" of Darton. Thickness 150-225 ft in Sacramento Mtns. Fm. separated into upper and lower membs. by a few ft of nonresistant argil. dol. from 40 to 70 ft above the base. Basal contact with Fusselman ls. is disconf. Fauna Ord. Same as Cutter fm. of Kelley and Silver.

Type section: NE. side of Alamo Canyon, SE¼ SW¼ SW¼ sec. 6, T. 17 S., R. 11 E., Sacramento Mtns.

Name: From Valmont station, on Southern Pacific Ry., 10 mi S. of Alamogordo.

Veredas group.

Pennsylvanian (Missourian): New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 57-63). *Veredas gp.*—Name proposed for the gp. of rocks which includes 3 fms., and which lies on Bolander gp. (Desmoinesian) and underlies Hansonburg gp. (Missourian). Fms. are (ascending): Coane fm., light bluish-gray dense massively bedded ls.; Adobe fm., noncherty to highly cherty gray lss., gray shs., and arkosic sss.; Council Springs ls., light-gray to white coarsely crystalline to fine-grained massive to massively bedded ls. Thickness of gp. at type loc. 125 ft; thicker, more clastic, to N. and S. Fusulinid fauna: *Triticites, Waeringella*(?).

Type locality and section: NW. side of Oscura Mtns., in SE¼ sec. 36, T. 5 S., R. 5 E., Socorro Co.

Name: From Canyon de Las Veredas, in central part of Oscura Mtns.

Victorio Peak gray member (massive member) of Bone Spring limestone.

Permian (Leonardian): Western Texas and southeastern New Mexico.

P. B. King and R. E. King, 1929 (AAPG Bull., v. 13, 921, 922, 925). Gray ls. unconf. below Delaware Mtn. ss. (a part only of Delaware Mtn. fm.); has thick-

ness of 500 to 1,000 ft; contains *Productus ivesi* and other forms which serve to correlate it with upper part of the Leonard on one hand and with the San Andres(?) on the other. Here name *Victorio Peak memb. of Leonard fm.*, because of prominent exposures at summit of mtn. of that name. Below it is Bone Canyon memb. Absent in Guadalupe Mtns., but a short distance N. of Bone Spring Canyon, on W. side of Guadalupe Mtns., it wedges into the section and separates Bone Canyon memb. from Delaware Mtn. ss. [This ls. and Bone Spring ls. originally were included in Delaware Mtn. fm. but are now excluded from the Delaware Mtn.]

P. B. King, 1934 (GSA Bull., v. 45, 731, 755-768), designated the Victorio Peak deposits as *Victorio Peak massive memb. of Bone Spring ls.* [This is designation of the USGS, approved in 1938].

P. B. King, 1942 (AAPG Bull., v. 25, 533-768), designated the Victorio Peak deposits as *Victorio Peak gray memb. of Bone Spring ls.*

P. B. King, 1948 (USGS Prof. Paper 215, 13-27). The Bone Spring is composed almost entirely of ls. beds, as contrasted with the dominantly sandy strata of the Delaware Mtn. gp. which overlies it. In Delaware Mtns., and extending as far N. as Bone Canyon, the exposed parts of the fm. are black cherty ls. in thin beds, with partings and a few membs. of shaly ls. and silic. sh. N. of Bone Canyon, in the Guadalupe Mtns., the upper part of the black ls. is replaced by a thick-bedded gray ls., the *Victorio Peak gray memb.*, which also forms the capping stratum of the Sierra Diablo. Btw. the main mass of lss. and the ss. of the Delaware Mtn. gp. is a small thickness of interbedded ls. and sh., which forms the Cutoff shaly memb. and its probable equivalents. The gray ls. deposits (*Victorio Peak gray memb.*) N. of the Bone Spring flexure were probably laid down in shallower, clearer, better aerated water than the black lss. Their moderately thick beds include layers, traceable for relatively long distances, that were spread out in broad sheets. They are thus unlike the irregularly bedded massive ls. deposits higher in the section, which have the form of reefs. The Victorio Peak deposits are designated better as ls. banks than as ls. reefs.

Type locality: Exposures at summit of Victorio Peak, Sierra Diablo escarpment, Culberson Co., Texas.

