



## *Lexicon of stratigraphic names of the Monument Valley-Four Corners region*

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1973, pp. 157-176. <https://doi.org/10.56577/FFC-24.157>

*in:*

*Monument Valley (Arizona, Utah and New Mexico)*, James, H. L.; [ed.], New Mexico Geological Society 24<sup>th</sup> Annual Fall Field Conference Guidebook, 232 p. <https://doi.org/10.56577/FFC-24>

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*This is one of many related papers that were included in the 1973 NMGS Fall Field Conference Guidebook.*

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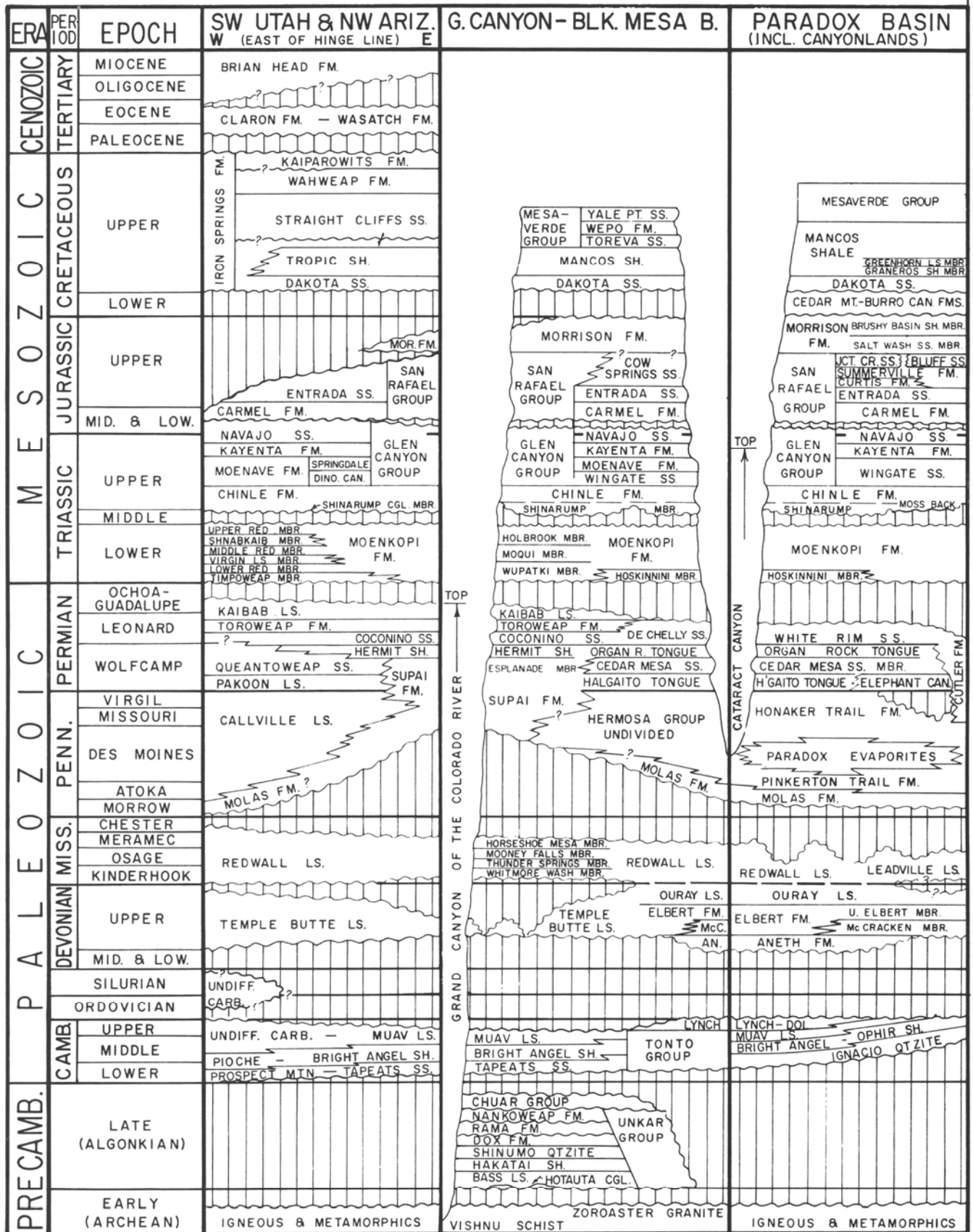
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# NOMENCLATURE CHART OF THE CANYONLANDS & ADJACENT AREAS



NOTE: VERTICAL TIME SCALE NOT UNIFORM

COMPILED BY C.M. MOLENAAR

# LEXICON OF STRATIGRAPHIC NAMES OF THE MONUMENT VALLEY-FOUR CORNERS REGION

by

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The general format of this Lexicon follows that of Christina Lochman-Balk in several guidebooks of the New Mexico Geological Society, of Daniel S. Turner in the N.M.G.S. 9th Guidebook, and of the Nomenclature Committee, Four Corners Geological Society, in several guidebooks of that society. A few stratigraphic units lying well beyond the limits of the region are included because certain papers make reference to them.

For each stratigraphic unit, the age is given, followed by: (1) areal distribution; (2) reference to paper in which the unit was first mentioned or defined; (3) type locality; (4) brief lithologic description plus thickness; (5) nature of contacts with both underlying and overlying units, additional information on areal distribution, emendations, changes in rank or status, and other aspects, with special reference to the area of the 24th Field Conference (1973).

Useful references are the series of lexicons of geologic names-U.S.G.S. Bulls. 896, 1200, and 1350-a total of 7,585 pages! Some of the older papers treating large parts of the entire area include H. E. Gregory, 1916, U.S.G.S. P.P. 93, and A. A. Baker, C. H. Dane, and J. B. Reeside, Jr., 1936, U.S.G.S. P.P. 183. For SE Utah, see H. E. Gregory, 1938, U.S.G.S. P.P. 188; for NW New Mexico, see J. B. Reeside, Jr., 1924, U.S.G.S. P.P. 134, and J.D. Sears, C. B. Hunt, and C. H. Dane, 1936, U.S.G.S. Bull. 860.

Geologic maps in color, columnar sections, and much detailed stratigraphic information for the Arizona and Utah parts of the 24th Field Conference area may be found in the following reports.

A. A. Baker, 1936, Geology of the Monument Valley-Navajo Mountain region, San Juan County, Utah: U.S.G.S. Bull. 865. (From San Juan River on N to the Utah-Arizona line, and from Rainbow Bridge Nat. Mon. and Navajo Mt. on W to Cedar Mesa and the Goosenecks on E.)

R. B. O'Sullivan, 1965, Geology of the Cedar Mesa-Boundary Butte area, San Juan County, Utah: U.S.G.S. Bull. 1186. (From Cedar Mesa to Bluff, and from Natural Bridges Nat. Mon. on N to the Utah-Arizona line on S.)

J. D. Strobel, Jr., 1956, Geology of the Carrizo Mountains area in northeastern Arizona and northwestern New Mexico: U.S.G.S. Oil and Gas Inv. Map OM-160. (Mostly extreme NE corner of Arizona.)

I. J. Witkind and R. E. Thaden, 1963, Geology and uranium-vanadium deposits of the Monument Valley area, Apache and Navajo Counties, Arizona: U.S.G.S. Bull. 1103. (Area in Arizona S of the Baker and O'Sullivan areas from the Utah-Arizona line nearly to latitude of Kayenta.)

Other sources include the 2d and 9th guidebooks of the N.M.G.S. (1951 and 1958) and those of the Four Cor. Geol. Soc. For pre-Pennsylvanian rocks, see J. C. Cooper, 1960,

Four Cor. Geol. Soc. 3d Gdbk., p. 69-78. For the Pennsylvanian, see numerous papers by S. A. Wengerd (1951-) and others. For basal Permian and older rocks, see N. W. Bass, 1944, U.S.G.S. Oil and Gas Inv. Prel. Chart 7. For the Permian of the entire Colorado Plateau: D. L. Baars, 1962, A.A.P.G. Bull., v. 46, p. 149-218. For the Moenkopi Fm.: E. D. McKee, 1954, G.S.A. Mem. 61. For the Chinle Fm.: numerous papers by J. H. Stewart, 1954-. For Triassic and Jurassic of the Navajo country: J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291. For the Morrison Fm. of the Colorado Plateau: W. L. Stokes, 1944, G.S.A. Bull., v. 55, p. 951-992. A recent summary of the Upper Cretaceous of the San Juan Basin is by E. C. Beaumont, 1971, N.M.B.M.M.R. Mem. 25, p. 15-30.

Further information on ages of units may be found in the series of correlation charts for each system, published in the G.S.A. Bull. between 1942 and 1960. A quantity of detailed data is presented in the series of paleotectonic maps by E. D. McKee and others, from 1956 on (U.S.G.S. Misc. Geol. Inv. Maps 1-175, Jurassic; 1-300, Triassic; 1-450, Permian).

Authors of papers included in this Guidebook kindly furnished lists of stratigraphic names used by them, but the compiler did not see the papers, except for the one by S. A. Wengerd. A skeletonized, much-abbreviated version of the road logs was also available. Thus there may be discrepancies between the Lexicon and the several papers, especially with respect to status of some of the units, and details of thickness and lithology. Abbreviations used for certain references:

A.A.P.G.-American Association of Petroleum Geologists  
A.J.S.-American Journal of Science  
G.S.A.-Geological Society of America  
N.M.B.M.M.R.-New Mexico Bureau of Mines and Mineral Resources

N.M.G.S.-New Mexico Geological Society  
U.S.G.S.-United States Geological Survey

Last-minute note and apology.-Recent papers not seen by the compiler until just before press time-when it was too late to draw upon them-include the series of U.S.G.S. reports on the Navajo and Hopi Indian Reservations: C. A. Repenning, M. E. Cooley, and J. P. Akers, 1969, P.P. 521-B, on the Chinle and Moenkopi Fms.; J. H. Irwin, P. R. Stevens, and M. E. Cooley, 1971, P.P. 521-C, on the Paleozoic rocks; and R. B. O'Sullivan, C. A. Repenning, E. C. Beaumont, and H. G. Page, 1972, P.P. 521-E, on the Cretaceous rocks and the Tertiary Ojo Alamo Ss. Nor did the compiler see J. E. Fassett and J. S. Hinds, 1971, U.S.G.S. P.P. 676, on the Fruitland Fm. and Kirtland Sh.; J. H. Stewart, F. G. Poole, and R. F. Wilson, 1972, P.P. 690, on the Chinle Fm.; and 1972, P.P. 691, on the Moenkopi Fm.

## LIST OF ABBREVIATIONS

aband.	abandoned	dk.	dark	nod.	nodule, -ar
abs.	abstract	dol.	dolomite	occ.	occasionally or occurrence
abund.	abundant	dom.	dominant	ol.	olive
acc.	according	equiv.	equivalent	ool.	oolitic
aggl.	agglomerate	esp.	especially	oran.	orange
alt.	alternate, -ing	est.	estimated	orig.	original, -ly
ang.	angular	evap.	evaporite, -s	overly,	overlying
anhyd.	anhydrite	exp.	exposed, -u re	partic.	particularly
app.	appearance, apparently	ext.	extent, -ded, -ing	peb.	pebble, pebbly
approx.	approximate, -ly, -tion	feld.	feldspar	perst.	persistent
aren.	arenaceous	fi.	fine	pk.	pink
argil l.	argillaceous	fiss.	fissile	poss.	possibly
ark.	arkose, -ic	fm.	formation	pred.	predominant, -ly
ascend.	ascending	form.	forming	prey.	prevalent, -ly
assoc.	associated, -ion	fossil.	fossiliferous	prob.	probable, -ly
av.	average	friab.	friable	prom.	prominent
band.	banded, -ing	Gdbk.	Guidebook	prop.	proposed
bed.	bedded	gen.	general, -ly	pt.	part, -ly
bent.	bentonite, -itic	glauc.	glaucinitic	ptg.	parting
bitum.	bituminous	gr.	grained	purp.	purple
blk.	black	Gr.	Group	qtz	quartz
bould.	boulder	grad.	grade, -s	qtzite	quartzite
br.	brown	gradat.	gradational, -ly	qtzitic	quartzitic
cal.	calcareous	gm.	green	quad.	quadrangle
calcaren.	calcareous	gry.	gray	recog.	recognize, -d
carb.	carbonate	gyp.	gypsum	recomm.	recommend, -ed, -ation
carbonac.	carbonaceous	gypsif.	gypsiferous	redef.	redefined
cem.	cement, -ed	horiz.	horizontal, -ly	ref.	referred, -ence
cgl.	conglomerate	incl.	include, -d, -ing	reg.	regarded
char.	characterized, -istically	indist.	indistinguishable	rep.	represent
choco.	chocolate	infill.	infilling	rept.	report, -ed
clayst.	claystone	interb.	interbedded	Reserv.	Reservation
Co.	County	intercal.	intercalated	resist.	resistant
cob.	cobble	intergrad.	intergradation, -al	restr.	restrict, -ed
col.	colored	intrafm.	intraformational	rev.	revised
comm.	commercial	in trod.	introduced	rhy.	rhyolite, -itic
compr.	comprises	inv.	investigate, -d, -ion	sdv.	sandy
concr.	concretion, -ary	irreg.	irregular, -ly	sec.	section
conf.	conformable, -ly	L .	L o w e r	sed.	sediment, -ary
consid.	consider, -ed	lam.	laminated	sep.	separate, -d, -able
const.	constitute	lat.	lateral, -ly	seq.	sequence
cont.	contains, -ing	laven.	lavender	sev.	several
correl.	correlate, -d, -ive	lent.	lenticular	sh.	shale
cred.	credited	lith.	lithologic, -ally	sil.	silicified, -eous
cse.	coarse	loc.	local, -ly, -ity	siltst.	siltstone
def.	define, -d	low.	lower	sim.	similar
dep.	deposit, -ed	ls.	limestone	sort.	sorted, -ing
der.	derived	lt.	light	ss.	sandstone
descend.	descending	M .	M i d d l e	strat.	stratified, -graphic, -ally
descr.	described, -ption	mass.	massive	subdiv.	subdivide, -d
desig.	designated	max.	maximum	subsurf.	subsurface
dev.	developed, -ment	meas.	measured	sugg.	suggest, -ed
diff.	different	med.	medium	U.	Upper
disc.	discussed, -ion	mem.	member	uncem.	uncemented
disconf.	disconformable, -ly	metam.	metamorphic	unconf.	unconformable, -ably
dist.	distinct, -ly or district	mi.	mile	underly.	underlying
disting.	distinguish, -ed, -able	mid.	middle	undiv.	undivided
div.	divided, -ision	mot.	mottled	unfossil.	unfossiliferous
		mudst.	mudstone		

up.	upper	vole.	volcanic	x-lam.	cross-laminated
varieg.	variegated	weath.	weather, -ed, -ing	x-strat.	cross-stratified
vert.	vertical, -ly	wh.	white	xtall.	crystalline
viol.	violet	x-bed.	cross-bedded, -ing	ylw.	yellow

#### ABO FORMATION-L. Permian (Wolfcampian-Leonardian)

(1) C New Mexico. (2) W. T. Lee, 1909, U.S.G.S. Bull. 389. (3) Abo Canyon, S end of Manzano Mts., Valencia and Torrance Cos., New Mexico, type sec. desig. and descr. by C. E. Needham and R. L. Bates, 1943, G.S.A. Bull., v. 54, p. 1654-1657: base 1 mi. NW of Scholle, top 2 mi. WNW of Abo. (4) About 60 percent red sh. and 40 percent dk. red to purp. cse-gr. ss., ark., with cgl. at base (915' at type loc.; ranges 0-1,400'). (5) Formerly called Abo Ss. or Abo redbeds. Conf. and gradat. on Bursum Fm. or disconf. on up. Madera Ls.; overlain conf. and gradat. by Yeso Fm. (Meseta Blanca Mem.).

#### ADMIRAL FORMATION OR GROUP-L. Permian (Wolfcampian)

(1) C, N-C, and W-C Texas. (2) F. B. Plummer and R. C. Moore, 1922, Univ. Texas Bull. 2132, p. 192-195. (3) Admiral, Callahan Co., Texas. (4) 270'-350'. (5) Formerly, basal fm. in Wichita Gr.; rank later raised to Admiral Gr.

#### AKAH SUBSTAGE (of Four Corners Stage of Paradox Fm. of Hermosa Gr.)-M. Pennsylvanian (Desmoinesian)

(1) Four Corners region. (2) W. J. Malin, 1958, I ntermt. Assoc. Pet. Geol. 9th Gdbk., p. 135. (3) Akah (N Boundary Butte) field, SE Utah; Shell No. 1 Hovenweep well, sec. 5, T. 40 S., R. 26 E., San Juan Co., Utah. (4) I nterb. algal mounds and thin gry. sh. pass lat. into thick anhyd. and salt; mounds dol. and anhyd. infill. (5) Overlies Barker Creek Substage; overlain by Desert Creek Substage. Also called Akah zone, cycle, and fm. D. L. Baars, J. W. Parker, and J. Chronic, 1967, A.A.P.G., Bull., v. 51, p. 393-403 prop. that units (ascend.) Barker Creek, Akah, Desert Creek, and Ismay (formerly pay zones) be called substages of Four Corners Stage. Akah Fm., of S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 159-164, incl. cycles 6-10.

#### ALDER GROUP-Precambrian

(1) C Arizona. (2) E. D. Wilson, 1937, G.S.A. Proc. 1936, p. 112 (abs.); 1939, G.S.A. Bull., v. 50, p. 1118-1123. (3) Vicinity of Alder Creek, Mazatzal Range, Jerome area, Arizona. (4) Metam. sh., grit, qtzite, and cob. cgl. (5,000'+). (5) Orig. called Alder sed. series in Yavapai Gr.; later called a fm.; rank later raised to Alder Gr. by C. A. Anderson and C. S. Creasey, 1958, U.S.G.S. P.P. 308, p. 9, 20-22; subdiv. into six fms.; thickness est. 20,000'-30,000'.

#### ALI BABA MEMBER (of Moenkopi Fm.)-L. Triassic

(1) SW Colorado and SE Utah. (2) E. M. Shoemaker and W. L. Newman, 1959, A.A.P.G. Bull., v. 43, p. 1840-1846. (3) All Baba Ridge, E side Sinbad Valley, sec. 15, T. 49 N., R. 19 W., Mesa Co., Colorado. (4) I nterb. red-br. cgl., ark., ss., silty sh., and thin beds ss. (0-290'). (5) Unconf. on Tenderfoot Mem.; overlapped by Sewemup and Pariott Mem.

#### ALKALI GULCH CYCLE (of Paradox Fm. of Hermosa Gr.) or FORMATION (of Paradox Gr.)-M. Pennsylvanian (Desmoinesian)

(1) Paradox basin, SE Utah. (2) J. A. Peterson and H. R. Ohlen, 1963, Four Cor. Geol. Soc. 4th Gdbk., fig. 5, p. 71. (3) Subsurf., Aneth area to Lisbon area, Paradox basin. (4) Ls., dol., sh., ss., anhyd., salt (110'). (5) Overlies Pinkerton Trail Fm.; overlain by Barker Creek Substage of Four Corners Stage. Orig. called a cycle by Peterson and Ohlen, 1963; has been called a zone; ref. to as a fm., incl. cycles 20-24, by S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 159-164. But not incl. in Four Corners Stage by D. L. Baars, J. W. Parker, and J. Chronic, 1967, A.A.P.G. Bull., v. 51, p. 393-403.

#### ALLISON MEMBER (of Menefee Fm.)-U. Cretaceous (Montanan)

(1) NW New Mexico. (2) J. D. Sears, 1925, U.S.G.S. Bull. 767, p. 18. (3) Near village of Allison, McKinley Co., New Mexico. (4) Lt. gry. to wh. lent. ss. interb. with gry. sh. and thin coal seams (0-800'+). (5) Conf. on up. Gibson Coal Mem. (Cleary Coal Mem.); overlain conf. by Cliff House Ss. Formerly called Allison Barren Mem. of Mesaverde Fm. E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2156-2157, reallocated Allison to mem. status in Menefee Fm.

#### ANETH FORMATION-U. Devonian

(1) Four Corners region-subsurf. only. (2) R. L. Knight and J. C. Cooper, 1955, Four Cor. Geol. Soc. 1st Gdbk., p. 56-58. (3) Aneth field: Shell Bluff No. 1, sec. 32, T. 39 S., R. 22 E., near Blanding, Utah; between 8161' and 8331'. (4) Dk. resinous ls. and dol. interb. gry., br., and blk. sh., and gry. siltst. (0-170'). (5) Unconf. on Ophir Fm. or Lynch Dol.; overlain by McCracken Ss. Mem. of Elbert Fm.

#### ANIMAS FORMATION-U. Cretaceous-Paleocene

(1) SW Colorado and NW New Mexico. (2) C. W. Cross, 1896, U.S.G.S. Mon. 27, p. 217-219; J. H. Gardner, 1917, U.S.G.S. P.P. 101, p. 185-186. (3) Animas River below Durango, La Plata Co., Colorado. (4) Low. pt.: ss. and cgl.; up. pt.: soft ss. and clay (1,200'-3,000'). (5) Conf. on Fruitland Fm.; overlain by Nacimiento Fm. J. B. Reeside, Jr., 1924, U.S.G.S. P.P. 134, div. seq. into (ascend.) McDermott Fm. and Animas Fm. Later, the McDermott was made a mem. of Animas Fm. by H. Barnes, E. H. Baltz, Jr., and P. T. Hayes, 1954, U.S.G.S. Oil and Gas Inv. Prel. Map OM-149. Note.-Not to be confused with Animas Clays (Quaternary) of SW New Mexico.

### **AUBREY GROUP-Pennsylvanian-Permian**

(1) N Arizona, S Utah, and SE Nevada. (2) G. K. Gilbert, 1875, U.S. Geol. and Geog. Surv. W 100th Mer., v. 3, p. 176-185, 197. (3) Aubrey Cliff, near Camp Apache, Arizona. (4) Incl. (ascend.): Supai Fm., Hermit Sh., Coconino Ss., Toroweap Fm., and Kaibab Ls. (5) Overlies Redwall Ls.; overlain by Moenkopi Fm. Note.-Older names, such as Aubrey Ls., Aubrey Ss., and Aubreyan Series, are abandoned.

### **BARKER CREEK SUBSTAGE (of Four Corners Stage of Paradox Fm. of Hermosa Gr.)-M. Pennsylvanian (Desmoinesian)**

(1) Four Corners region. (2) D. L. Baars, J. W. Parker, and J. Chronic, 1967, A.A.P.G. Bull, v. 51, p. 393-403. (3) Shell No. 1 Hovenweep well, sec. 5, T. 40 S., R. 26 E., San Juan Co., Utah. (4) Lowest substage of the Four Corners Stage. (5) Overlies Alkali Gulch Cycle; overlain by Akah Substage. Also called Barker Creek zone, pay zone, cycle, and fm. The Barker Creek Fm. of S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 159-164, incl. cycles 11-19.

### **BARTLETT BARREN MEMBER (of Crevasse Canyon Fm.)U. Cretaceous**

(1) NW New Mexico. (2) J. D. Sears, 1925, U.S.G.S. Bull. 767, p. 17. (3) Near old Bartlett mine shaft near Dilco, McKinley Co., New Mexico. (4) Lt. gry. to wh. ss., gry. sh., and thin coal seams (330'-400'). (5) Conf. on Dilco Coal Mem.; overlain conf. by low. Gibson Coal Mem. Formerly a mem. of Mesaverde Fm. E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2153-2157, reallocated to Crevasse Canyon Fm.

### **BIDAHOCHI FORMATIONPliocene**

(1) NE Arizona and NW New Mexico. (2) A. B. Reagan, 1924, Pan-Am. Geol., v. 41, p. 357, 366. (3) Type loc. not desig., prob. 15-20 mi. N and E of Bidahochi, near Twin Buttes, Arizona. Ref. sec.: Pueblo Colorado Wash, 15 mi. E of Bidahochi. (4) Clayst., siltst., rhy. ash. aggl., and basalt flows (0-1,000'). (5) Overlies Mesozoic and Permian rocks. Roughly equiv. to Chuska Ss. and Santa Fe Fm. C. A. Repenning and J. H. Irwin, 1954, A.A.P.G. Bull., v. 38, p. 1821-1826, recog. three mems.; overlies unconf. Wingate Ss. Six mems. mapped by E. M. Shoemaker, F. S. Hensley, and R. W. Hallagan, 1957, U.S.G.S. TEI Rept. 690, p. 389-398.

### **BLACK CREEK MEMBER (of De Chelly Ss.)L. Permian (Leonardian)**

(1) NE Arizona. (2) H. W. Peirce, 1964, Mus. North. Arizona Bull. 40, p. 15-32. (3) Black Creek, Defiance Plateau, Apache Co., Arizona. (4) Pale buff, gry., pk. qtz ss., cliff-form.; eolian x-bed. and horiz.-strat. water-dep. (0-225'). (5) Conf. on and gradat. with White House Mem.; overlain unconf. by Shinarump Conglomerate Mem. of Chinle Fm. or conf. by Fort Defiance Mem. of De Chelly Ss. Lengthy disc. by H. W. Peirce, 1967, N.M.G.S. 18th Gdbk., p. 57-62, of the five members of De Chelly Ss.; suggests that Black Creek Mem. equiv. to up. DeChelly of Read and Wanek (1961) and to Glorieta of Baars (1962). Note.-Not be confused with Black Creek Fm. (U. Cretaceous) of South Carolina and North Carolina.

### **BLUFF SANDSTONE (of San Rafael Gr.)U. Jurassic**

(1) Four Corners region. (2) A. A. Baker, C. H. Dane, and J. B. Reeside, Jr., 1936, U.S.G.S. P.P. 183, p. 21. (3) Cap rock of cliffs at Bluff, San Juan Co., Utah. (4) Mass. x-bed. gry. to buff, well-sort. ss., minor mudst. lenses (0-350'). (5) Formerly Bluff Ss. Mem. of Morrison Fm. Conf. on and gradat. with Summerville Fm.; gradat. with Cow Springs Ss.; conf. and grad. with Salt Wash Mem. of Morrison Fm. Overlain by Recapture Mem. Is SW lateral eolian equiv. of Summerville and Cow Springs.

### **BRIGHT ANGEL SHALE (of Tonto Gr.)M. Cambrian**

(1) N Arizona (and Four Corners region), SE California, S Nevada. (2) L. F. Noble, 1914, U.S.G.S. Bull. 549. (3) Bright Angel Canyon, Coconino Co., Arizona. (4) Soft grn. mic. foss. ss. and sh.; br. xtall. loc. (325' at type loc.; 25'-375'). (5) Conf. on Tapeats Ss.; overlain conf. by Muav Ls.; intertongues with Muav to W. H. E. Wheeler and E. M. Beesley, 1948, G.S.A. Bull., v. 59, p. 75-78, prop. term Bright Angel Gr. for strata ranging in age from Precambrian in SE California to M. Cambrian in Arizona. Name Bright Angel preferred to Ophir in Four Corners region by A. J. Loleit, 1963, Four Cor. Geol. Soc. 4th Gdbk., p. 21-30.

### **BRUSHY BASIN SHALE MEMBER (of Morrison Fm.)U. Jurassic**

(1) Four Corners region. (2) H. E. Gregory, 1938, U.S.G.S. P.P. 188, p. 59, pl. 15. (3) Brushy Basin, near Blanding, San Juan Co., Utah. (4) Band. varieg. gry., grn., and red sh.; thin ls., ss., and cgl.; mudst. and clayst., in pt. bent. (0-470'; 600'+ at Vernal, Utah). (5) Upper mem. of Morrison Fm. Conf. on and gradat. with Westwater Canyon Mem.; overlain conf. by Burro Canyon Fm. (Cedar Mountain Fm.) or disconf. by Dakota Ss.

### **BURRO CANYON FORMATIONL. Cretaceous**

(1) Four Corners region. (2) W. L. Stokes and D. A. Phoenix, 1948, U.S.G.S. Oil and Gas Inv. Prel. Map 93. (3) Burro Canyon, sec. 29, T. 44 N., R. 18W., near Dolores River, San Miguel Co., Colorado. (4) Varieg. cgl., ss., ls., sh., and chert (0-260'). (5) Unconf. on Morrison Fm.; overlain unconf. by Dakota Ss. R. G. Young, 1960, A.A.P.G. Bull., v. 44, p. 157-158, prop. name be dropped and older name Cedar Mountain Fm. be used.

### **CARLILE SHALE MEMBER (of Mancos Sh.)U. Cretaceous (Coloradoan)**

(1) NW New Mexico. (2) G. K. Gilbert, 1896, U.S.G.S. 17th Ann. Rept., pt. 2, p. 565. (3) Type loc. for Carlile Shale: Carlile Spring and Carlile Station, 21 mi. W of Pueblo, Colorado. (4) In type area: med. gry. sh.; some ls. or ss. at top (175'-200'). In Rio Arriba Co., New Mexico, Carlile Shale Mem. of Mancos Sh. incl. lower 200' of dk. to blk. sh. cont. basal bent. clay beds and abundant large septarian concr.; upper 400' of dk. to blk. sh., weath. lt. br.-gry. with numerous beds dk. platy sdy. ls. or cal. ss.; total 600' at

El Vado, New Mexico-C. H. Dane, 1948, U.S.G.S. Oil and Gas Inv. Prel. Map 78. (5) Conf. on Greenhorn Mem.; overlain conf. by Niobrara Mem. See also Juana Lopez Mem. of Mancos Sh.

#### CARMEL FORMATION (of San Rafael Gr.)-M.-U. Jurassic

(1) Four Corners region. (2) J. Gilluly and J. B. Reeside, Jr., 1926, U.S.G.S. Press Bull. 6064; 1928, P.P. 150-D, p. 73-76. (3) Mount Carmel, W Kane Co., Utah. (4) Red-br., red-oran., and buff ss. and fiss. siltst., red and grn. sh., thick gyp.; loc. basal gry. ls. (35'-650'). (5) Basal fm. of San Rafael Gr. Unconf. in places on and intertongues in places with Navajo Ss.; overlain conf. by Entrada Ss.

#### CEDAR MESA SANDSTONE (of Cutler Gr.) or CEDAR MESA SANDSTONE MEMBER (of Cutler Fm.)-L. Permian (Wolfcampian)

(1) SE and E-C Utah. (2) A. A. Baker and J. B. Reeside, Jr., 1929, A.A.P.G. Bull., v.13, p. 1420-1446. (3) Cedar Mesa, San Juan Co., Utah, on San Juan River, W of Mexican Hat (Bluff P. 0.). (4) Mass. wh., gry., br., oran.-br. x-bed. ss., thin sh., ls., anhyd., and gyp.; also buff ss. and interb. red-br. siltst. (0-1,200'). (5) Overlies Halgaito Tongue; in some areas overlies Rico Fm.; overlain by Organ Rock Tongue. Raised from mem. to fm. rank in Cutler Gr. by S. A. Wengerd and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2054-2055.

#### CEDAR MOUNTAIN FORMATION (of Dakota Gr.)-L. Cretaceous

(1) C Utah and NW Colorado; Four Corners region. (2) W. L. Stokes, 1944, G.S.A. Bull., v. 55, p. 951-992. (3) SW flank, Cedar Mountain, N end of San Rafael Swell, just N of Buckhorn Reservoir, Emery Co., Utah. (4) Varieg. mudst. and cgl. (272' at type loc.; 0-550'+). (5) Overlies Brushy Basin Shale Mem. of Morrison Fm.; overlain by Naturita Fm. Has been called Cedar Mountain Sh. and lower fm. of Dakota Gr. Equiv. of Burro Canyon Fm.; R. G. Young, 1960, A.A.P.G. Bull., v. 44, p. 156-194, prefers name Cedar Mountain to Burro Canyon.

#### CHETOH FORMATION-L. Miocene-L. Pliocene

(1) NE Arizona and NW New Mexico. (2) P. W. Howell, 1959, Dissert. Abs., v. 20, no. 2, p. 641. (3) Chetoh country, a sec. of Colorado Plateau N of Little Colorado River, ext. from Zuni uplift to Painted Desert. (4) Sand and silt, lenses of wh. rhy. ash (now montmorillonite). (5) Overlies Zuni pebble zone; overlain by Bidahochi Fm.

#### CHINLE FORMATION (of Dockum Gr.)-U. Triassic

(1) Four Corners region to SE Nevada. (2) H. E. Gregory, 1915, A.J.S., 4th, v. 40, p. 102. (3) Chinle Valley, NE Arizona. (4) Varieg. sh. and aren. sh., ss., siltst., thin ls. cgl. (400'-1,500'). Sil. wood abund. (5) Unconf. on Moenkopi Fm.; overlain conf. by Wingate Ss. Many subdiv. have been attempted. J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 441-462, prop. for SE Utah seven moms. (ascend.): Temple Mountain, Shinarump, Monitor Butte, Moss Back, Petrified Forest, Owl Rock, and Church Rock. Some of these are missing in certain areas. Voluminous literature.

#### CHUAR GROUP (of Grand Canyon Series) Precambrian

(1) N Arizona. (2) C. D. Walcott, 1883, A.J.S., v. 26, p. 439-442, 484. (3) Chuar Valley, Grand Canyon, Arizona. (4) Sdy. and clay sh., interb. ss. and ls. (0-5,100'+). (5) Unconf. on Unkar Gr.; overlain unconf. by M. Cambrian Tonto Gr. This is the upper group of the Grand Canyon Series. C. E. Van Gundy, 1941, G.S.A. Bull., v. 62, p. 953-954, reassigned lower mem. to Nankoweap Gr., so that Chuar Gr. overlies disconf. Nankoweap Gr.

#### CHURCH ROCK MEMBER (of Chinle Fm.)-U. Triassic

(1) NE Arizona, SE Utah, and SW Colorado. (2) J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 448, 459-461. (3) Church Rock, near Monticello, Utah; Monument Valley, Arizona. (4) Pale red-br. and lt. br. to red-oran. x-bed. sdy. siltst.; also red to grn. ss. (0-400'). (5) Described in SE Utah but named for exposures in Monument Valley, Arizona. Conf. on Owl Rock Mem. in most of SE Utah; unconf. on Moenkopi Fm. in Moab area. Overlain disconf. by Wingate Ss. But note that in a large part of Arizona, the Church Rock Mem. is the same as the Rock Point Mem. of the Wingate Ss., acc. to J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291. However, I. J. Witkind and R. E. Thaden, 1963, U.S.G.S. Bull. 1103, think that intertonguing between Owl Rock and Church Rock Mem. in Arizona confirms concept that the Church Rock is an integral part of the Chinle Fm.

#### CHUSKA SANDSTONE-Tertiary

(1) NW New Mexico and NE Arizona. (2) H. E. Gregory, 1916, U.S.G.S. W-S P. 380. (3) Chuska Peak, McKinley Co., New Mexico. (4) Mass. wh. to gry. x-bed. ss.; thin basal cgl. (700'-1,800'). (5) Forms cap rock of Chuska Mts. Overlies with ang. unconf. fms. ranging from Summerville to Tohatchi Fm. of Mesaverde Gr. Overlain unconf. by vole. rocks formerly believed to be of Pliocene age, now dated 31 m.y. Chuska Ss. may be late Eocene-early Oligocene. Has been correl. with low. mem. of Bidahochi Fm. See J. T. Hack, 1942, G.S.A. Bull., v. 53, p. 350; C. A. Repenning, J. F. Lance, and J. H. Irwin, 1958, N.M.G.S. 9th Gdbk., p. 123-129; and J. W. Blagbrough, 1967, N.M.G.S. 18th Gdbk., p. 70-77.