Name: From Victorio Peak.

Virgilian.

A time term used by many geologists to cover the epoch during which the Upper Penn. Virgil series of the midcontinent region was deposited. A recognized subdivision of the Penn. (R. C. Moore et al., GSA Bull., v. 55, 657-706, 1944).

***Virgil series.**

Pennsylvanian (Upper): Midcontinent only.

Term used by many geologists to indicate rocks deposited at the same time as the Upper Penn. Virgil series of the midcontinent region.

Waddell sandstone member (of McLish formation).

Middle Ordovician: Subsurface of western Texas and southeastern New Mexico.

T. Cole, C. D. Cordry, and H. A. Hemphill, 1942 (AAPG Bull., v. 26, 279-282). *Waddell ss. memb.*—Basal sand of McLish fm. Consists of (ascending): (1): Medium- to coarse-grained angular ss., shaly toward base, 8 ft; (2) green sh., 1 ft; (3) medium- to coarse-grained ss., with shaly and calc. cementing material, 8 ft; (4) green splintery sh., 2 ft; (5) medium- to coarse-grained ss., with rare green sh. cementing sand grains, 37 ft; (6) medium- to coarse-grained ss., with

abund. large frosted grains, 1 ft. Total thickness 75 ft. Top 480 ft below top of McKee sand and 355 ft above top of Ellenburger. Same as bed 9, zone 6, of Powers.

Type section: Gulf Oil Corp. N. W. Waddell et al. No. 2, sec. 17, Blk. B-27, P.S.L. Surv., Crane Co., Texas.

Name: From Waddell well.

Warmington limestone member (of Elephant Butte formation).

Pennsylvanian (Desmoinesian): Central New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 49). *Warmington ls. memb.*—22 ft of medium- to light-gray dense and cherty ls. at base of *Elephant Butte fm.* Contains distinctive fusulinid fauna, including oldest known form of genus *Fusulina* in N. Mex. and most highly developed form of genus *Fusulinella* known from N. Mex., as well as *Pseudostaffella, Eoschubertella,* and *Millerella.* Lies unconf.(?) on Derry series.

Type locality and section: W. end of Whiskey Canyon, in northern part of Mud Springs Mtns., in SW¼ sec. 1, T. 13 S., R. 5 W.

Name: From village of Warmington, in Rio Grande Valley, S. of Caballo dam.

Whiskey Canyon limestone. (Of Armendaris group.)

Pennsylvanian (Desmoinesian): Central and southern New Mexico (widespread).

M. L. Thompson, 1942 (N. Mex. Bur. Mines Bull. 17, 50). *Whiskey Canyon ls.*—At type section 163 ft of massive bluish-gray to gray cherty lss. which form prom. ls. cliffs. Ls. is massive and resistant, and contains several thick zones of light-gray chert near its base, and scattered masses and lenses of chert in its lower and upper portions. Fusulinid fauna: *Millerella, Eoschubertella, Pseudostaffella, Wedekindellina,* and *Fusulina.* Lies conf. of Elephant Butte fm.; conf.(?) overlain by Garcia fm.

Type locality and section: W. end of Whiskey Canyon, Mud Springs Mtns., in SW¼ sec. 1, T. 13 S., R. 5 W.

Name: From Whiskey Canyon.

Whitehorse group. (Only in Texas and Oklahoma by USGS.)

Permian (Guadalupian): Western Texas and southeastern New Mexico; also western Oklahoma and southern Kansas.

C. N. Gould, 1905 (USGS Water-Supply Paper 148, 55). *Whitehorse ss. memb.* of Woodward fm.—(Introduced to replace preoccupied name "Red Bluff ss." Quotes Cragin's definition of "Red Bluff.") Extends from vicinity of Whitehorse Springs, Woods Co., Okla., SW. across the Cimarron to high divides beyond. Overlies Dog Creek shale and underlies Day Creek dol.