#### CLEAR FORK GROUP-L. Permian (Leonardian)

(1) Texas. (2) E. T. Dumble and W. F. Cummins, 1890, Texas Geol. Surv. 1st Ann. Rept., p. 188. (3) Prob. named for Clear Fork of Brazos River, Jones and Shackelford Cos., Texas.

#### CLEARY COAL MEMBER (of Menefee Fm.)-U. Cretaceous

(1) NW New Mexico. (2) E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2149, 2157. (3) Cleary mine,

sec. 31, T. 19 N., R. 1 W., 2 mi. NW of La Ventana, Sandoval Co., New Mexico. (4) Interb. lt. gry. to buff ss., dk. gry. sh., with comm. coal (250'-300'). (5) Conf. on Point Lookout Ss., Hosta Tongue, or Gibson Coal Mem.; overlain conf. by Allison Barren Mem. This unit replaces up. pt. of Gibson Coal Mem. of Mesaverde Fm.

#### CLIFF HOUSE SANDSTONE (of Mesaverde Gr.)-U. Cretaceous

(1) SW Colorado and NW New Mexico. (2) A. J. Collier, 1919, U.S.G.S. Bull. 691-K, p. 297. (3) In canyons above cliff houses of Mesa Verde Nat. Park, Montezuma Co., Colorado. (4) Lt. gry., buff, br. thin-bed. to mass. ss., with shale ptgs. (0-800'). (5) Overlies and intertongues with Menefee Fm. Underlies and intertongues with Lewis Sh. Name replaces Chacra Ss. in San Juan Basin, New Mexico. P. T. Hayes and A. D. Zapp, 1955, U.S.G.S. Oil and Gas Inv. Map OM-144. See E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2158-2159.

#### COCONINO SANDSTONE (of Aubrey Gr.)-L. Permian (Leonardian)

(1) Arizona, S Utah, and SE Nevada. (2) N. H. Darton, 1910, U.S.G.S. Bull. 435, p. 21, 27. (3) Aubrey Cliffs, Coconino Plateau, Coconino Co., Arizona. (4) Wh. to gry. x-bed. ss. (50'-1,000'). (5) Conf. on and gradat. with Hermit Sh. and Rico Fm.; overlain conf. by Toroweap Fm. Grad. into De Chelly Ss.

#### COLORADO GROUP-U. Cretaceous (in most places)

(1) Colorado, New Mexico, and Great Plains. (2) F. V. Hayden, 1876, U.S. Geol. and Geog. Surv. Terr. 8th Ann. Rept., p. 45. (3) Exp. along E base of Colorado or Front Range, Colorado. (4) Incl. (ascend.): Graneros, Greenhorn, Carlile, and Niobrara Fms. (5) Overlies Dakota; overlain by Montana Gr. "Coloradoan" is a useful time term.

#### COW SPRINGS SANDSTONE-U. Jurassic

(1) Four Corners region. (2) E. D. McKee in C. R. Longwell, 1949, G.S.A. Mem. 39, p. 46; name cred. to J. W. Harshbarger; see J. W. Harshbarger, C. A. Repenning, and R. L. Jackson, 1951, N.M.G.S. 2d Gdbk., p. 97-98. (3) In cliff along N face of Black Mesa, 4 mi. E of Cow Springs Trading Post, along Reserv. Highway 3, Coconino Co., Arizona. (4) Grn.-gry. to ylw.-gry., fi.-gr., well-sort., x-bed. ss. (342'; range 0-450'). (5) Disconf. on Entrada Ss.; conf. on and gradat. with Summerville Fm.; overlain disconf. by Dakota Ss. May be in pt. equiv. of Summerville Fm., Bluff Ss., and Recapture Sh. Mem. of Morrison Fm.

#### CREVASSE CANYON FORMATION (of Mesaverde Gr.)-U. Cretaceous

(1) NW New Mexico. (2) J. E. Allen and R. Balk, 1954, N.M.B.M.M.R. Bull. 36, p. 91-92. (3) On a N fork of Catron Creek, 3 mi. SW of mouth of Crevasse Canyon, Tohatchi quad., San Juan Co., New Mexico. (4) Interb. sh., siltst., coal, and thin buff ss. (420'-700'). (5) Conf. on Gallup Ss.; overlain conf. by Point Lookout Ss. Incl. three mems. (ascend.): Dilco Coal, Dalton Ss., and Gibson Coal.

#### CURTIS FORMATION (of San Rafael Gr.)-U. Jurassic

(1) SE and C Utah and W Colorado. (2) J. Gilluly and J. B. Reeside, Jr., 1926, U.S.G.S. Press Bull. 6064. (3) Curtis Point, near head of Cottonwood Springs Wash, on NE side of San Rafael Swell, Utah. (4) Gry.-grn., glauc., cal., fossil., x-bed. ss. with basal cgl., grn. sh. (type loc.: 193'; 76'-253'). (5) Disconf. or unconf. on Entrada Ss.; overlain conf. by and gradat. with Summerville Fm. J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, consid. lower Summerville the S equiv. of Curtis Fm.

#### CUTLER FORMATION or GROUP-Pennsylvanian Permian

(1) Four Corners region. (2) C. W. Cross and E. Howe, 1905, U.S.G.S. Silverton Folio 120. (3) On Cutler Creek, which enters Uncompahgre River 4 mi. N of Ouray, Ouray Co., Colorado. (4) Red-br. ark. siltst. and ss. redbed tongues with lt., fi.-gr. x-strat. ss. members; sdy. sh. and ls. (0-8,000'). (5) Overlies Rico Fm.; overlain by Moenkopi Fm. Approved as a fm. by U.S.G.S. but S. A. Wengert and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2054-2055 raised rank to gr. In Monument Valley, J. H. Stewart, 1959, A.A.P.G. Bull., v. 43, p. 1854-1857, descr. mems. (ascend.): Halgaito (400'), Cedar Mesa Ss. (800'), Organ Rock (500'), and De Chelly Ss. (300'). Fm. restr. to exclude the Hoskinnini Mem., now reallocated to Moenkopi Fm. For lengthy disc., see D. L. Baars, 1962, A.A.P.G. Bull., v. 46, p. 149-218.

#### DAKOTA SANDSTONE, FORMATION, or GROUP-L. to lower U. Cretaceous

(1) Nebraska, Great Plains, and Four Corners region. (2) F. B. Meek and F. V. Hayden, 1862, Phila. Acad. Nat. Sci. Proc., v. 13, p. 419-420. (3) Type loc. for fm.: Missouri River bluffs of Dakota Co., Nebraska. Type loc. for gr.: 2 mi. N of Bellevue, Larimer Co., Colorado (W. T. Lee, 1927). (4) At many loc.: ylw., buff, br., red, and wh. ss. interb. with varieg. clays, gry. sh., and lignite; also mass. qtz ss., sil. cem. (0-350'). In Black Mesa country, three mems. (ascend.): ss., carbonac. mem., ss. (ay. 80'; max. 119'). (5) Unconf. on Morrison Fm. or L. Cretaceous rocks; overlain conf. or disconf. by Mancos Sh. Incl. Cedar Mountain (Burro Canyon) and Naturita Fms. Voluminous literature; see U.S.G.S. Bull. 1200, p. 1028-1037.

#### DALTON SANDSTONE MEMBER (of Crevasse Canyon Fm.)-U. Cretaceous

(1) NW New Mexico. (2) J. D. Sears, 1934, U.S.G.S. Bull. 860-A. (3) Dalton Pass near Gallup, McKinley Co., New Mexico. (4) Two mass. ss.; low. pt. oran.-pk., cse.- to fi.-gr., well-sort. qtz grs. in clay matrix; up. pt. gry.-wh. to gry.-oran., cse.- to med.-gr., well-sort. qtz and feld. grs. in clay matrix; x-lam. (180'). (5) Overlies Mulatto Tongue of Mancos Sh., or Dilco Coal Mem.; overlain by low. Gibson Mem. Orig. a member of Mesaverde Fm., reallocated by J. E. Allen and R. Balk, 1954, N.M.B.M.M.R. Bull. 36, p. 90-93, to mem. status in Crevasse Canyon Fm. Loc. equiv. of Bartlett Barren Mem. Note.—Not to be confused with the Dalton Fm. (L. Cambrian) of New England.

**DE CHELLY SANDSTONE MEMBER (of Cutler Fm.) or DE CHELLY SANDSTONE (of Cutler Gr.)—L. Permian (Leonardian)**

(1) NE Arizona, SE Utah, NW New Mexico. (2) H. E. Gregory, 1915, A.J.S., 4th, v. 40, p. 102. (3) Canyon de Chelly, Apache Co., Arizona. (4) Mass. x-bed., lt. red, buff, and br. ss. and cgl. (0-1,000'). Pale br.-red, tan, oran., even-gr. cse. x-bed. ss. with a few sh. (300'-800'). (5) Orig. a mem. of the Cutler Fm.; raised to fm. rank by J. A. Momper, 1957, Four Cor. Geol. Soc. 2d Gdbk., p. 90. In Monument Valley, overlies the Organ Rock Tongue; in places overlies Supai Fm.; overlain by Hoskinnini Mem. of Moenkopi Fm. In pt., equiv. to Supai Fm. and Coconino Ss. Prob. equiv. of White Rim Ss. in Utah and of Meseta Blanca Ss. Mem. of Yeso Fm. in New Mexico. In type area, H. W. Peirce, 1964, N.M.G.S. 18th Gdbk., p. 57-62, recog. five mems. (ascend.): Hunters Point, Oak Springs Cliffs, White House, Black Creek, and Fort Defiance (all not present at some lots.).

**DESERT CREEK SUBSTAGE (of Four Corners Stage of Paradox Fm. of Hermosa Gr.)—M. Pennsylvanian (Desmoinesian)**

(1) Four Corners region. (2) D. L. Baars, J. W. Parker, and J. Chronic, 1967, A.A.P.G. Bull., v. 51, p. 393-403. (3) Shell No. 1 Hovenweep well, San Juan Co., Utah. (4) Low. cal. pt.: algal-mound ls. and anhyd.; up. pt. interb. ool. ls. and dol. (5) Conf. on Akah Substage; overlain conf. by Ismay Substage. Has been called a zone, pay zone, cycle, and fm. Incl. cycles 4-5 of S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 159-164.

**DEZA FORMATION—Miocene(?)**

(1) NW New Mexico and NE Arizona. (2) H. E. Wright, Jr., 1954, A.A.P.G. Bull., v. 38, p. 1831-1833. (3) Deza Bluff, up to E foot slope of Chuska Mt., 3 mi. N of Tohatchi, New Mexico. (4) Thin-bed. wh.-buff-grn. ss. interb. with choco.-red sh., sdy. cgl. (0-250'). (5) Formerly low. pt. of Chuska Ss. Unconf. on Tohachi Fm.; conf. and gradat. with Chuska Ss. Rejected by C. A. Repenning, J. F. Lance, and J. H. Irwin, 1958, N.M.G.S. 9th Gdbk., p. 123-129, because of poor exp. and because the Deza-Chuska contact is difficult to map.

**DILCO COAL MEMBER (of Crevasse Canyon Fm.)—U. Cretaceous**

(1) NW New Mexico. (2) J. D. Sears, 1925, U.S.G.S. Bull. 767. (3) Dilco Village and mine, McKinley Co., New Mexico. (4) Lt. gry. silty sh., lam. siltst., thin coal, gry. to wh. thin- to med.-bed., fi.-gr. ss. (240'-300'). Thins Sward. (5) Conf. on Gallup Ss.; overlain conf. by Bartlett Barren Mem., or Mulatto Tongue of Mancos Sh., or Dalton Ss. Formerly a mem. of Mesaverde Fm.; reallocated to mem. status in Crevasse Canyon Fm. by J. E. Allen and R. Balk, 1954, N.M.B.M.M.R. Bull. 36, p. 90-92.

**DINOSAUR CANYON SANDSTONE MEMBER (of Moenave Fm.)—U. Triassic(?)**

(1) NE Arizona and S Utah. (2) E. H. Colbert and C. C. Mook, 1951, Am. Mus. Nat. Hist. Bull., v. 97, art. 3, p. 151-153. (3) Dinosaur Canyon, 10 mi. E of Cameron, Arizona. Completely exp. in cliffs of Kachina Point, 40 mi. NW of Winslow, Navajo Co., Arizona. (4) Lent. oran.-red and gry. silty ss. (202'; 321' at Kachina Point; 28' at Piute Canyon). (5) Overlies Chinle Fm.; overlain by so-called "Wingate" or Springdale Sandstone Mem. of Moenave Fm. See P. Averitt et al., 1955, A.A.P.G. Bull., v. 39, p. 2517-2519; J. W. Harshbarger et al., 1957, U.S.G.S. P.P. 291, p. 3, 13-16, 63.

**DOLORES FORMATION—Triassic-Jurassic(?); U. Triassic (U.S.G.S.)**

(1) SW Colorado. (2) C. W. Cross, 1899, U.S.G.S. Telluride Folio 57. (3) Exp. in valley of Dolores River, SW Colorado. (4) Red ss. and cgl.; red siltst., ss., sh., a few thin ls.-peb. cgl. beds (800'±). Unconf. on Cutler Fm.; overlain unconf. by Entrada Ss. Prob. equiv. of Moenkopi, Shinarump, Chinle, Wingate, and Kayenta. Name now largely aband.

**DRIPPING SPRING QUARTZITE (of Apache Gr.)—Precambrian**

(1) SE Arizona. (2) F. L. Ransome, 1903, U.S.G.S. P.P. 12. (3) Dripping Spring Mts., Globe quad., Arizona. (4) Low. 175': mass. buff and pk. qtzite; upper 225': thinner-bed., hard, lam., rusty-col. qtzite; total 400'. (450'-700' in Sierra Ancha area and 820' in Superior area.) (5) Overlies Barnes Cgl.; overlain by Mescal Ls. But Barnes Cgl. may be a mem. of the Dripping Spring Qtzite. See H. C. Granger and R. B. Raup, 1959, U.S.G.S. Bull. 1046-P, p. 422-424. Note.—Not to be confused with the Pleistocene Dripping Springs Fm. of S California.

**ELBERT FORMATION—U. Devonian**

(1) SW Colorado; Four Corners region. (2) C. W. Cross, 1899, U.S.G.S. Telluride Folio 57; 1904, Al. S., 4th, v. 18, p. 245-252. (3) Elbert Creek, a W tributary of Animas River, just above Rockwood, SW Colorado. (4) Interb. sdy. dol., pastel-col. sh., glauc. ss., and qtzite (0-887'). (5) Subdiv. into (descend.): Up. mem. (0-300') and McCracken Ss. Mem. (0-580'?) by R. L. Knight and J. C. Cooper, 1955, Four Cor. Geol. Soc. 1st Gdbk. Unconf. on Ignacio Qtzite; overlain unconf. by Ouray Ls. In subsurf. of Four Corners area, overlies Aneth Fm.

**ELEPHANT CANYON FORMATION—L. Permian (Wolfcampian)**

(1) SE to E-C Utah. (2) D. L. Baars, 1961, N.M.G.S. 12th Gdbk., p. 196 (abs.); 1962, A.A.P.G. Bull., v. 46, p. 172-177. (3) Elephant Canyon, near confluence of Green and Colorado Rivers, secs. 4 and 9, T. 30 S., R. 19 E., San Juan Co., Utah. Alt. type sec.: General Petroleum 45-5-G well, sec. 5, T. 24 S., R. 15 E., Emery Co., Utah, at depth of 2,940'-4,415'. (4) Marine carb. seq., with three mems. (ascend.): (1) low. ls., ss., siltst., minor sh.; (2) red, br., purp. ss., siltst., sh. with thin ls. beds; (3) ls., dol., red siltst., lt. ss. similar to Cedar Mesa Ss. (type sec.: 1,050'; in alt. type sec.: 1,475'). (5) Grad. on Honaker Trail Fm.; grades S into Halgaito redbeds; see D. L. Baars (1962, fig. 8, p. 172-173). In Straight Wash Canyon, overlain by Coconino Ss. Recog. from underly. Pennsylvanian rocks of sim. lith. only on basis of fusulinids.

### **ENTRADA SANDSTONE (of San Rafael Gr.)—U. Jurassic**

(1) Four Corners region. (2) J. Gilluly and J. B. Reeside, Jr., 1926, U.S.G.S. Press Bull. 6064. (3) Entrada Point, in N part of San Rafael Swell, Utah. (4) Thin-bed. red-oran., red-br., and buff x-bed. ss.; mass. red-br. earthy ss. and siltst. (type loc. 312'; 35'-844'; near Circle Cliffs, Utah, 1,000. (5) Conf. on Carmel Fm. or unconf. on Navajo, Kayenta, or Wingate; conf. and gradat. with Todilto Ls.; disconf. or unconf. with Summerville; overlain conf. or unconf. by Curtis Fm. In Monument Valley, acc. to I. J. Witkind and R. E. Thaden, 1963, U.S.G.S. Bull. 1103, low. pt.: oran.-br. mass. fi.-gr. ss.; up. pt.: choco.- to red-br. even-bed. shaly siltst. and ss. In Mexican Water area, Arizona, three mems. recog. by J. W. Harshbarger et al., 1957, U.S.G.S. P.P. 291: low. sdy., medial silty, and up. sdy. mems. Many descriptions in the literature. Note.—A. A. Baker, C. H. Dane, and J. B. Reeside, Jr., 1947, A.A.P.G. Bull., v. 31, p. 1664-1668, applied name Entrada to Wingate Ss. of New Mexico—admittedly a violation of principles of priority, which would require that name Wingate be applied to unit heretofore called Entrada and would require a new name to be applied to Wingate of Utah.

### **ESPLANADE SANDSTONE MEMBER (of Supai Fm.)—L. Permian (Wolfcampian)**

(1) N Arizona. (2) D. White, 1929, Carn. Inst. Wash. Pub. 405, p. 11. (3) Grand Canyon, Arizona. (4) A group of hard ss. at top of Supai Fm., forming the shelf known as the Esplanade. (5) Overlies part of Supai Fm.; overlain by Hermit Sh.

### **FARMINGTON SANDSTONE MEMBER or TONGUE (of Kirtland Sh.)—U. Cretaceous**

(1) NW New Mexico and SW Colorado. (2) C. M. Bauer, 1916, U.S.G.S. P.P. 98-K. (3) Well-exp. near Farmington, San Juan Co., New Mexico. (4) Thin- to mass.-bed. lenses of ss. sep. by sh. and sdy. silty sh. (345'; range 0-480'). (5) This is the middle mem. of Kirtland Sh. Overlies unnamed sh. mem.; overlain by unnamed sh. mem. Pinches out S-ward in San Juan Basin. Note.—Not to be confused with Pennsylvanian Farmington Shale of Illinois.

### **FORT DEFIANCE MEMBER (of De Chelly Ss.)—Permian**

(1) NE Arizona. (2) H. W. Peirce, 1964, Mus. North. Arizona Bull. 40, p. 15-32. (3) Bonito Canyon, near Fort Defiance, Apache Co., Arizona. (4) Interb. siltst. and ss.; dark red-br. to pale red-br. ss. and siltst., small- to med.-scale x-bed., and horiz.-strat.; ripple marks (0-105'). (5) Conf. on Black Creek Mem.; overlain unconf. by Shinarump Cgl. Mem. of Chinle Fm. Disc. by H. W. Peirce, 1967, N.M.G.S. 18th Gdbk., p. 57-62. Consid. by D. L. Baars, 1962, as correl. of San Andres Ls. of New Mexico.

### **FOUR CORNERS STAGE (of Paradox Fm. of Hermosa Gr.)—M. Pennsylvanian (Desmoinesian)**

(1) Four Corners region. (2) D. L. Baars, J. W. Parker, and J. Chronic, 1967, A.A.P.G. Bull., v. 51, p. 393-403. (3) Shell No. 1 Hovenweep well, sec. 5, T. 40 S., R. 26 E., San Juan Co., Utah. (4) Prop. as a formal time-strat. unit—a subdiv. of the Desmoinesian Series. Incl. four substages (ascend.): Barker Creek, Akah, Desert Creek, and Ismay—known formerly as "pay zones." (5) Overlies Alkali Gulch Cycle or Fm.; overlain by Honaker Trail Fm.

### **FRUITLAND FORMATION—U. Cretaceous (late Montanan)**

(1) NW New Mexico and SW Colorado. (2) C. M. Bauer, U.S.G.S. P.P. 98-P. (3) Village on San Juan River, San Juan Co., New Mexico. (4) Lat. and vert. intercal. ss., sdy. sh., clay ss., and coal; horiz. iron-carb. concr. (194'-292'; 530' at N.M.-Colo. border). (5) Conf. on and intertongues with Pictured Cliffs Ss.; overlain conf. and gradat. by Kirtland Sh.

### **GALLUP SANDSTONE (of Mesaverde Gr.)—U. Cretaceous**

(1) NW New Mexico. (2) J. D. Sears, 1925, U.S.G.S. Bull. 767, p. 17. (3) Gallup, McKinley Co., New Mexico. (4) Three perst. mass. pk. or lt. gry. ss. interb. with gry. sh. and coal (0-450'). (5) Conf. on lower Mancos Sh.; overlain conf. by Crevasse Canyon Fm. Orig. prop. as a mem. of Mesaverde Fm. Raised to fm. rank by J. E. Allen and R. Balk, 1954, N.M.B.M.M.R. Bull. 36, p. 91. E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2156: Gallup Ss. replaces in its entirety the Tocito Ss. Lentil of the Mancos Sh.

### **GAME RCO FORMATION—Recent**

(1) NW New Mexico. (2) L. B. Leopold and C. T. Snyder, 1951, U.S.G.S. W-S P. 1110-A, p. 6-9. (3) In outskirts of Gallup, 300 yds. E of El Rancho Hotel; in gully wall of Rio Puerco River. Name der. from Gamerco, a suburb of Gallup, McKinley Co., New Mexico. (4) Ascend.: 1'2' of br. compact fi. gravel partly cem. with caliche; 2' of br. compact silty sand with mottling of caliche; 2' of reddish to reddish-br. silty fi. compact sand enclosing hard cal. concr. (5) Disconf. on sh. and ss. of Gibson Coal Mem. of Crevasse Canyon Fm.; overlain disconf. by Nakaibito Fm.

### **GIBSON COAL MEMBER (of Crevasse Canyon Fm.)—U. Cretaceous**

(1) NW New Mexico. (2) J. D. Sears, 1925, U.S.G.S. Bull. 767, p. 17-18. (3) Village of Gibson, McKinley Co., New Mexico. (4) Lt. gry. to wh. lent. mass. x-bed. ss. interb. with fiss. gry. sh. and comm. coal (150'-350'). (5) Conf. on Bartlett Barren Mem. or up. Dalton Ss.; overlain conf. by Allison Barren Mem. Orig. a mem. of the Mesaverde Fm.; then incl. as part of Crevasse Canyon Fm. E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2157, introd. name Cleary Coal Mem. to replace up. Gibson Coal Mem.

### **GLEN CANYON GROUP—Triassic-Jurassic**

(1) Four Corners region. (2) A. A. Baker and others, 1927, A.A.P.G. Bull., v. 11, p. 787. (3) In Glen Canyon of Colorado River, Kane Co., Utah. (4) Orig. incl. (ascend.): Wingate Ss., Todilto(?) Fm., and Navajo Ss. Now incl. (ascend.): Wingate Ss., Kayenta Fm., and Navajo Ss. In places, incl. (ascend.): Wingate Ss., Moenave Fm., Kayenta Fm., and Navajo Ss. (5) Overlies Chinle Fm.;

overlain by various units of the San Rafael Gr. See J. Gilluly and J. B. Reeside, Jr., 1928, U.S.G.S. P.P. 150-D, p. 68-73; A. A. Baker, C. H. Dane, and J. B. Reeside, Jr., 1936, U.S.G.S. P.P. 183, p. 4-6; 1947, A.A.P.G. Bull., v. 31, p. 1667-1668; J. W. Harshbarger, C. A. Reppenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291.

**GRANEROS SHALE MEMBER (of lower Mancos Sh.)-U. Cretaceous (Coloradoan)**

(1) Colorado, N New Mexico, and Great Plains. (2) G. K. Gilbert, 1896, U.S.G.S. 17th Ann. Rept., pt. 2, p. 564. (3) Graneros Creek, near Walsenburg, Pueblo Co., Colorado. (4) Gry. and blk., evenly thin-bed. sh. with ss. stringers, thin beds of bent. (100'-130'). (5) Basal mem. of Mancos Sh. Overlies Dakota Ss.; overlain by Greenhorn Ls. Mem. Graneros is lowermost mem. of Mancos Sh. in E side of San Juan Basin, Rio Arriba Co., New Mexico; C. H. Dane, 1948, U.S.G.S. Oil and Gas Inv. Prel. Map 78.

**GREENHORN LIMESTONE MEMBER (of lower Mancos Sh.)U. Cretaceous (Coloradoan)**

(1) Colorado, N New Mexico, and Great Plains. (2) G. K. Gilbert, 1896, U.S.G.S. 17th Ann. Rept., pt. 2, p. 564. (3) Named for Greenhorn Station, 14 mi. S of Pueblo, Colorado, and also for Greenhorn Creek, Pueblo and Walsenburg quads. (4) Alt. beds of lt. gry. dense ls. and marl or dk. gry. cal. sh.; thin bent. beds (40'-70'). (5) Overlies Graneros Sh. Mem.; overlain by Carlile Sh. Mem. Term applied on E side of San Juan Basin by C. H. Dane, 1948, U.S.G.S. Oil and Gas Inv. Prel. Map 78.

**HALGAITO TONGUE or MEMBER (of Cutler Fm.) or HALGAITO SHALE (of Cutler Gr.)-Pennsylvanian-Permian or L. Permian (Wolfcampian)**

(1) NE Arizona and SE Utah. (2) A. A. Baker and J. B. Reeside, Jr., 1929, A.A.P.G. Bull., v. 13, p. 1420-1446. (3) Halgaito Springs, SW of Mexican Hat, Utah, but between Lees Ferry and Kayenta, Arizona. (4) Red to red-br. and choco.-br. ss. and sdy. sh. and siltst.; some thin ls. and irreg. clay-pellet cgl. (0-465'). (5) Overlies Rico Fm.; overlain by Cedar Mesa Ss. This is the basal mem. of the Cutler Fm.; it was raised to fm. status by S. A. Wengerd and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2054. Equiv. of Elephant Canyon Fm.-see D. L. Baars, 1962, A.A.P.G. Bull., v. 46, fig. 8, p. 172-173.

**HERMIT SHALE (of Aubrey Gr.)L. Permian (Wolfcampian)**

(1) N Arizona, S Utah, and SE Nevada. (2) L. F. Noble, 1922, U.S.G.S. P.P. 131-B, p. 26, 28, 64. (3) Hermit Basin, Grand Canyon, Arizona. (4) Brick-red sdy. sh. and fi.-gr. ss. Thickness ranges 267'-317', but 700' rept. at North Grand Wash Cliffs, 933' at South Hurricane Cliffs, and 1,053' in Uinkaret Plateau. (5) Unconf. on Supai Fm.; overlain by Cocnino Ss. Equiv. of Organ Rock Sh. See E. D. Koons, 1945, G.S.A. Bull., v. 56, p. 154; A. H. McNair, 1951, A.A.P.G. Bull., v. 35, p. 515-528.

**HERMOSA FORMATION or GROUP Pennsylvanian**

(1) Four Corners region. (2) C. W. Cross and A. C. Spencer, 1899, U.S.G.S. La Plata Folio 60, p. 8. (3) Hermosa Creek, which flows into Animas River N of Durango, Colorado. Type sec.: secs. 26 and 35, T. 37 N., R. 9 W., La Plata Co., Colorado. (4) Carb. seq. with interb. sh., ss., and evap. (500-3,000' in Paradox basin; poss. 6,000-7,000' along trench bordering Uncompahgre uplift on E). (5) Overlies Molas Fm.; overlain by Cutler Gr. Rank raised from fm. to gr. by S. A. Wengerd and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2056; subdiv. into (ascend.): Pinkerton Trail, Paradox, and Honaker Trail Fms.

**HITE BED (in Church Rock Mem. of Chinle Fm.)U. Triassic**

(1) SE Utah. (2) J. H. Stewart et al., 1959, U.S.G.S. Bull. 1046-Q, p. 518-520. (3) Exp. 2 mi. S of Hite, San Juan Co., Utah. (4) Pale red and lt. grn.-gry., very fi. gr. ss., with many lenses of pale red-br. siltst. (10'-50'). (5) Occurs in up. pt. of Church Rock Mem.

**HOLBROOK SANDSTONE MEMBER (of Moenkopi Fm.)L. Triassic**

(1) E Arizona. (2) D. Hager, 1922, Min. and Oil Bull., v. 8, nos. 1-3; sec E. D. McKee, 1951, N.M.G.S. 2d Gdbk., p. 85-92. (3) In cliffs just N of r.r. between Winslow and Holbrook, Arizona. (4) Red, thin- to thick-bed., x-bed. channel ss. and siltst., mud-pellet cgl., red mudst., and clay (48'-200'). (5) Conf. or disconf. on Moqui Mem., but to E, unconf. on Permian rocks; overlain disconf. by Shinarump Mem. of Chinle Fm. This is the up. mem. of the Moenkopi in Black Mesa basin.

**HONAKER TRAIL FORMATION (of Hermosa Gr.)-Pennsylvanian-Permian (Desmoinesian-Virgilian, poss. to Wolfcampian)**

(1) Four Corners region. (2) S. A. Wengerd and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2048-2106. (3) At Honaker Trail, sec. 29, T. 41 S., R. 18 E., along San Juan Canyon, W of Mexican Hat, San Juan Co., Utah. (4) Gry. to red-gry., fi.-gr. to cse.-gr. ls. with gry. and red chert, and red-gry. to buff-gry. cal. sdy. siltst. and sh. (0-2,500'). (5) Conf. on Paradox Fm.; overlain conf. by Rico Mem. of Cutler Fm. Introd. by S. A. Wengerd and J. W. Strickland, 1954, A.A.P.G. Bull., v. 38, p. 2157-2199, to replace prey. used "Upper Hermosa." Note.-Not to be confused with Honaker Ls. or Dol. (M. Cambrian) of Appalachian region.

**HOSKINNINI MEMBER or TONGUE (of Moenkopi Fm.)L. Triassic**

(1) SE Utah and NE Arizona. (2) A. A. Baker and J. B. Reeside, Jr., 1929, A.A.P.G. Bull., v. 13, p. 1422-1446. (3) Exp. on N face of Hoskinini (Hoskinnini) Mesa, San Juan Co., Utah. Exp. in elongate area ext. from Monument Valley in Arizona to about 6 mi. SW of Moab, Utah. (4) Red-br. and wh. ss. and sdy. sh.; some interb. siltst.; nod.-weath.; basal pt. mass. (0-126'; in most areas: 50'-120'). (5) Overlies Organ Rock Tongue of Cutler in places or De Chelly Ss. of Cutler in other places. Formerly desig. a mem. or tongue of the Cutler and supposedly Permian in age. J. H. Stewart, 1959, A.A.P.G. Bull., v. 43, p. 1852-1868, sugg. that unit be correl. with Tenderfoot Mem. of Moenkopi Fm.

**HOSTA SANDSTONE TONGUE (of Point Lookout Ss. of Mesaverde Gr.)U. Cretaceous**

(1) NW New Mexico. (2) J. D. Sears, 1934, U.S.G.S. Bull. 860-A, p. 18. (3) Hosta Butte at W side of S end of Dalton Pass,

McKinley Co., New Mexico. (4) Cliff-form., lt. gry. to ylw. mass. ss. (0-250'). (5) Conf. on low. Gibson Coal Mem.; overlain conf. by up. Gibson Coal Mem. (Cleary Coal Mem.). The Hosta is a littoral ss. split by the Satan Tongue of the Mancos Sh. Acc. to W. S. Pike, "1947, G.S.A. Mem. 24, the up. Hosta is lat. equiv. of Point Lookout Ss. In rev. nomenclature of low. pt. of Mesaverde, E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2156: Point Lookout Ss. as a fm. in Mesaverde Gr. replaces Hosta Ss. Mem. where that mem. is undiv., and also replaces up. pt. of Hosta Ss. Mem. where its low. pt. is absent or is sep. from its up. pt. by tongue of Mancos Sh. Hosta Tongue of Point Lookout Ss. replaces low. pt. of Hosta Ss. Mem. where that is present.

#### **HUNTERS POINT MEMBER (of De Chelly Ss.)—Permian**

(1) NE Arizona. (2) H. W. Peirce, 1964, Mus. North. Ariz. Bull. 40, p. 15-31. (3) Prom. cliffs at Hunters Point, Defiance Plateau, Apache Co., Arizona. Also exp. at Bonito Canyon, Buell Park, Oak Springs Cliffs, and Canyon de Chelly, Arizona. (4) Pale red-br. to oran.-pk. x-bed. ss. (0-238'). (5) Conf. on Supai Fm.; overlain by Oak Springs Cliffs Mem. of De Chelly Ss. Applied to lowermost mem. of De Chelly Ss. In pt. equiv. to San Ysidro Mem. of Yeso Fm. of New Mexico; see H. W. Peirce, 1967, N.M.G.S. 18th Gdbk., p. 57-62.

#### **IGNACIO QUARTZITE—U. Cambrian**

(1) SW Colorado and subsurf. of Four Corners region. (2) C. W. Cross and A. C. Spencer, 1899, U.S.G.S. La Plata Folio 60, p. 8. (3) Ignacio Reservoir (Electra Lake), Silverton quad., La Plata Co., Colorado. (4) Qtzite and sdy. sh. (0-300'). (5) Unconf. on Precambrian rocks; overlain unconf. by Elbert Fm. Term restr. to U. Cambrian elastics in San Juan Mts. and subsurf. of Four Corners region by D. L. Baars, 1958, Intermt. Assoc. Pet. Geol. 9th Gdbk., p. 93-101. Correl. with Tapeats Ss. in Arizona and Tintic Qtzite W of Kaibab uplift and San Rafael Swell. May be younger than Cambrian in San Juan Mts. outcrops.

#### **ISMAY SUBSTAGE (of Four Corners Stage of Paradox Fm. of Hermosa Gr.)—M. Pennsylvanian (Desmoinesian)**

(1) Four Corners region. (2) W. J. Malin, 1958, Intermt. Assoc. Pet. Geol. 9th Gdbk., p. 135. (3) Ismay field, SE boundary of Utah with Colorado. Shell No. 1 Hovenweep well, sec. 5, T. 40 S., R. 26 E., San Juan Co., Utah. (4) Shelf carb.; interb. lens algal mounds, calcaren., blk. and dk. gry. sh. (5) The uppermost of four substages of the Four Corners Stage of D. L. Baars, J. W. Parker, and J. Chronic, 1967, A.A.P.G. Bull., v. 51, p. 393-403. Also called Ismay zone, pay zone, cycle, and fm. Overlies Desert Creek Substage; overlain by Honaker Trail Fm. of Hermosa Gr. Incl. cycles 1-3 of S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 159-164.