R. W. Sawyer, 1924 (AAPG Bull., v. 8), proposed restricting *Whitehorse ss.* to upper part of the Whitehorse, and named lower part *Marlow fm.* This usage did not prevail, and in 1929 Sawyer named his restricted Whitehorse ss. the *Rush Springs memb. of Whitehorse,* and called the lower part the *Marlow memb.*

N. Evans, 1931 (AAPG Bull., v. 15), stated that Day Creek dol. overlies (instead of underlies) Cloud Chief gyp., and treated the Cloud Chief as a memb. of the Whitehorse.

M. G. Wilmarth, 1938 (USGS Bull. 896, 2321). Is middle fm. of Woodford group of Okla. In Kansas is in Cimarron group. The name has also been used by Tex. Geol. Survey in Texas.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14). *Whitehorse gp.*—According to prevalent usage in Okla., where the Whitehorse was named, the Whitehorse gp. comprises (in ascending order) the Marlow, Rush Springs, and Cloud Chief fms. The Cloud Chief is overlain in places by the Day Creek dol. For more than 10 years (almost since the beginning of careful study of the Perm. Basin of western Tex. and N. Mex.), the term *Whitehorse* has been applied to the beds btw. the Upper Castile ("main salt") and the San Andres. Frank E. Lewis, in his stereograms, applies Okla. names to western Tex. approximately as follows: Marlow to the lowest fm. (Grayburg) of the western Tex. "Whitehorse"; Rush Springs to the Queen sand; Cloud Chief to the Seven Rivers fm. Most western Tex. geologists concur in these approximate correlations. Thus the western Tex. term *Whitehorse*, if it be otherwise suitable, has the advantage of long-established usage. It also has the advantage of applying a single name to beds of the same age over a region at least 500 mi wide. According to the viewpoint of some geologists, the term has disadvantages that outweigh the advantages. Certain symposium papers indicate that the Yates and Tansill fms. of the top part of western Tex. "Whitehorse" gp. pinch out in subsurf. before they reach the E. side outcrops. According to this interpretation, Seven Rivers fm. is approximately equiv. to the Cloud Chief fm. of Okla., and Yates and Tansill equivalents are not present in the typical Whitehorse of Okla. It is also possible that the oldest "Whitehorse" beds of western Tex. and N. Mex. are represented by a hiatus in Okla. Such evidence is used by Cordry and others as argument against continued use of *Whitehorse* in western Tex. and N. Mex. The *Whitehorse gp.* of western Tex. and N. Mex. is divided from the base upward into 5 fms.: Grayburg, Queen, Seven Rivers, Yates, and Tansill. The 5 fms. of the Whitehorse gp. grade SE. into beds of Guadalupe age in the Delaware Basin. Lang's term *Chalk Bluff* is a suitable N. Mex. synonym for "Whitehorse," if one is needed. [See under *Chalk Bluff fm.*]

R. L. Bates, 1942 (N. Mex. Bur. Mines Bull. 18, 42-43). *Whitehorse group.*—Lying some distance northwest of the reef zone and grading laterally into the Goat Seep and Carlsbad limestones is a section belonging to the Guadalupe series which consists of five distinct formations. These formations, which are restricted to the sheld (back-reef) area, are named in ascending order the Grayburg, Queen, Seven Rivers, Yates, and Tansill. They have been penetrated in hundreds of wells in southeastern New Mexico. The Whitehorse group is essentially the same as the Chalk Bluff formation of Lang.

P. B. King, 1948 (USGS Prof. Paper 215, 68). The description of relations of beds of middle and upper Guadalupe age in N. Guadalupe Mtns., as given in this rpt., is based on nomenclature adopted by the USGS, which emphasizes lithologic units. A different system, emphasizing time units, regardless of their lithologic variations from place to place, has been used by petroleum geologists, both in subsurf. correlations and surface mapping. By the latter system, the beds here discussed are termed the *Whitehorse gp.*, which is divided from below upward into the Grayburg, Seven Rivers, Yates, and Tansill fms. These fms. are delimited and traced in both the Chalk Bluff and Carlsbad facies of present usage. Both systems of terminology have merit and originated for specific needs. The lithologic units are of value for reconnaissance surface mapping, and the time units are of value for subsurf. work, such as well-log correlations and recognition of subsurf. structural features.

The term *Whitehorse* is used in southeastern New Mexico and western Texas to indicate beds that are approximately correlative with those designated as Whitehorse ss. and Whitehorse group in Okla.