#### **JEDDITO FORMATION—Late Pleistocene**

(1) NE Arizona. (2) J. T. Hack, 1941, Geog. Rev., v. 31, p. 262-263; 1942, Harvard Univ. Peabody Mus. Am. Arch. and Ethnol. Papers, v. 35, p. 48-51. (3) Central pt. of Jeddito Valley, in stretch between Jeddito Trading Post and Awatovi, in W Navajo Co., Arizona. (4) Russet-col. sand. In low. pt. of valley it is sdy. floodplain dep; in up. pt. of valley it is prob. in places a channel dep. and in places a floodplain dep. Abund. layers of hard caliche. Capped by 2' of fairly pure and hard ls. at one loc.; more common are thin layers of sand, cem. by cal. carb. (9'). (5) Overlain by Tsegi Fm. In W Navajo country, C. B. Hunt, 1953, U.S.G.S. Bull. 996-A, p. 4, prop. boundary between Pleistocene and Recent would be at top of Jeddito Fm.

#### **JUANA LOPEZ MEMBER (of Mancos Sh.)—U. Cretaceous**

(1) N New Mexico and W Colorado. (2) C. H. Rankin, 1944, N.M.B.M.M.R. Bull. 20, p. 7, 12, 19-20. (3) In sec. 32, T. 15 N., R. 7 E., on Mesita Juana Lopez Grant, 6 mi. NW of Cerrillos, Santa Fe Co., New Mexico. (4) Very cal. thin-bed. ss. near top of Carlile Sh.; weath.br.; grad. into sh. at base (6'-10'). (5) Has been called Juana Lopez Sandstone Mem. of Carlile Sh. See C. E. Stearns, 1953, G.S.A. Bull., v. 64, p. 463, 466. In the Galisteo-Tonque area, New Mexico, the Juana Lopez Mem. of the Mancos Sh. is close approx. to Carlile-Niobrara contact and marks break between low. Mancos and mid. Mancos Sh. Equiv. of Sanostee Mem.

#### **JUNCTION CREEK SANDSTONE (of San Rafael Gr.)—U. Jurassic**

(1) SW Colorado, near La Plata Mts. (2) M. I. Goldman and A. C. Spencer, 1941, A.A.P.G. Bull., v. 25, p. 1745-1767. (3) Exp. opposite Animas City Mountain between Junction Creek and Animas River, near Durango, La Plata Co., Colorado. (4) Mass. and x-bed. wh. ss. (0-500'). (5) Overlies Wanakah Fm.; also gradat. on Summerville Fm.; overlain by Salt Wash Sandstone Mem. of Morrison Fm. Junction Creek Ss. has been reg. as a mem. of the Morrison Fm. and also as a mem. of the Wanakah Fm. It may be equiv. of Bluff Ss.

#### **KAIBAB LIMESTONE (of Aubrey Gr.)—L. Permian (Leonardian)**

(1) S Utah, N Arizona, SE Nevada, and SE California. (2) N. H. Darton, 1910, U.S.G.S. Bull. 435, p. 21-32. (3) Kaibab Gulch, 8 mi. SW of Paria, Utah. (4) Dense gry. cherty ls. (0-800'). (5) Conf. on and gradat. with Toroweap Fm.; overlain unconf. by Moenkopi Fm. Subdiv. into three mems. E. D. McKee, 1937, Carn. Inst. Wash. Year Book 36, p. 341-343; 1938, Pub. 492, p. 12, 35-61. Prob. equiv. of pt. of San Andres Ls. of New Mexico. Gen. consid. Leonardian, but up. pt. near Flagstaff, Arizona, cont. low. Guadalupean fossils.

#### **KAYENTA FORMATION (of Glen Canyon Gr.)—U. Triassic(?)**

(1) NE Arizona, S and SE Utah, SW Colorado. (2) A. A. Baker, C. H. Dane, and E. T. McKnight, 1931, U.S.G.S. Prel. Map (unnumbered). (3) In Comb Ridge, 1 mi. NE of Kayenta, Navajo Co., Arizona. (4) Pale viol. to red-purp. to red-oran., pale red, red-br., and gry. fi.-gr. ss. and sh.; local lenses of cgl. and aren. ls. (type loc.: 144'; 15'-320'; thickens SW-ward to 678' along Ward Terrace). (5) Unconf. or conf. on Wingate Ss. or conf. on Moenave Fm.; overlain gradat. by Navajo Ss. In the Carrizo Mts., bout. of Wingate Ss. occur in base of Kayenta Fm.—J. D. Strobel, Jr., 1956, U.S.G.S. Oil and Gas Inv. Map OM-160. A. A. Baker, C. H.

Dane, and J. B. Reeside, Jr., 1936, U.S.G.S. P.P. 183, applied name to beds prey. called "Todilto(?)." Formerly reg. as L. Jurassic; reassigned to U. Triassic(?) by G. E. Lewis, J. H. Irwin, and R. F. Wilson, 1961, G.S.A. Bull., v. 72, p. 1437-1440.

#### KIRTLAND SHALE.U. Cretaceous (late Montanan)

(1) NW New Mexico and SW Colorado. (2) C. M. Bauer, 1916, U.S.G.S. P.P. 98-P. (3) Exp. at Kirtland P. O., San Juan Co., New Mexico. (4) Pred. gry. sh., some blue, ylw.-grn.; friab. wh. ss.; in up. pt., br. resist. ss. (300'1,500'). (5) Conf. on and gradat. with Fruitland Fm.; overlain conf. or unconf. by McDermott Fm., Animas Fm., or Ojo Alamo Ss. J. B. Reeside, Jr., 1924, U.S.G.S. P.P. 134, recog. three mems. (descend.): up. sh., 12'-475'; mid. Farmington Ss. Mem., 20'-480'; low. sh. 271'1,031'. H. Barnes, E. H. Baltz, Jr., and P. T. Hayes, 1954, U.S.G.S. Oil and Gas Inv. Map OM-149, noted that up. sh. mem. incl. 95' of peb. ss. and sdy. sh. incl. in McDermott Fm. by Reeside.

#### LABORCITA FORMATION.Pennsylvanian Permian

(1) S-C New Mexico. (2) C. Otte, Jr., 1959, N.M.B.M.M.R. Bull. 50. (3) Near mouth of Laborcita Canyon, Otero Co., New Mexico. Gry. and red mudst., gry. ls., ss., and cgl. (type loc.: 480'; ranges to 1,000' to N). (5) Overlies Holder Fm.; overlain by Abo Fm. Prob. equiv. to Red Tanks Mem. of Madera Ls. in Lucero uplift, to Aqua Torres Fm. in Los Pinos Mts., and to Bursum Fm. in Oscura and Sacramento Mts., New Mexico.

#### LEADVILLE LIMESTONE.Mississippian

(1) Colorado and Four Corners region. (2) G. H. Eldridge, 1894, U.S.G.S. Anthracite-Crested Butte Folio 9. (3) Leadville mining district, Colorado. (4) Mass. ls. and dol., interb. sh. and chert (0-700'). (5) Unconf. on Ouray Ls.; overlain unconf. by Molas Fm. J. C. Cooper, 1955, Four Cor. Geol. Soc. 1st Gdbk., p. 63, 65, prop. up. ls. unit be called Leadville and underly. dol. be called Madison Fm. J. W. Parker and J. W. Roberts, 1963, Four Cor. Geol. Soc. 4th Gdbk., p. 31-60, sugg. using Redwall Ls. in subsurf. of Four Corners region.

#### LEONARD IAN PROVINCIAL SERIES.L. Permian

(1) W Texas, New Mexico, Oklahoma. (2) J. A. Udden, C. L. Baker, and E. Bose, 1916, Univ. Texas Bur. Econ. Geol. Tech. Bull. 44, p. 51. (3) On S face of Glass Mts. and S face of Leonard Mts., Hess Canyon quad., Brewster Co., Texas. (4) Overlies Wolfcampian Series; underlies Guadalupian Series.

#### LEWIS SHALE.U. Cretaceous (Montanan)

(1) W Colorado, NW New Mexico, Wyoming, Montana. (2) C. W. Cross and A. C. Spencer, 1899, U.S.G.S. La Plata Folio 60. (3) Exp. at Fort Lewis in La Plata Valley, T. 34 N., R. 11 W., La Plata Co., Colorado. (4) Dk. gry. to drab gry. sdy. sh., clay, ss., with thin cal. lens and concr. of ls. Well-bed. cal. sh., thin-bed. wh. to gry. ss. (0-2,000'). (5) Overlies Mesaverde Gr.; overlain by Pictured Cliffs Ss. Acc. to C. H. Dane, 1948, U.S.G.S. Oil and Gas Inv. Prel. Map 78, in E pt. of San Juan Basin, New Mexico, the Lewis Sh. overlies La Ventana Ss. Mem. of Mesaverde Fm. Acc. to P. T. Hayes and A. D. Zapp, 1955, U.S.G.S. Oil and Gas Inv. Map OM-144, the Lewis overlies and interfingers with Cliff House Ss.; overlain by and interfingers with Pictured Cliffs Ss. in Barker dome-Fruitland area., San Juan Co., New Mexico.

#### LIME RIDGE FORMATION.M. Pennsylvanian (Atokan)

(1) Four Corners region. (2) J. R. Clair, 1958, Rocky Mt. Assoc. Geol. Symposium, p. 31-46. (3) In Al Hill et al. No. 1 State, sec. 32, T. 40 S., R. 20 E., San Juan Co., Utah. On Lime Ridge anticline. (4) Varies from ool. dense fossil. ls. to interb. sh. and ls.; cherty in pt., cherts red, tan, or br.; red to gry.-grn. sh. (215'). (5) Overlies gradat. Molas Fm.; overlain unconf. by Pinkerton Trail Fm. S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 161, disc. Lime Ridge problem and sugg. that Pinkerton Trail of orig. type loc. be called Lime Ridge (incl. cycles 30-34?) and that Pinkerton Trail Fm. be moved up into basal Desmoinesian.

#### LUEDERS LIMESTONE or FORMATION (of Wichita Gr.) Permian

(1) C-N and C Texas. (2) W. E. Wrather, 1917, S.W. Assoc. Pet. Geol. Bull., v. 1, p. 94, 96. (3) Small town on Clear Fork of Brazos River, Jones Co., Texas. (4) Rank raised from fm. to gr. by M. G. Cheney, 1940, A.A.P.G. Bull., v. 24, p. 66, 94.

#### LUKACHUKAI MEMBER (of Wingate Ss.)U. Triassic

(1) Four Corners region. (2) J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, p. 10. (3) Escarpment NE of Lukachukai, Apache Co., Arizona. (4) Pale red-br., fi.-gr. ss., mass. and x-bed.; ls. lenses common (300'). (5) Disconf. on Chinle Fm. or conf. and gradat. with Rock Point Mem. of Wingate Ss.; overlain conf. by Moenave Fm. or unconf. by Kayenta Fm. Const. low. half of orig. "Wingate" as def. by Darton. Widespread in Navajo country.

#### LYNCH DOLOMITE.U. Cambrian

(1) C and E-C Utah. (2) J. Gilluly, 1932, U.S.G.S. P.P. 173. (3) Lynch Ridge, N of Ophir, Utah. (4) Lt. to dk. gry. dol. (0-1,400'). (5) Overlain by Aneth Fm. See J. C. Cooper, 1960, Four Cor. Geol. Soc. 3d Gdbk., p. 69-75.

#### MANCOS SHALE.U. Cretaceous (Coloradoan and Montanan)

(1) Four Corners region to Wyoming. (2) C. W. Cross, 1899, U.S.G.S. Telluride Folio 57. (3) Mancos Valley, near town of Mancos, SW Colorado. (4) Lt. to dk. gry. sdy. sh., ss. lenses, fossil. cal. sh., thin ls. lenses (1,200'-3,000'+). (5) Overlies Dakota; overlain by Mesaverde. The marine Mancos intertongues with the nonmarine Mesaverde in W New Mexico. Numerous named and unnamed members. Voluminous literature!

## MAZATZAL QUARTZITE-Precambrian

(1) C Arizona. (2) E. D. Wilson, 1922, Pan-Am. Geol., v. 38, p. 299-312; 1939, G.S.A. Bull., v. 50, p. 1118, 1124-1126. (3) Named for dev. in Mazatzal Range, Arizona. (4) Indurated ss., cgl. (up to bould. size), sh. (1,300'-3,800'). (5) Conf. on Maverick Sh. in places; or unconf. on Red Rock Rhyolite; overlain unconf. by Paleozoic and Tertiary beds; or faulted against Red Rock Rhyolite and overlain unconf. by Apache, Paleozoic, and Tertiary beds.

## McCRACKEN SANDSTONE MEMBER (of Elbert Fm.) U. Devonian

(1) Four Corners region. (2) R. L. Knight and J. C. Cooper, 1955, Four Cor. Geol. Soc. 1st Gdbk., p. 56-58. (3) Shell Bluff No. 1 well, sec. 32, T. 39 S., R. 23 E., on McCracken Mesa near Blanding, San Juan Co., Utah. (4) Gry. to grn. ss., fi.- to very fi.-gr., glauc., pt. dol. (at depth of 8,059' to 8,161' in type well; range 0-150', or 0-580'?). (5) Basal mem. of Elbert Fm. Unconf. on Aneth Fm. or Ignacio Qtzite; overlain by up. mem. of Elbert Fm. Orig. incl. in Ignacio.

## McDERMOTT MEMBER (of Animas Fm.) U. Cretaceous

(1) SW Colorado and NW New Mexico. (2) J. B. Reeside, Jr., 1924, U.S.G.S. P.P. 134, p. 22-25. (3) McDermott Arroyo, SW La Plata Co., Colorado. (4) Purp. ss., sh., and cgl., cont. much andesitic debris (200'-400' in Colorado, 150'-200' in San Juan Co., New Mexico; restr. to 127'). (5) Conf. or unconf. on Kirtland Fm.; overlain in New Mexico by Ojo Alamo Ss. H. Barnes, E. H. Baltz, Jr., and P. T. Hayes, 1954, U.S.G.S. Oil and Gas Inv. Map 0M-149, subdiv. Reeside's (1924) sec. of McDermott Fm. in T. 32 N., R. 11 W. as follows: lowest 95' of peb.-bearing ss. and sdy. sh. assigned to underlying Kirtland Fm.; overlying 127' of purplish beds is here termed McDermott Mem. of Animas Fm.; the top 106' is incl. in up. pt. of Animas Fm.

## MENEFEE FORMATION (of Mesaverde Gr.) U. Cretaceous

(1) SW Colorado and NW New Mexico. (2) A. J. Collier, 1919, U.S.G.S. Bull. 691-K, p. 296. (3) Menefee Mt., Mesa Verde Nat. Park, Montezuma Co., Colorado. (4) Interb. gry.-buff mass. to thin ss., gry. sh., coal seams and comm. coal (400'-1,000'). Acc. to J. E. Allen and R. Balk, 1954, N.M.B.M.M.R. Bull. 36, p. 92-95, thickness in Fort Defiance-Tohatchi quads.: 1,200'-2,290'. (5) Conf. on Point Lookout Ss. or low. Gibson Coal Mem.; overlain conf. by Cliff House Ss. Subdiv. (ascend.): Cleary Coal Mem. (equiv. of up. Gibson Coal Mem.), and Allison Barren Mem.

## MESA REDONDO MEMBER (of Chinle Fm.) U. Triassic

(1) NE Arizona. (2) M. E. Cooley, 1958, Plateau, v. 31, p. 7-15. (3) Along N side of Little Colorado River, 1-3 mi. E of Arizona Highway 260, 16 mi. NW of Concho, Arizona. Named from exp. at base of Mesa Redondo, a prom. landmark 20 mi. E of Snowflake and about 10 mi. SW of type sec. (4) Gry., red-purp. fi.-gr. silty ss., siltst., and mudst., with a medial cgl. ss. (95'-159'). (5) Conf. on and gradat. with Shinarump Mem.; gradat. with low. red mem.; conf. with Petrified Forest Mem. It is S lat. equiv. of low. red mem. Monitor Butte Mem. in Monument Valley-a diff. facies-is N and W equiv. of low. red mem. Note.-Not to be confused with Mesa Redonda flow (Pleistocene), E of Socorro, New Mexico, nor with Mesa Redonda Ss. bed (U. Cretaceous), W Apache Co., Arizona; sometimes spelled "Mesa Redondo."

## MESAVE RD E GROUP U. Cretaceous (Coloradoan/Montanian)

(1) Four Corners region and Wyoming. (2) W. H. Holmes, 1877, U.S. Geol. and Geog. Surv. Terr. 9th Ann. Rept. for 1875, p. 245-248. (3) Mesa Verde, Montezuma Co., Colorado. (4) Ss., sh., and coal (900'-2,500'). (5) Overlies Mancos Sh. or Dakota Ss.; overlain conf. by Lewis Sh. The essentially nonmarine Mesaverde intertongues with the marine Mancos. Many fms., mems., tongues prop. in various areas. Voluminous literature! In San Juan Basin, incl. (ascend.): Point Lookout Ss., Menefee Fm., and Cliff House Ss. In Black Mesa area (ascend.): Toreva Fm., Wepo Fm., and Yale Point Ss.