Type locality: Not designated.

Name: From Whitehorse Springs, Woods Co., Oklahoma.

White Ridge quartzite.

Precambrian: Central New Mexico (Los Pinos and South Manzano Mountains).

J. T. Stark and E. C. Dapples, 1946 (GSA Bull., v. 57, 1121-1172). *White Ridge qtzite.*—Near the base, composed of massive qtzite beds 2 to 7 ft thick, varying from white to light pink, tan, and red. Impure shaly beds occur throughout the fm. and become prom. near the top. Here thin beds of gray qtzite, 1 to 2 ft thick, alternate with zones of gray and white sericitic schist. Hematite is conspicuous near the top. The beds vary from light pink to red. Recrystallization and shearing have locally altered the impure qtzite beds, so that they may be confused with sericitic schists formed by shearing of the overlying rhyolite flows. All the qtzite is at least slightly sericitic. Thickness 900 to 3,700 ft. The upper part is silic. and sheared by faulting. Overlies Blue Springs schist; overlain disconf. by Sevilleta metarhyolite.

Type locality: Not designated.

Name: From White Ridge, Los Pinos Mtns.

Wolfcampian.

A time term used by many geologists to indicate the epoch during which the lower Perm. Wolfcamp series of western Tex. was deposited. An approved subdivision of Perm. time.

Wolfcamp series.

Permian (lowermost division of the Permian of North America).

J. E. Adams et al., 1939 (AAPG Bull., v. 23, 1673-1681). Wolfcamp fm. of western Tex. (restricted) is here raised to series rank and considered oldest div. of Perm. of N. Am. It is equiv. to Hueco fm. and Abo fm. of N. Mex.

P. B. King, 1942 (AAPG Bull., v. 26, 535-763). Because of uncertainty of Penn.-Perm. boundary, *Wolfcamp* is classed as "Perm.(?)." In this paper the terms *Wolfcamp*, Leonard, Guadalupe, and Ochoa series are considered to be provincial terms.

F. E. Kottlowski et al., 1956 (N. Mex. Bur. Mines Mem. 1, 47). Noteworthy is a decision by the Geologic Names Committee of the USGS, dated July 28, 1955, here quoted in part: "The Chief Geologist has approved the recommendation by James Steele Williams that age designation of Wolfcamp series and strata of equiv. age in U. S. be Permian without query in official nomenclature of U. S. Geol. Survey. Also approved [that] . . . the use of provincial series be continued as subdivisions of the Perm. system in preference to lower, middle, and upper."

Thus, the term Wolfcamp series has been extended to include strata deposited at the same time as the lower Perm. Wolfcamp series of western Tex.

Type locality and section: Exposures in hills just NW. of Wolfcamp, the site of an old dwelling place just S. of the two buttes located 6½ mi E. and 2 mi N. of E. end of Leonard Mtn., in Glass Mtns., Brewster Co., Texas.

Name: From Wolfcamp site.

***Woodford chert (shale).**

Devonian: Central southern and southeastern Oklahoma (Ouachita Mountains) and subsurface of western Texas and southeastern New Mexico.

J. A. Taff, 1902 (USGS Atoka folio, n. 79). *Woodford chert.*—Thin-bedded chert and fissile black sh., 500 to 700 ft thick. Underlies Caney sh.; overlies Hunton ls.

S. P. Ellison, 1950 (Tex. Univ. Bur. of Econ. Geol. Rpt. Inv. 7). Woodford sh.—Brownish-black iron sulfide-rich resinous spore-bearing fissile sh. Small quantities of calc. sh. and brown and black mottled chert are found at various strat. positions within the Woodford. A distinctive detrital memb., sandy and cgl., occurs about 100 ft above the base of the sh. in Winkler Co., Tex. The Woodford in Winkler Co. is divided into 3 units on the basis of lithology and electric log patterns. Upper unit is brownish-black sh., with very few small resinous spores. The middle unit, the main spore-bearing unit, is marked at the top with a brownish-black chert and calc. sh. Various other calc. and cherty beds occur in this unit. The lower Woodford has much chert and calc. material, and fewer spores. Max. thickness 610 ft in Winkler Co., Tex.; 0 to 600 ft in Lea and Eddy Cos., N. Mex. Upper Devonian; correlates with Ready Pay memb. of Percha sh. in N. Mex., and with Woodford and Chattanooga of Okla., Kans., and Ark.

Type locality: Exposures about ¼ mi N. of Woodford, Carter Co., Oklahoma.

Name: From town of Woodford.

Yates sandstone (formation, sand).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

R. V. Hennen and R. J. Metcalf, 1929 (AAPG Bull., v. 13, 1509-1556). *Yates sand.*—A subsurf. sand of Perm. age, 50 to 60+ ft thick, lying 400± ft below eroded top of Perm. in Yates oil pool, Pecos Co., western Tex. Also known locally as *Smith sand.* Oil-bearing lss. lying at approx. horizon of this sand have been called Yates lime and Yates ls.

R. K. DeFord and E. R. Lloyd, 1940 (AAPG Bull., v. 24, 1-14), show *Yates fm.* as a memb. of Whitehorse gp. of Permian Basin area. Yates consists of sss. and lss.

R. K. DeFord and G. D. Riggs, 1941 (AAPG Bull., v. 25, 1713-1728), show *Yates fm.* as a series of sands separated by lss.; approx. 350 ft thick. Underlies Tansill fm.; lies upon Seven Rivers fm.

Although there does not appear to be any adequate definition of Yates fm. in the literature, it is underlain and overlain by well-defined fms. which restrict it to a particular gp. of beds. This fm. should be defined more adequately.

Type locality and section: Not designated.

Name: From Yates oil pool, Pecos Co., Texas.

Yeso formation (member [of Chupadera formation]).

Permian (Leonardian): New Mexico (widespread) and subsurface of western Texas.

W. T. Lee, 1909 (USGS Bull. 389). *Yeso fm.*—Consists of 1,000 to 2,000 ft of ss., sh., earthy ls., and gyp. The ss. varies in color from gray to many shades of pink, yellow, red, and purple, and in texture from soft coarse-grained friable masses to fine-grained layers, evenly bedded and flinty. The shs., frequently gypsif., are soft, pink to yellow; beds of massive white gyp., 100 to 200 ft thick, occur in many places. Is middle fm. of Manzano gp. Underlies San Andreas ls.; lies with apparent conf. on Abo ss. [See also under *San Andreas ls.*] Until further information is available, San Andreas ls. cannot be separated definitely from Yeso fm. except in type loc. in San Andreas Mtns. Typically exposed on Mesa del Yeso, a small tableland 12 mi NE. of Socorro. In several sections the top memb. of Yeso fm. is shown as consisting of 200 to 275 ft of pink, yellow, and white ss.

W. B. Lang, 1937 (AAPG Bull., v. 21, 833-898), abandoned *Picacho ls.* of Pecos Valley region for *San Andreas ls. memb. of Chupadera fm.*, and replaced *Nogal fm.* of that area with *Hondo ss. memb. of Chupadera fm.* (above) and *Yeso memb. of Chupadera fm.* (below). The recognition of Hondo ss. involves a slight redefinition of both San Andres and Yeso as heretofore used.

M. G. Wilmarth, 1938 (USGS Bull. 896, 831). As there is no fm. btw. San Andres ls. and *Yeso fm.* as defined (now called *Yeso memb. of Chupadera fm.*), the ss. of Glorieta Mesa is top part of Yeso memb. of that area. See under *Chupadera fm.* (N. H. Darton, 1922) for reasons for making *Yeso fm.* a memb. of Chupadera fm.

C. E. Needham, 1942 (Bates et al., N. Mex. Bur. Mines Bull. 18, 35). *Yeso fm.* thickens to SE.; also becomes limy to SE. The Yeso is believed to change laterally into the Bone Spring ls. of the Guadalupe Mtns. and to be equiv. to about the lower two-thirds of the Leonard series.