## MOENAVE FORMATION (of Glen Canyon Gr.) U. Triassic(?)

(1) NE Arizona and S Utah. (2) G. A. Williams, 1954, U.S.G.S. Rept. TEI-440, p. 34; P. Averitt et al., 1955, A.A.P.G. Bull., v. 39, p. 2517-2519. (3) Near Moenave, 6 mi. W of Tuba City, Coconino Co., Arizona. (4) Lent. oran.-red and gry. silty ss.; lam. pale red x-bed. ss. with sh. lenses (20'-385'). (5) Overlies Wingate Ss.; overlain by Kayenta Fm. Incl. two mems. (ascend.): Dinosaur Canyon Ss. Mem. and Springdale Ss. Mem. The basal Dinosaur Canyon Ss. Mem. intertongues with up. pt. of Lukachukai Mem. of Wingate Ss. The Springdale Mem. is gradat. with overlying Kayenta Fm. J. W. Harshbarger et al., 1957, U.S.G.S. P.P. 291, p. 12-18, 62, 63.

## MOENKOPI FORMATION L. and M.(?) Triassic

(1) Four Corners region and SE Nevada. (2) L. F. Ward, 1901, A.J.S., 4th, v. 12, p. 401-413. (3) Moenkopi Wash, Grand Canyon, Arizona. (4) Even-bed. dk. to choco.-br., red, laven., purp. argill. gypsif. sh.; ripple-marked platy to mass. argill. ss. and sh., wh. cal. sh., thin ls., and anhyd. (0-2,000'). (5) Unconf. on Permian rocks; overlain disconf. by Chinle Fm. In SW Utah, E. D. McKee, 1954, G.S.A. Mem. 61, subdiv. into (ascend.): Timpoweap, low. red, Virgin Ls., mid. red, Shnabkaib, and up. red mems. (not included in this Lexicon). Present classif. in Little Colorado River valley is (ascend.): Wupatki, Moqui, and Holbrook Ss. Mem.; in places, Hoskinnini Mem. is correl. with Wupatki Mem. For the Salt Anticline region of Utah and Colorado, E. M. Shoemaker and W. L. Newman, 1959, A.A.P.G. Bull., v. 43, p. 1840-1846, subdiv. into four mems. (ascend.): Tenderfoot, Ali Baba, Sewemup, and Pariott.

## MOLAS FORMATION L. M. Pennsylvanian (Morrowan/Desmoinesian)

(1) SW Colorado. (2) C. W. Cross and E. Howe, 1905, U.S.G.S. Silverton Folio 120. (3) Molas Lake, Needle Mts. quad., N of Durango, Colorado. (4) Red cal. sh. and ss., with chert, ls., and qtzite peb. and cob., and thin fossil. ls. lenses (0-200'). (5) Unconf. on Leadville Ls.; overlain conf. by Lime Ridge or Pinkerton Trail Fm. S. A. Wengerd and J. W. Strickland, 1954, A.A.P.G. Bull., v.

38, p. 2157-2199, recog. three mems. (ascend.): low. mem. is a ls.-chert regolith cem. by cal. silty clayst.; mid. mem. is siltst. and sh. with some intrafm. cgl.; up. mem. is fossil. marine red and grn. sh. and ss. See Lime Ridge Fm.

#### MONITOR BUTTE MEMBER (of Chinle Fm.)\_U. Triassic

(1) SE Utah and NE Arizona. (2) G. A. Kiersch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4-5; see also J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 452-453. (3) Exp. in SE Utah near San Juan River S of Clay Hills area. Widespread in SE Utah and Monument Valley area, Arizona. Monitor Butte itself is in T. 41 S., R. 12 E. (4) Dk. gry. clayst. and clayey x-bed. ss., with lenses of mudst. and siltst; grn.-gry. with pale red-br. spots (0-250'). Much sil. wood. (5) Conf. on Shinarump Cgl. Mem.; unconf. on Moenkopi Fm. where Shinarump is missing. Overlain conf. by Petrified Forest Mem.; in places overlain by Moss Back Mem.

#### MONTANA GROUP\_U. Cretaceous

(1) Montana, Great Plains, and New Mexico. (2) G. H. Eldridge, 1888, Colorado Sci. Soc. Proc., v. 3, pt. 1, p.93; 1889, A.J.S., 3d, v. 38, p. 313-321. (3) Exp. in Montana, esp. in upper Missouri River region. (4) In Montana incl. (ascend.): Telegraph Creek Fm., Eagle Ss., and sev. younger units. In South Dakota, Wyoming, and Nebraska, incl. (ascend.): Pierre Sh., Fox Hills Ss., and younger units. In S Colorado and NE New Mexico, incl. (ascend.): Pierre Sh., Trinidad Ss., and Vermejo Fm. In NW New Mexico, incl. (ascend.): up. pt. of Mancos Sh., Mesaverde Gr., and sev. younger units. (5) Overlies Colorado Gr. "Montanan" is a useful time term.

#### MOQUI MEMBER (of Moenkopi Fm.)\_L. Triassic

(1) NE Arizona. (2) E. D. McKee, 1954, G.S.A. Mem. 61, p. 18-19. (3) Moqui Wash, S of U.S. Highway 66, W of Winslow, Arizona. In the Poverty Tank-Concho area. (4) Pale br.-ol.-gry. siltst., clayst. with gry.-grn. gyp. beds, lenses, and nod. (20'-144'). Gen. a light color in contrast to red-br. of Wupatki and Holbrook Mem. (5) Conf. on Wupatki Mem; overlain conf. or disconf. by Holbrook Mem.

#### MORRISON FORMATION\_U. Jurassic

(1) Four Corners area to Great Plains. (2) G. H. Eldridge, 1896, U.S.G.S. Mon. 27, p. 22-23, 60-62. (3) Morrison, Jefferson Co., Colorado. Type sec.: along N side of West Alameda Parkway roadcut, SE' sec. 23, T. 4 S., R. 70 W., about 2 mi. N of Morrison. (4) Variieg. cal. mudst., siltst., ss., sh., cgl. (0-1,550'). (5) Disconf. on various fms. of San Rafael Gr.; overlain unconf. by Dakota. Has been subd iv. into several mems. (ascend.): Salt Wash, Recapture, Westwater Canyon, and Brushy Basin. Has been descr. in hundreds of papers.

#### MOSS BACK MEMBER (of Chinle Fm.)\_U. Triassic

(1) SE Utah and SW Colorado. (2) J. H. Stewart and J. F. Smith, Jr., 1954, Intermt. Assoc. Pet. Geol. 5th Gdbk., p. 29-32; see also J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 453-465. (3) Moss Back, White Canyon area, San Juan Co., Utah. Sec. meas. 0.4 mi. W and 0.2 mi. S of N tip of NW-most of four buttes loc. on or near divide between Fry and Red Canyons. (4) Ylw.-gry. and pale oran., fi.- to med.-gr. x-bed. ss., with cgl. lens (0-150'). (5) Disconf. on Monitor Butte Mem., or on Moenkopi Fm., or loc. on Cutler. Overlain conf. by either Petrified Forest Mem., Owl Rock Mem., or Church Rock Mem. Has been mapped and ref. to as Shinarump in many areas.

#### MUAV LIMESTONE (of Tonto Gr.)\_M. Cambrian

(1) N Arizona and SE Utah. (2) L. F. Noble, 1914, U.S.G.S. Bull. 549. (3) Muav Canyon, Grand Canyon district, Arizona. (4) Blk.-blue-gry. thin-bed. mottled buff sh. and ls. (136'-827'). (5) Overlies Bright Angel Sh.; overlain by Lynch Dol. At least seven mems. recog.; several tongues named. This name, Muav, is preferred to name "Maxfield" in Four Corners region by A. J. Loleit, 1963, Four Cor. Geol. Soc. 4th Gdbk., p. 25.

#### MULATTO TONGUE (of Mancos Sh.)\_U. Cretaceous (Niobraran)

(1) NW New Mexico. (2) J. D. Sears, 1934, U.S.G.S. Bull. 860-A, p. 14; C. B. Hunt, 1936, Bull. 860-B, p. 44-45. (3) At S end of Canyon Mulatto, in T. 14 N., R. 9 W., McKinley Co., 9 mi. NW of San Mateo, Valencia Co., New Mexico. (4) To S: lt. tan sdy. sh. with thin ss. and loc. grits; to N: grad. into dk. gry. sh. (250'-400' in Mount Taylor coal field). (5) Conf. on Dilco Coal Mem. of Crevasse Canyon Fm. or on Gallup Ss.; overlain conf. by Dalton Ss. Mem. of Crevasse Canyon Fm. It is strat. below the Satan Tongue of the Mancos Sh.

#### NAHA FORMATION\_Recent

(1) NE Arizona. (2) J. T. Hack, 1941, Geog. Rev., v. 31, p. 262-263. (3) Naha Well is loc. in lower reaches of Jeddito Valley, W Navajo country. (4) Loose sand with gravel lenses. (5) Overlies Tsegi Fm. It contains abund. pottery fragments of Pueblo IV and Pueblo III age; dated between Pueblo III time (A.D. 1100-1300) and about A.D. 1700.

#### NAKAIBITO FORMATION\_Recent

(1) NW New Mexico. (2) L. B. Leopold and C. T. Snyder, 1951, U.S.G.S. W-S P. 1110-A, p. 9-15. (3) Mexican Springs Wash, near Nakaibito, 18 mi. N of Gallup, New Mexico. (4) Interb. tan-br. sand and silt, incl. sev. thick layers of uncem. mass. sand. Irreg. x-bed.; occ. lenses of fine gravel, partic. near base (22'). (5) Disconf. on Gamero Fm. Contains potsherds.

#### NATURITA FORMATION (of Dakota Gr.)\_L.U. Cretaceous

(1) SW Colorado. (2) R. G. Young, 1959, Rocky Mt. Assoc. Geol. 11th Symposium, p. 17-21. (3) Near Naturita, Montrose Co.,

Colorado. (4) Carbonac. mudst. and sh., cgl., ss., coal (0-200'). (5) Overlies disconf. and interfingers with Cedar Mountain Fm.; overlain conf. by Mancos Sh. This unit, formerly called "Dakota Ss.," is the up. carbonac. pt. of the Dakota Gr. See R. G. Young, 1960, A.A.P.G. Bull., v. 44, p. 156-194, for a comprehensive descr. of the Cedar Mountain-Naturita seq.

#### NAVAJO SANDSTONE (of Glen Canyon Gr.) U. Triassic(?) Jurassic

(1) Four Corners region and SE Nevada. (2) H. E. Gregory, 1915, A.J.S., 4th, v. 40, p. 102-112. (3) Navajo Canyon and Navajo Indian Reserv., Arizona. (4) Pk., lt. red, and gry.-oran. to buff and gry., mass., highly x-bed. ss.; some thin gry. sil. ls. (0-2,200'). (5) Conf. on and gradat. with Kayenta Fm.; overlain disconf. or unconf. by various fms. of San Rafael Gr. In SW Utah, up. pt. of Navajo intertongues with Carmel Fm. (of M. and U. Jurassic age). Formerly consid. L. Jurassic, but reassigned to U. Triassic(?) and L. Jurassic by G. E. Lewis, J. H. Irwin, and R. F. Wilson, 1961, G.S.A. Bull., v. 72, p. 1437-1440.

#### NIOBRARA SHALE MEMBER (of Mancos Sh.) U. Cretaceous (Coloradoan)

(1) Nebraska and Great Plains to Colorado and New Mexico. (2) F. B. Meek and F. V. Hayden, 1862, Phila. Acad. Sci. Proc., v. 13, p. 419-422. (3) Exp. along Missouri River near mouth of Niobrara River, Knox Co., Nebraska. (4) Chalk, ls., marl, sh. (100'-1,000'). (5) The Niobrara Fm. of the Colorado Gr. in Great Plains region is often subdiv. into two moms. Over a large area, the Niobrara Fm. is conf. on Carlile Sh.; overlain conf. by Pierre Sh. The term Niobrara Calcareous Sh. Mem. of Mancos Sh. was applied by C. H. Dane, 1948, U.S.G.S. Oil and Gas Inv. Prel. Map 78, in E San Juan Basin, Rio Arriba Co., New Mexico; here it is about 600'-800' thick, overlies Carlile Sh. Mem., and underlies an unnamed sh. mem. at top of Mancos. In NW San Juan Basin, the term "basal Niobrara Sandstone" has been used informally by some for the Tootoosie or Gallup Ss.

#### OAK SPRINGS CLIFFS MEMBER (of De Chelly Ss.) Permian

(1) NE Arizona. (2) H. W. Peirce, 1964, Mus. North. Ariz. Bull. 40, p. 15-32. (3) Oak Springs Cliffs, Canyon de Chelly, Apache Co., Arizona. (4) Pale red-br. mic. siltst. and ss. (0-128'). (5) Conf. on Hunters Point Mem.; overlain conf. by White House Mem. Has been called simply "Oak Springs Mem." Prob. equiv. of San Ysidro Mem. of Yeso Fm. of New Mexico. Note.-Not to be confused with the Oak Spring Fm. or Gr. (Tertiary) of S Nevada.

#### OJO ALAMO SANDSTONE U. Cretaceous Paleocene

(1) NW New Mexico and SW Colorado. (2) B. Brown, 1910, Am. Mus. Nat. Hist. Bull., v. 28, p. 267-274. (3) Named for occ. near Ojo Alamo, San Juan Co., New Mexico. (4) Ss., with lenses of sh. and cgl., highly x-bed. (63'-110', as restr. by C. M. Bauer, 1916, U.S.G.S. P.P. 98-K). (5) Conf. or unconf. on Kirtland Sh. or McDermott Mem. of Animas Fm.; overlain unconf. by Nacimiento Fm. Acc. to R. Y. Anderson, 1960, N.M.B.M.M.R. Mem. 6, p. 2-4, 13, the Ojo Alamo is of U. Cretaceous age from vertebrate evidence but of Tertiary age from a few fragmentary plant fossils. In 1966, E. H. Baltz, Jr., S. R. Ash, and R. Y. Anderson, U.S.G.S. P.P. 524-D, redef. and restr. the Ojo Alamo Ss. to incl. only the up. cgl. (unit 4), assigning a Paleocene age; underly. units 2 and 3 were redef. as Naashoibito Mem. of Kirtland Sh.

#### OPHIR SHALE, FORMATION, or GROUP L. M. Cambrian

(1) N and E-C Utah. (2) G. F. Loughlin, 1919, U.S.G.S. P.P. 107, p. 25-27; name prop. by B. S. Butler. (3) Ophir, E Toole Co., Utah. (4) Sdy. sh., interb. with ls., dol., and ss. (0-375'). (5) Overlies Ignacio Qtzite in Four Corners region. Name formerly used in SE Utah and SW Colorado. A. J. Loleit, 1963, Four Cor. Geol. Soc. 4th Gdbk., p. 25, prop. that name Ophir should be replaced by Bright Angel Sh. in Four Corners region.

#### ORGAN ROCK TONGUE (of Cutler Fm.) or ORGAN ROCK SHALE (of Cutler Gr.)-L. Permian (Wolfcampian)

(1) SE Utah and NE Arizona. (2) A. A. Baker and J. B. Reeside, Jr., 1929, A.A.P.G. Bull., v. 13, p. 1420-1446. (3) Organ Rock, Monument Valley, S of San Juan River, between Moonlight and Copper Creeks, San Juan Co., Utah. (4) Even-bed. red-br. silty ss., red mic. and shaly ss. and siltst., thin pellet-cgl.; grades N-ward into wh. x-bed. ss. (200'-900'). (5) Conf. on Cedar Mesa Ss. Mem.; overlain conf. by White Rim Ss. Mem. In Monument Valley region, underlies De Chelly Ss. Mem. Acc. to J. H. Stewart, 1959, A.A.P.G. Bull., v. 43, p. 1855-1862, underlies Hoskinnini Mem. of Moenkopi Fm. in most of SE Utah. Prob. equiv. of Hermit Sh.

#### OURAY LIMESTONE U. Devonian

(1) SW Colorado, E Arizona, and SE Utah. (2) C. W. Cross and A. C. Spencer, 1899, U.S.G.S. La Plata Folio 60, p. 8. (3) Prom. occ. near Ouray, Ouray Co., Colorado, at junction of Canon Creek with Uncompahgre River. (4) Mass. argill. ls. with streaks of grn. sh., dol. ls. Colors of buff, tan, cream to gry. (0-300'). (5) Conf. on Elbert Fm.; overlain conf. by Leadville Ls. E. Kirk, 1931, A.J.S., 5th, v. 22, p. 224, restr. name Ouray to Devonian pt. of orig. Ouray, the Mississippian pt. to be called Leadville.

#### OWL ROCK MEMBER (of Chinle Fm.) U. Triassic

(1) NE Arizona, SE Utah, W-C New Mexico. (2) G. A. Kiersch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4-5; see also J. H. Stewart, 1957, A.A.P.G. Bull. v. 41, p. 458. (3) Owl Rock, N of Kayenta, Monument Valley, Navajo Co., Arizona. (4) Pale red to red-br. and lt. purp. siltst. and lt. blue-gry. clayst. with thin to thick cherty ls. (0-450'). At type sec., 131' of interb. ls. and cal. siltst. Ls. mot. pale blue and gry.-pk.; contains chert nod. and mud pellets; loc. silty; bedding of siltst. irreg. and lent.-J. P. Akers, M. E. Cooley, and C. A. Repenning, 1958, N.M.G.S. 9th Gdbk., p. 93-94. (5) Conf. on Petrified Forest Mem. or Moss Back Mem.; overlain conf. by Church Rock Mem. of Chinle Fm. or disconf. by Wingate Ss.

#### PAKOON LIMESTONE L. Permian (Wolfcampian)

(1) NW Arizona. (2) A. H. McNair, 1951, A.A.P.G. Bull., v. 35, p. 515, 524-525. (3) On W face and crest of Pakoon Ridge, NW of

Pakoon Spring, Mohave Co., approx. T. 35 N., R. 16 W., Arizona. (4) Dol. ls. (688' at type loc.; 305' in Grand Wash Cliffs). (5) Overlies Callville Ls.; overlain by Queantoweap Ss.