C. E. Needham and R. L. Bates, 1943 (GSA Bull., v. 54, 1653-1668). *Yeso fm.*, 593 ft thick at type loc., may be subdivided into at least 4 units. The lowest is a general zone of clastic material, characterized by abund. pink or orange ss. Next above is a thick succession of interbedded thin lss., gyps., silts, and sandy shs., with progressively more ls. and gyp. toward the SE. This unit is referred to informally as the middle evaporites. Above the middle evaporite unit is a thick bed of gyp., here named the *Canas memb.* of Yeso fm. Uppermost unit consists of a soft crossbedded ss., to which the name *Joyita memb.* is here given. Joyita memb. is 185 ft thick in Yeso type section. In type section basal bed of Yeso is thin ls. Lies disconf. on Abo fm.; conf. overlain by Glorieta ss. (regarded as a separate fm.).

R. E. King, 1945 (N. Mex. Bur. Mines Bull. 23, 13-15), named *Drinkard sandy memb. of Yeso fm.* in subsurf. of southeastern N. Mex. and western Tex.

G. H. Wood and S. A. Northrup, 1946 (USGS Oil and Gas Inv. Prelim. Map 57), named *Meseta Blanca ss. memb.* (below) and *San Ysidro memb.* (above) of Yeso fm. in Nacimiento Mtns.

V. C. Kelley and G. H. Wood, 1946 (USGS Oil and Gas Inv. Prelim. Map 47), named *Los Vallos memb.* of Yeso fm. in Lucero uplift area.

R. H. Wilpolt et al., 1946 (USGS Oil and Gas Inv. Prelim. Map 61), named *Torres memb.* of Yeso fm. in area of Joyita Hills.

R. L. Bates et al., 1947 (N. Mex. Bur. Mines Bull. 26, 26-28). The uppermost unit of the type Abo of Needham and Bates (1943) is a 6-ft white massive ss. Further field work in the area has shown the presence just above this unit of a thin ls. identical with the lowest unit of the Yeso as redefined by the same authors. However, as pointed out by C. B. Read (personal communication, 1945), the "basal Yeso ls." cannot be found in Yeso sections in the northern part of the State (in Glorieta Mesa and the Zuni Mtns., for example); consequently it cannot serve as a universally recognizable "base of Yeso." Read further states that a 100- to 300-ft section of ss. and shs., heretofore considered uppermost Abo, can be recognized and mapped regionally. As most of these beds are apparently of marine origin and in many places, including Abo Canyon, have a pink color more similar to that of the Yeso than to the dark red of the Abo, Read and his coworkers on the USGS have included the beds in the Yeso and have mapped the Abo-Yeso contact some distance below the basal Yeso ls. of Needham and Bates. Applied to the Abo type section, this revision lowers the Abo-Yeso contact 104 ft, to the top of interval 32 in the Needham and Bates section. This interval has been named the Meseta Blanca ss. memb. of the Yeso fm. by Wood and Northrup (1946). A new composite section of the Yeso fm. gives a total thickness of 678 ft when these beds are included.

Type locality and section: 11.2 mi N. 46° E. of Socorro, at the point where the eastern edge of Socorro quad. intersects the 34°10′ parallel; from

this point NE., in secs. 4 and 5, T. 2 S., R. 2 E., and in sec. 33, T. 1 S., R. 2 E., Socorro Co., New Mexico.

Name: From Mesa del Yeso, Socorro Co., New Mexico.

Yoakum dolomite member (of Queen formation).

Permian (Guadalupian): Western Texas and southeastern New Mexico.

W. C. Fritz and J. Fitzgerald, Jr., 1940 (AAPG Bull., v. 24, 15-28). *Yoakum dol. memb.*—Persistent 35-ft layer of brown sandy dol. and gray dolo. ss., in Yoakum Co., Tex., and in surrounding counties in Tex. and N. Mex. A memb. of Queen fm. [What part of Queen fm. not specified.]

Type locality and section: Honolulu-Cascade, Bennett No. 1, NE¼ sec. 678, Blk. D, John D. Gibson Survey, Yoakum Co., Texas (from -4,195 to -4,230 ft).

Name: From Yoakum Co., Texas.

‡Ysidro shale.

Precambrian: Central New Mexico (Sandia and Manzano Mountains).

C. R. Keyes, 1915 (Iowa Acad. Sci. Proc., v. 22, 257-259; Conspectus of geol. fms. of N. Mex., 4, 12). *Ysidro shs.*—The thick argil. memb. (of Proterozoic sediments) lying above the great qtzite; best exposed in a sharp truncated arch in Tijeras Canyon, btw. the Sandia and Manzano Mountains. Thickness 1,500 ft.

Type locality: Not designated.

Name: From village of San Ysidro, Sandoval Co.

Appendix

LISTING OF NAMES BY GEOLOGIC PERIODS

Precambrian

Agua Caliente gabbro
Antonio slate
Badito quartzite member
Blue Springs schist
Cabresto metaquartzite
Cleveland Gulch quartzite member
Dixon granite
Embudo granite
Graphic lavas
Hondo slate
Incarnacion granite
Lacorocah metatuff member
Los Pinos granite
Monte Largo granite
Ninos schist
Ojito granite
Ortega formation
Ortega quartzite
Penasco quartzite
Petaca schist member
Picuris basalts
Pilar phyllite member
Priest granite
Pueblo quartzite
Rinconada schist member
Rociada limestone
Sais quartzite
Sandoval granite
Sapello quartzite
Serna schist
Sevilleta metarhyolite
Solitario slate
Tijeras quartzite
Truchas slate
Tusas granite
Vadito formation
Vallecitos rhyolites
White Ridge quartzite
Ysidro shale

Divisional Names

Albuquerquan series
Garnuan series
Hopewell series
Percusian series
Taosan series
Valencian series

Cambrian

Bliss sandstone (also Ord.)
Burro quartzites
Carrasco limestone
Hawkins limestone
Lone quartzite
Mangas quartzite
Ophir formation
Shandon quartzite
Tintic quartzite

Divisional Names

Chiricahuan series
Chloridian series
Dragoonan series

Ordovician

Aleman formation
Armendaris limestone
Bat Cave formation
Bliss sandstone (also Camb.)
Bromide formation
Cable Canyon sandstone
Cibola limestone
Connell sandstone member
Cristobal limestone
Cutter formation
Ellenburger group
El Paso group

Frondosa limestone
Gorman formation
Honeycut formation
Joins formation
McKee sandstone member
McLish formation
Montoya group
Oil Creek formation
Par Value member
Pinos Altos limestones
Raven member
Second Value member
Sierrite limestone
Simpson group
Staendebach member
Tanyard formation
Threadgill limestone
Threadgill member
Tulip Creek formation
Upham dolomite
Valmont dolomite
Waddell sandstone member

Divisional Names

El Pasan series
Mimbresian series
Montoyan series

Silurian

Fusselman limestone
Santa Rita limestone

Devonian

Aneth formation
Bella shale
Box member
Canutillo formation
Chloride
Contadero formation
Ignacio quartzite
McCracken sandstone member
Naiad limestone
Onate formation
Ouray limestone
Percha shale
Ready Pay member
Silver shales
Sly Gap formation
Woodford shale (chert)

Divisional Names

Martinian series
Perchan series

Other

Hunton group (Sil.-Dev.)
Mimbres limestone (Ord.-Sil.)

Mississippian

Alamogordo member
Andrecito member
Arcente member
Arroyo Penasco formation
Augur limestone member
Berenda limestone
Caballero formation
Caloso formation
Chloride formation (Dev.?)
Dona Ana member
Escabrosa limestone
Grande limestone
Graphic-Kelly limestone
Hanover limestone
Helms formation
Kelly limestone
Lake Valley limestone (formation)
Las Cruces formation
Leadville limestone
Madison limestone
Nunn member
Paradise formation
Rancheria formation
Sierra limestone
Silver Pipe limestone
Tierra Blanca member