### PARADOX FORMATION (of Hermosa Gr.)M. Pennsylvanian (AtokanDesmoinesian)

(1) Four Corners region: W Colorado and SE Utah; subsurface of NE Arizona and NW New Mexico. (2) A. A. Baker, 1933, U.S.G.S. Bull. 841. (3) Paradox Valley, Montrose Co., Colorado. (4) Cyclic dep. of salt, gyp., and anhyd. with blk. and br. sh.; some ls. and shalt' dol. (0-5,000' orig. dep. thickness; in anticlines ruptured by salt flowage, up to 12,000'). (5) Conf. on Pinkerton Trail Fm. or Lime Ridge Fm.; overlain conf. by Hermosa Fm. or Honaker Trail Fm. Formerly considered a mem. of Hermosa Fm. and as the evap. facies of the Hermosa. See S. A. Wengerd and J. W. Strickland, 1954, A.A.P.G. Bull., v. 38, p. 2157-2199; S. A. Wengerd and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2048-2106; S. A. Wengerd, 1962, Penn. System in the United States (A.A.P.G.), p. 264-330. See Four Corners Stage; Lime Ridge Fm.; Pinkerton Trail Fm.; also S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., table 1, p. 161, for emendations.

### PARIOTT MEMBER (of Moenkopi Fm.)M.(?) Triassic

(1) SW Colorado and SE Utah, Paradox basin. (2) E. M. Shoemaker and W. L. Newman, 1959, A.A.P.G. Bull., v. 43, p. 1838-1848. (3) S side of Pariott Mesa, Castle Valley, sec. 5, T. 25 N., R. 23 E., Grand Co., Utah. (4) Red to purp.-br. ss. and choco.-br., oran., and red mudst., siltst., and sh. (134' at type sec.; 252' in Sinbad Valley, Colorado; thickens W-ward to several hundred ft.). (5) Overlies Sewemup Mem.; overlain unconf. by Chinle Fm. This is uppermost mem. of Moenkopi Fm. in N Paradox basin.

### PETRIFIED FOREST MEMBER (of Chinle Fm.)U. Triassic

(1) N Arizona, S Utah, W-C New Mexico, and SE Nevada. (2) Incidental mention by G. B. Maxey, 1946, A. J.S., v. 244, p. 337; H. E. Gregory, 1947, G.S.A. Bull., v. 58, p. 223, 228; 1950, U.S.G.S. P.P. 220, p. 67. (3) Petrified Forest Nat. Mon., Arizona. Named for fact that it contains band of fossil wood resembling dom. rock in Petrified Forest of Arizona. In much of the area, this mem. forms thickest and most char. pt. of fm. (4) Varieg. red, oran., purp., grn. bent. siltst. and clay; also marl, cal. ss., ls. cgl., carbonac. sh., cal. sh. (0-800'; in Monument Valley, 500 '-700'; only 100' in White Canyon area; 70' or less in places). (5) In SE Utah, conf. on Monitor Butte Mem.; overlain conf. by Owl Rock Mem. In White Canyon and Elk Ridge areas, conf. on Moss Back Mem. It loses its identity by intergrad. with Owl Rock Mem. near junction of Green and Colorado Rivers; J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 457-458.

### PICTURED CLIFFS SANDSTONEU. Cretaceous (Montanan)

(1) NW New Mexico and SW Colorado. (2) W. H. Holmes, 1877, U.S. Geol. and Geog. Surv. Terr. 9th Ann. Rept. for 1875, p. 248-251. (3) Pictured Cliffs on San Juan River, W of Farmington, San Juan Co., New Mexico. (4) Up. wh. mass. ss. (130') underlain by ylw.-br. to wh. ss. (100'; max. 281'). (5) Conf. on and gradat. with Lewis Sh.; overlain conf. and gradat. by Fruitland Fm. This is highest marine fauna in the San Juan Basin. To S, where Lewis Sh. ends, Pictured Cliffs Ss. is not sep. from the Cliff House Ss.; see E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2159.

### PINKERTON TRAIL FORMATION (of Hermosa Gr.)M. Pennsylvanian (Desmoinesian)

(1) Paradox salt basin, Four Corners region. (2) S. A. Wengerd and J. W. Strickland, 1954, A.A.P.G. Bull., v. 38, p. 2161-2169. (3) Pinkerton Trail near D. and R. G. R.R. tracks, in sec. 26, T. 37 N., R. 9 W., 12 mi. N of Durango, Colorado; on W side of U.S. Highway 550. (4) Dk. gry., fi.- to cse.-xtall., crinoidal and fusulin id ls. and dk. sh.; siltst., ss., reefs (at type loc.: 84'; ranges 0-600'; usually 50'-150'). (5) Conf. on Molas Fm. or on Lime Ridge Fm.; overlain conf. by Alkali Gulch Fm. This is the lowest unit of the Hermosa Gr. S. A. Wengerd and E. Szabo, 1968, N.M.G.S. 19th Gdbk., p. 161, sugg. that Pinkerton Trail Fm. of orig. type [loc. be](#) called Lime Ridge and that Pinkerton Trail be moved up into basal Desmoinesian, as a valid mappable fm. below the Alkali Gulch. Note.-Not to be confused with Pinkerton Ss. (L. Miss.) of West Virginia.

### POINT LOOKOUT SANDSTONE (of Mesaverde Gr.)U. Cretaceous

(1) SW Colorado and NW New Mexico. (2) A. J. Collier, 1919, U.S.G.S. Bull. 691-K. (3) Cliffs at Point Lookout, 7.5 mi. SW of Mancos, Montezuma Co., Colorado. (4) Mass. lt. gry. to ylw. ss. (0-320'). (5) Conf. on up. Mancos Sh.; overlain conf. by Menefee Fm. E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2156, disc. rev. nomenclature of Mesaverde Gr. in San Juan Basin, partic. relations of Point Lookout Ss. with Hosta Ss. In the Fort Defiance-Tohatchi quad., Point Lookout overlies Crevasse Canyon Fm.; see J. E. Allen and R. Balk, 1954, N.M.B.M.M.R. Bull. 36, p. 90-94. See also Hosta Ss. Tongue.

### PONY EXPRESS LIMESTONE (of San Rafael Gr.)U. Jurassic

(1) SW Colorado, SE Utah, and NW New Mexico. (2) J. D. Irving, 1905, U.S.G.S. Bull. 260, p. 56. (3) Pony Express mine, Ouray dist., San Juan Mts., SW Colorado. (4) Bitum. ls., up. beds mass., low. beds thinly lam.; some sh. and breccia (0-30'; ay. 3'). (5) Overlies Entrada Ss.; overlain by Bilk Creek Ss. Mem. Earlier ref. to as ls. mem. of Morrison Fm. In La Plata dist., E. B. Eckel, 1949, U.S.G.S. P.P. 219, p. 27-29, reallocated to mem. status in Wanakah Fm.-which see. Pony Express Ls. may be equiv. to Todilto Ls.

### RECAPTURE SHALE MEMBER (of Morrison Fm.)U. Jurassic

(1) Four Corners region. (2) H. E. Gregory, 1938, U.S.G.S. P.P. 188, p. 58. (3) Exp. near mouth of Recapture Creek, 6 mi. E of Bluff, San Juan Co., Utah. (4) Dk. red and red-br. to varieg. pk., ash, br., and gry. cal. gypsif. sh. and siltst., thin buff to wh. ss., cgl. (0-500'; gen., 100'-300'; 59' at Fort Wingate, New Mexico; 483' at N end of Chuska Mts.). (5) Disconf. on Bluff Sandstone of San Rafael Gr.; conf. on and gradat. with Cow Springs Ss. and Salt Wash Mem. Overlain by Westwater Canyon Ss. Many ref. in the literature.

#### RED MESA MEMBER (of Entrada Fm.)-U. Jurassic

(1) Four Corners region. (2) W. B. Hoover, 1950, N.M.G.S. 1st Gdbk., p. 77-80. (3) W end of Red Mesa, on Utah-Arizona line, 17 mi. W of the Four Corners. (4) Crinkly sh. and ss. (100'). (5) Overlies low. bed of Entrada Fm.; in places overlies Todilto Ls. Overlain by Bluff Ss. In pt., same age as Summerville; in pt., equiv. to Wanakah.

#### RED ROCK RHYOLITE (of Yavapai Gr.)-Precambrian

(1) C Arizona. (2) E. D. Wilson, 1937, G.S.A. Proc. 1936, p. 112 (abs.); 1939, G.S.A. Bull., v. 50, p. 1118, 1120-1121. (3) Red Rock Butte, in Mazatzal Range. (4) Dom. rhy. rocks: flows, aggl., breccia, and intrusives. Char. mass., gry.-br. to red-br. (1,000'+). (5) In fault contact with Yaeger Greenstone below and Alder Series above. G. Gastil, 1958, G.S.A. Bull., v. 69, p. 1498, placed Red Rock Rhyolite strat. above Alder Ser.; overlain unconf. by Deadman Qtzite. Note.-Not to be confused with Red Rock Fm. (Quaternary) of NE Arizona and NW New Mexico-named for Red Rock Valley by J. W. Blagbrough, 1965, Dissert. Abs., v. 26, no. 3, p. 1589.

#### REDWALL LIMESTONE-M. Mississippian

(1) N Arizona and S-C Utah. (2) G. K. Gilbert, 1875, U.S. Geol. and Geog. Surv. W 100th Mer., v. 3, p. 162-197. (3) Exp. in Shinumo drainage basin, N side of Grand Canyon, Arizona. Named for red app. of escarpment on both sides of Grand Canyon. (4) Wh. to blue-gry. ls.; xtall., dense, ool., cherty (285'-700'). (5) Unconf. on Temple Butte Ls.; overlain disconf. by Supai Fm.

#### RICO FORMATION-Pennsylvanian-Permian

(1) Four Corners region. (2) C. W. Cross, 1899, U.S.G.S. Telluride Folio 57. (3) Rico Mts., Colorado. (4) Red sh., ss., cgl.; some gry. to wh. fossil., sdy. cherty ls., buff limy ss., red-br. silst., sh. (100'-555'). (5) Overlies Hermosa Fm. or Gr.; overlain by Halgaito Sh. Tongue of Cutler. Formerly a mem. of the Cutler Fm.; some workers think Rico should be aband. See D. L. Baars, 1962, A.A.P.G. Bull., v. 46, p. 158-159, for disc. of the Rico problem and recomm. that Rico be aband. Acc. to S. A. Wengerd and J. W. Strickland, 1954, A.A.P.G. Bull., v. 38, p. 2174-2175, Rico is basal mem. of Cutler Fm.; not a mappable unit; should not be desig. a fm. S. A. Wengerd and M. L. Matheny, 1958, A.A.P.G. Bull., v. 42, p. 2054-2056, give Rico as transitional between Hermosa Gr. and Halgaito Fm. See R. B. O'Sullivan, 1965, U.S.G.S. Bull. 1186, p. 25, for names of prom. ledges (ascend.): Little Loop oil sand, Mendenhall oil sand, third oil sand, Shafer ls., Goodridge oil sand, Baby oil sand, McKim ls., and "A ls." Descriptions of these are not incl. in this Lexicon.

#### ROCK POINT MEMBER (of Wingate Ss.) U. Triassic

(1) Four Corners region. (2) G. A. Kirsch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4-5. (3) Lower, slope-form. unit exp. in Little Round Rock, a prom. butte, 15 mi. S of Rock Point School, Apache Co., Arizona. (4) Pale red-br., red-oran. silty ss. and siltst., in pt. x-bed., qtzitic (344'-804'). (5) Conf. on Chinle Fm.; overlain conf. and gradat. by Lukachukai Mem. of Wingate Ss. See J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, p. 3, 8-10.

#### SALT WASH SANDSTONE MEMBER (of Morrison Fm.)-U. Jurassic

(1) Four Corners region. (2) C. T. Lupton, 1914, U.S.G.S. Bull. 541, p. 127. (3) Salt Wash, 30 mi. SE of Green River, Grand Co., Utah. (4) Lt. gry., gry.-oran., and wh. ss., interb. grn.-gry. and gry.-red sh. and siltst.; thin cgl. lenses (0-616'). (5) Basal mem. of Morrison Fm. Disconf. on San Rafael Gr.; conf. and gradat. with Recapture Mem. Intertongues Sward with overly. Recapture, Cow Springs and up. Bluff Ss. See L. C. Craig et al., 1955, U.S.G.S. Bull. 1009-E, p. 135-138; J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, p. 52.

#### SANGRE DE CRISTO FORMATION-Pennsylvanian-Permian

(1) 5 Colorado and N New Mexico. (2) R. C. Hills, 1899, U.S.G.S. Elmore Folio 58; C. B. Read and G. H. Wood, Jr., 1947, Jour. Geol., v. 55, p. 223. (3) Area E of Crestone townsite, on W flank of C anticline between Crestone Needle on S and Eureka Mt. on N, Saguache Co., Colorado. (4) Red ark. cgl. to fi.-gr. elastic strata; some nod. ls. (500'-9,500'). (5) Disconf. or conf. on Madera Ls.; intertongues with Madera; interfingers with Yeso Fm. Overlain by Yeso Fm. or Glorieta Ss.

#### SANOSTEE MEMBER (of Mancos Sh.)-U. Cretaceous

(1) NW New Mexico and SW Colorado. (2) Informally named by W. B. Hoover, 1951, in road log, N.M.G.S. 2d Gdbk., p. 46. (3) Prom. dev. around Sanostee Trading Post, S of Shiprock, San Juan Co., New Mexico. Has been spelled "Sanastee." (4) Br., cal., fossil. ss. and dk. sh. (0-200'). (5) Gen. marks top of blk. sh., and rather uniformly about 450' above Dakota Ss. over much of W part of San Juan Basin. Equiv. of Juana Lopez Mem.

#### SAN RAFAEL GROUP-late M.-U. Jurassic

(1) Four Corners region. (2) A. A. Baker et al., A.A.P.G. Bull., v. 11, p. 787. (3) San Rafael Swell, Utah. (4) At type loc., incl. (ascend.): Carmel, Entrada, Curtis, and Summerville Fms. In Navajo country, incl. (ascend.): Carmel, Entrada, Todilto, Summerville, and Bluff Fms. (5) Unconf. on units of Glen Canyon Gr., such as Navajo Ss. or Wingate Ss. Overlain by Salt Wash or Recapture Mem. of Morrison Fm.; or by Cow Springs Ss. Name has been spelled "San Raphael." Voluminous literature.

#### SATAN TONGUE (of Mancos Sh.)-U. Cretaceous (Coloradoan)

(1) NW New Mexico. (2) J. D. Sears, 1934, U.S.G.S. Bull. 860-A, p. 14; C. B. Hunt, 1936, Bull. 860-B, p. 42, 45. (3) Satan Pass, 12 mi. W of Mount Taylor coal field, New Mexico. (4) Drk. gry. sh. (200'-300'). (5) The Satan Tongue wedges into the Hosta Ss. Mem.

of the Mesaverde Fm.; thus, conf. on low. Hosta Ss.; overlain conf. by up. Hosta Ss. (now Point Lookout Ss.). Satan Tongue is strat. above the Mulatto Tongue of the Mancos Sh.

#### **SEWEMUP MEMBER (of Moenkopi Fm.)-L.M.(?) Triassic**

(1) SW Colorado and SE Utah. (2) E. M. Shoemaker and W. L. Newman, 1959, A.A.P.G. Bull., v. 43, p. 1839-1847. (3) E side of Sinbad Valley, sec. 15, T. 49 N., R. 19 W., Mesa Co., Colorado. Named for Sewemup Mesa, which forms E wall of Sinbad Valley. (4) Choco.-br. fiss. siltst. or sh.; also lt. br. fi.-gr. ss.; gyp. as cem., veinlets, and thin nod. beds; some lt. maroon ss., some cglitic ss. (0-450'). (5) Conf. on and intertonguing with All Baba Mem.; overlain unconf. by Pariott Mem.

#### **SHINARUMP CONGLOMERATE MEMBER (of Chinle Fm.)-U. Triassic**

(1) Four Corners region. (2) G. K. Gilbert, 1875, U.S. Geol. and Geog. Surv. W 100th Mer., v. 3, p. 1-187. (3) Shinarump Cliffs, S of Vermilion Cliffs, Kane Co., Utah. (4) Ylw.-wh. to buff cgl., ss., and sh.; mass. gry. x-bed, cglitic ss.; lenses of red-gry. sh. Sil. wood abund. (0-225'). (5) Recog. as basal cgl. mem. of Chinle Fm. Disconf. or unconf. on Moenkopi Fm.; conf. and gradat. with Monitor Butte Mem. of Chinle Fm. Acc. to J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 442-452, in Moab, Utah area, the so-called Shinarump cgl. of Baker (1933) and McKnight (1940) is a strat. higher unit at base of Chinle and is assigned to Church Rock Mem. of Chinle. The Shinarump was long regarded as a fm.

#### **SONSELA SANDSTONE BED (in Petrified Forest Mem. of Chinle Fm.)-U. Triassic**

(1) NE Arizona, SE Utah, and NW New Mexico. (2) G. A. Kiersch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4-5. (3) Exp. 3.5 mi. N of W Sonselata Butte, E flank of Defiance uplift, Arizona. (4) Lt. gry. ss., siltst., and mudst.; peb. and cob. cgl. with sil. wood loc. at base (50'-200'). (5) In Petrified Forest Mem. of Chinle Fm.; in E part of Black Mesa basin, the Sonselata Ss. Bed serves to div. the Petrified Forest Mem. into a low. and an up. pt. J. P. Akers, M. E. Cooley, and C. A. Repenning, 1958, N.M.G.S. 9th Gdbk., p. 93.