Divisional Names

Chester series
Kinderhook series
Meramec series
Osage series

Age Terms

Chesterian
Kinderhookian
Meramecian
Osagean
Socorran series

Mississippian-Pennsylvanian

Fierro limestone

Pennsylvanian

Adobe formation
Alamito shale
Antonito limestone
Apodaca formation
Armendaris group
Arrey formation
Atrasado member
Bar B formation
Beeman formation
Berino member
Bishop's Cap member
Bolander group
Bruton formation
Bug Scuffle limestone member
Burrego formation
Coane formation
Council Springs limestone
Coyote sandstone member
Cuchillo Negro formation
Del Cuerto formation
Don limestone
Earp formation
Elephant Butte formation
Fra Cristobal formation
Fresnal group
Gallegos sandstone
Garcia formation
Gobbler formation
Gray Mesa member
Green Canyon group
Hansonburg group
Hermosa formation
Holder formation
Horquilla limestone
Hot Springs formation
Humboldt formation
Incarnacion fire clay
Keller group
La Tuna member
Log Springs formation
Madera limestone
Magdalena group
Molas formation
Montosa limestone
Mosca limestone
Mountain Home shale
Moya formation
Mud Springs group
Naco group (or formation)
Nakaye formation
Oscuro limestone
Oswaldo formation
Panther Seep formation
Paradox formation
Pinkerton Trail formation
Placitos limestone
Red House formation
Red Tanks member
Rico formation (also Perm.)
Sandia formation
Sandia quartzites
Sangre de Cristo formation
Story formation
Syrena formation
Tellera limestone
Veredas group
Warmington limestone member
Whiskey Canyon limestone

Divisional Names

Ardian series
Atoka series
Bend series
Canyon series
Cisco series
Derry series

Des Moines series
Kawvian series
Ladronesian series
Lampasas series
Lunasan series
Maderan series
Manzanan series
Missouri series
Morrow series
Oklan series
Rio Grande series
Sandia series
Strawn series
Virgil series

Age Terms

Ardian
Atokan
Bendian
Canyon
Cisco
Derryan
Desmoinesian
Kawvian
Lampasan
Missourian
Morrowan
Oklan
Strawn
Virgilian

Permian

Abo formation
Aqua Torres formation
Artesian red sand
Azotea tongue
Bell Canyon formation
Bernal formation
Bernalillo shale
Bone Canyon limestone
Bone Spring limestone
Bone Springs limestone
Brushy Canyon formation
Bursum formation
Canas gypsum member
Capitan limestone
Carlsbad limestone
Castile formation
Ceja Glorieta sandstone
Chalk Bluff formation
Chaves shale
Cherry Canyon formation
Cherry Canyon sandstone tongue
Chiricahua limestone
Chupadera formation
Cimarron formation
Colina limestone
Concha limestone
Cowden anhydrite member
Culebra dolomite member
Cutler formation
Cutoff shaly member
Deer Mountain red shale member
Delaware Mountain formation (group)
Delaware Mountain sandstone
Dewey Lake formation
Dog Canyon limestone
Drinkard sandy member
Eddy sandstone
El Capitan limestone
Epitaph dolomite
Fierro limestone
Fletcher anhydrite member
Frijole limestone member
Getaway limestone member
Glorieta sandstone
Goat Seep limestone
Grayburg formation
Guadalupe group
Gym limestone
Hegler limestone member
Hondo sandstone
Hueco limestone
Joyita sandstone member
La Huerta siltstone member
Lamar limestone member
Lobo formation
Los Vallos member
Lovington sandstone member
McCombs limestone member
McNutt zone
Magenta dolomite member
Manzanita limestone member
Manzano group
Meseta Blanca sandstone member
Nogal formation
Ocotillo silt member
Otero limestone
Pecos formation
Pecos shale
Pecos Canyon sandstone
Pecos Valley red beds
Picacho limestone
Pinery limestone member

Powwow conglomerate member
Queen sandstone
Rader limestone member
Rico formation
Rustler formation
Salado halite (formation)
San Andres limestone
Sangre de Cristo formation
San Ysidro member
Scherrer formation
Seven Rivers formation
Shattuck member
South Wells limestone member
Tansill formation
Three Twins member
Torrance shale
Torres member
Vaca Triste sandstone member
Victorio Peak gray member
Whitehorse group
Yates sandstone
Yeso formation
Yoakum dolomite member

Divisional Names

Bernalillan (Bernallian) series
Brazos series
Cimarronian series
Guadalupe series
Leonard series
Ochoa series
Rican series
Sandia series
Wolfcamp series

Age Terms

Guadalupian
Hueconian
Leonardian
Ochoan
Wolfcampian