#### **SPRINGDALE SANDSTONE MEMBER (of Moenave Fm.)-U. Triassic(?)**

(1) S Utah and NE Arizona. (2) H. E. Gregory and N. C. Williams, 1947, G.S.A. Bull., v. 58, p. 223-233; H. E. Gregory, 1950, U.S.G.S. P.P. 220, p. 52, 67-68. (3) Springdale, Washington Co., Utah, where it forms a prom. cliff. Traceable from Kanab, Utah, along Vermilion Cliffs to Lees Ferry, Arizona, and Sward along Echo Cliffs. (4) Lam., pale red x-bed. ss., with sh. lenses and mud pockets (40'-221'). (5) Orig. assigned to Chinle Fm.; later to Wingate Fm.; and later to Moenave Fm. by J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, p. 3, 16-17, 62. Overlies Dinosaur Canyon Mem. of Moenave Fm.; overlain by Kayenta Fm. (in many areas not disting. from Kayenta). In Echo Cliffs area, formerly ref. to as Wingate Ss.

#### **SUMMERVILLE FORMATION (of San Rafael Gr.)-U. Jurassic**

(1) Four Corners region. (2) J. Gilluly and J. B. Reeside, Jr., 1926, U.S.G.S. Press Bull. 6064; also, 1928, U.S.G.S. P.P. 150-D, p. 79-80. (3) Summerville Point, SE of head of Summerville Wash, N end of San Rafael Swell, SE Utah. (4) Thin-bed., choco.-col. to dk. red-br. ss., earthy red-br. and grn. siltst., sh., some gyp., a few gry. ls. (125'-331'). (5) Disconf. on Entrada Ss. or Todilto Ls.; gradat. and conf. with Curtis Fm.; conf. and gradat. with Cow Springs Ss. Has been reg. as equiv. of Wanakah Fm. of San Juan Mts., Colorado. J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, p. 3, 39-42.

#### **SUPAI FORMATION (of Aubrey Gr.)-PennsylvanianPermian**

(1) Four Corners region to E California and SE Nevada. (2) N. H. Darton, 1910, U.S.G.S. Bull. 435, p. 21-25. (3) Supai Village, in Havasu (Cataract) Canyon, N Arizona. Supai is contraction of word "Havasupai". (4) Red ss. and sh., purp. ls. (500'-1,000'; 1,700'-1,800' along Mogollon Rim, Arizona; 3,000' (?) in Confusion Range, Utah). (5) Conf. on Naco Ls. or unconf. on Redwall Ls.; overlain disconf. or gradat. by Hermit Sh. or Rico Mem. of Cutler; or by Kaibab Ls.; or by Coconino Ss. In Grand Canyon area, the Hermit Sh. sep. Supai from Coconino. In Defiance uplift and Toadlena area, Supai interfingers with overly. De Chelly Ss. Equiv. to Cutler Gr., and to Abo and Yeso Fms.

#### **TAPEATS SANDSTONE (of Tonto Gr.)-L.M. Cambrian**

(1) N Arizona, SE Utah, SE California, and S Nevada. (2) L. F. Noble, 1914, U.S.G.S. Bull. 549. (3) Tapeats Creek, Grand Canyon, Arizona. (4) Cse.-gr., x-bed. ss. and qtzite with cgl. lenses, weath. into sheer cliff of choco.-br. color (0-285'+). (5) Overlies Precambrian with prom. ang. unconf.; overlain conf. by Bright Angel Sh.

#### **TEMPLE BUTTE LIMESTONE U.(?) Devonian**

(1) N Arizona. (2) C. D. Walcott, 1889, G.S.A. Bull, v. 1, p. 50. (3) Temple Butte, 3 mi. S of junction of Little Colorado River with Colorado River, Grand Canyon, Arizona. (4) Purp. and cream-col. ls. and ss. (0-100'). (5) Overlies Tonto Gr.; overlain by Redwall Ls; Temple Butte Ls. absent in places, so that Redwall Ls. rests on Tonto Gr. Equiv. of Ouray, Elbert, and Aneth Fms.

#### **TEMPLE MOUNTAIN MEMBER (of Chinle Fm.)--U. Triassic**

(1) E-C Utah. (2) R. C. Robeck, 1956, A.A.P.G. Bull., v. 40, p. 2499-2506. (3) NE side of South Temple Mt., SE flank of San Rafael Swell, Emery Co., Utah. (4) Siltst., mudst., ss. Siltst. lt. gry. to mot. and band. purp. and wh.; mudst. purp.-red, mot. purp. and wh.; ss. lt. gry.; some cgl. (33' at type sec.; ranges 5'-101'). (5) Disconf. or unconf. on Moenkopi Fm.; overlain unconf. by Moss Back Mem. of Chinle. J. H. Stewart, 1957, A.A.P.G. Bull., v. 41, p. 441-465, thinks Temple Mountain Mem. should be restr. to San Rafael Swell and not ext. beyond.

#### TENDERFOOT MEMBER (of Moenkopi Fm.)—L. Triassic

(1) SW Colorado and SE Utah. (2) E. M. Shoemaker and W. L. Newman, 1959, A.A.P.G. Bull., v. 43, p. 1814, 1843-1845. (3) E side of Sinbad Valley, sec. 15, T. 49 N., R. 19 W., Mesa Co., Colorado. Named for Tenderfoot Mesa, where it const. whole of fm. on N side of mesa. (4) Muddy or silty ss., ark. at base; overlain by 7' of gyp.; brick-red or oran.- to dk.-br. mudst. to siltst.; succeeded by dist. bed. ss. (0-290'). (5) Unconf. on Cutler Gr.; loc. overlies Paradox Mem. of Hermosa Fm. Overlain unconf. by Chinle Fm. Equiv. of Hoskinnini Mem. of Moenkopi Fm.

#### TOCITO SANDSTONE LENTIL (of Mancos Sh.)—U. Cretaceous

(1) NW New Mexico. (2) J. B. Reeside, Jr., 1924, U.S.G.S. P.P. 134. (3) Outcrops near Tocito Trading Post, San Juan Co., New Mexico. (4) Cse., br., x-bed. ss., with lenses of cgl. (35'). (5) Occurs about 735'± above base of Mancos Sh. In rev. nomenclature of Mesaverde Gr. of San Juan Basin, the name Gallup Ss. prop. to replace Tocito Ss. Lentil—E. C. Beaumont, C. H. Dane, and J. D. Sears, 1956, A.A.P.G. Bull., v. 40, p. 2156.

#### TODILTO LIMESTONE (of San Rafael Gr.)—U. Jurassic

(1) NW New Mexico, NE Arizona, and SW Colorado. (2) H. E. Gregory, 1916, U.S.G.S. W-S P. 380; 1917, P.P. 93, p. 55-56. (3) Todilto Park, McKinley Co., New Mexico. (4) Mudst., ls., mudst. (25' at type loc.); near San Ysidro, New Mexico, incl. 111' of gyp. Total: 0-150'. (5) Overlies Entrada Ss.; underlies Summerville Fm. or Morrison Fm. Formerly consid. a mem. of either Morrison Fm. or Wanakah Fm. Has been correl. with Curtis Fm. of Utah and with Pony Express Ls. Mem. of Wanakah Fm. of Colorado.

#### TOHACHI FORMATION (of Mesaverde Gr.)—U. Cretaceous

(1) NW New Mexico and NE Arizona. (2) H. E. Gregory, 1916, U.S.G.S. W-S P. 380. (3) Exp. 2 mi. N and 3 mi. W of Tohachi (or Tohatchi) Indian School, McKinley Co., New Mexico. (4) Low. mem. a cliff-former, 400'-850', thin- to med.-bed. ss. with sh.; up. mem., 850', ol.-gry. to ylw.-gry. bent. clays, with few ss. (max. 1,350'). (5) Conf. on top mass. channel ss. of Menefee Fm.; overlain unconf. by Chuska Ss. Low. mem. may be equiv. of Cliff House and Pictured Cliffs Ss.; up. mem. may be equiv. of Fruitland and/or Kirtland Fms. See J. E. Allen, 1953, A.A.P.G. Bull., v. 37, p. 2569-2571; C. Silver, 1954, A.A.P.G. Bull., v. 38, p. 660-661; J. E. Allen, 1954; J. E. Allen and R. Balk, 1954; H. E. Wright, Jr., 1954; E. C. Beaumont et al., 1956.

#### TONTO GROUP—L.-M. Cambrian

(1) C and NW Arizona. (2) G. K. Gilbert, 1874, Phil. Soc. Wash. Bull., v. 1, p. 109 (abs.). (3) Tonto basin, W Gila Co., Arizona. (4) Ss. and qtzite, sh., ls. (800'±). (5) Incl. (ascend.): Tapeats Ss., Bright Angel Sh., Muav Ls. Unconf. on Precambrian rocks; overlain by Temple Butte Ls.

#### TOREVA FORMATION (of Mesaverde Gr.)—U. Cretaceous

(1) NE Arizona. (2) G. A. Kiersch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4, 7; C. A. Repenning and H. G. Page, 1956, A.A.P.G. Bull., v. 40, p. 255-294. (3) Rim rock of Black Mesa, 1.3 mi. NW of Toreva, Hopi Indian Reserv., Navajo Co., Arizona. (4) Three mems. (ascend.): ss. (128'), carbonac. mudst. or sh. (106'), and ss. (79'). (5) Overlies Mancos Sh.; underlies Wepo Fm. Toreva is basal unit of Mesaverde Gr.

#### TOROWEAP FORMATION (of Aubrey Gr.)—L. Permian (Leonardian)

(1) NW Arizona, SW Utah, and SE Nevada. (2) E. D. McKee, 1937, Carn. Inst. Wash. Year Book 36, p. 341-343; 1938, Pub. 492, p. 12-28. (3) E wall of Toroweap Valley in Grand Canyon, Arizona. Sec. is about 8 mi. N of Colorado River. (4) Two red-bed series sep. by a mass. ls.; some gyp. (325'). (5) Conf. on Coconino Ss.; overlain by restr. Kaibab Ls.

#### TSEGI FORMATION—Recent

(1) NE Arizona. (2) J. T. Hack, 1941, Geog. Rev., v. 31, p. 262-263. (3) In Tsegi Canyon, W Navajo country. (4) Gry. to br. clay and silt beds, with gravel lenses. (5) Overlies Jeddito Fm.; underlies Naha Fm. Dep. before A.D. 1100.

#### UNKAR GROUP (of Grand Canyon Series)—Precambrian

(1) N Arizona. (2) C. D. Walcott, 1894, U.S.G.S. 14th Ann. Rept., pt. 2, pl. 60. (3) Unkar Valley, Grand Canyon, Arizona. (4) Incl. (descend.): Dox Ss., Shinumo Qtzite, Hakatai Sh., Bass Ls., and Hotauta Cgl. "Rama Fm." incl. diabase and basalt intruded following dep. of Dox Ss.: sills, dikes, and flows. (5) Overlain disconf. by Nankoweap Gr.; C. E. Van Gundy, 1959, G.S.A. Bull., v. 62, p. 953-954.

#### UTE CANYON TONGUE (of Cliff House Ss.)—U. Cretaceous

(1) NW New Mexico. (2) P. T. Hayes and A. D. Zapp, 1955, U.S.G.S. Oil and Gas Inv. Map OM-144. (3) Well displayed in Ute Canyon in SE part of Ute Mountain Indian Reserv., San Juan Co., New Mexico. (4) Mass. ss., thinning NE-ward. (5) The Cliff House Ss. consists of two mass. ss. bodies sep. by 350' of shaly ss. The up. ss. thins NE-ward and is difficult to differentiate from enclosing Lewis Sh. This wedge is called the Ute Canyon Tongue.

#### WANAKAH FORMATION—U. Jurassic

(1) SW Colorado; formerly, also NW New Mexico and NE Arizona. (2) W. S. Burbank, 1930, Colorado Sci. Soc. Proc., v. 12, p. 172; M. I. Goldman and A. C. Spencer, 1941, A.A.P.G. Bull., v. 25, p. 1748-1762. (3) Exp. in Wanakah mine, Ouray dist., Colorado. (4) Ss., sh., breccia, gyp., ls. (0-125'); hard cal. concr., sdy. argill. beds with thin ss. (25'-150'). (5) Overlies Entrada Ss.; underlies Junction Creek Ss. (but L. C. Craig and C. N. Holmes, 1951, N.M.G.S. 2d Gdbk., p. 94, redef. to incl. Junction Creek Ss. Mem.) In

1947, A.A. Baker et al., A.A.P.G. Bull., v. 31, p. 1668, desig. Todilto Ls. and Gyp. Mem. of Wanakah Fm. E. B. Eckel, 1949, U.S.G.S. P.P. 219, p. 28-29, redef. Wanakah to incl. (ascend.): Pony Express Ls. Mem., Bilk Creek Ss. Mem., and unnamed marl mem. Now restr. to W and S margins of San Juan Mts., Colorado. Note.-Not to be confused with Wanakah Fm. (M. Devonian) of New York.

#### WEBER SANDSTONE, QUARTZITE, or FORMATION.Pennsylvanian.Permian

(1) NE Utah and W Colorado. (2) C. King, 1876, A.J.S., 3d, v.11, p. 477-479. (3) Named for Weber Canyon, Wasatch Range, E of Morgan, Morgan Co., Utah. (4) Qtzite, with a few beds of red ss. at base and occ. sh., cgl. Some workers had incl. older rocks, so thickness orig. believed to be 6,000'-10,000'; now prob. 1,000'-3,000'. (5) Once interpreted as overly. Wasatch Ls., and underly. Pennsylvanian rocks. E. Blackwelder, 1910, G.S.A. Bull., v. 21, p. 517-542, adopted name Morgan Fm. for underly. Is. Weber in places overlain by Park City Fm. Many disc. in literature.

#### WEPO FORMATION (of Mesaverde Gr.)U. Cretaceous

(1) NE Arizona. (2) G. A. Kiersch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4; C. A. Repenning and H. G. Page, 1956, A.A.P.G. Bull., v. 40, p. 271-279. (3) 7 mi. NE of Pinon, on W side of Wepo Wash, Black Mesa region, Navajo Co., Arizona. (4) Interb. ark. siltst., mudst., ss., and coal (318'-743'). (5) Overlies and intertongues with Toreva Fm.; underlies and intertongues with Yale Point Ss.

#### WESTWATER CANYON SANDSTONE MEMBER (of Morrison Fm.)U. Jurassic

(1) Four Corners region. (2) H. E. Gregory, 1938, U.S.G.S. P.P. 188, p. 59; J. W. Harshbarger, C. A. Repenning, and R. L. Jackson, 1951, N.M.G.S. 2d Gdbk., p. 98. (3) In canyon of Westwater Creek, 15 mi. SW of Blanding, San Juan Co., Utah. (4) Lt. gry. to grn.-ylw. and ylw.-br. ss., interb. grn. and ol.-gry. sh.; a few cgl. and red mudst. lenses (0-330'). (5) Conf. and gradat. with underlying Recapture and with overlying Brushy Basin Mem. Intertongues with Cow Springs. Where Brushy Basin Mem. has been removed by pre-Dakota erosion, the Westwater Canyon Mem. is overlain unconf. by Dakota Ss. See J. W. Harshbarger, C. A. Repenning, and J. H. Irwin, 1957, U.S.G.S. P.P. 291, p. 53-55.

#### WHITE HOUSE MEMBER (of De Chelly Ss.)Permian

(1) NE Arizona. (2) H. W. Peirce, 1964, Mus. North. Ariz. Bull. 40, p. 15-32. (3) Canyon de Chelly, Apache Co., Arizona. White House Trail provides only access to a complete sec. of unit. White House is a ruin in a natural alcove formed in this unit. (4) Cliff-form. large-scale x-bed. gry., oran., pk. ss.; siltst. and sdy. siltst. (0-570'). (5) Overlies Oak Springs Cliffs and Hunters Point Mem.; overlain unconf. by Shinarump Cgl. or conf. and gradat. by Black Creek Mem. of De Chelly Ss. Equiv. to Glorieta and San Andres in Zuni Mts., New Mexico. Descr. at length by H. W. Peirce, 1967, N.M.G.S. 18th Gdbk., p. 57-62. This mem. forms sheer walls of Canyon de Chelly.

#### WHITE RIM SANDSTONE MEMBER (of Cutler Fm.) or WHITE RIM SANDSTONE (of Cutler Gr.)Permian

(1) SE Utah. (2) A. A. Baker and J. B. Reeside, Jr., 1929, A.A.P.G. Bull., v. 13, p. 1423-1446. (3) In escarpment between Green and Colorado Rivers, known as the White Rim, Utah. (4) Wh., highly x-bed. ss. (0-250'). (5) Conf. on Organ Rock Sh.; overlain unconf. by Moenkopi Fm. Equiv. of De Chelly Ss.

#### WICHITA FORMATION or GROUPL. Permian (Wolfcampian.Leonardian)

(1) N and C Texas and W Oklahoma. (2) E. T. Dumble and W. F. Cummins, 1890, Texas Geol. Surv. 1st Ann. Rept., p. 188. (3) Wichita River and Wichita Co., Texas. (4) Overlies Cisco Gr.; underlies Clear Fork Gr. Orig. a fm., the Wichita Gr. now comprises seven fms.-all rocks assigned to the Wolfcamp Series and about half of those assigned to the Leonard Series.

#### WINGATE SANDSTONE (of Glen Canyon Gr.)U. Triassic

(1) Four Corners region. (2) C. E. Dutton, 1885, U.S.G.S. 6th Ann. Rept., p. 136; A. A. Baker, C. H. Dane, and J. B. Reeside, Jr., 1936, U.S.G.S. P.P. 183, p. 4-5. (3) Cliffs N of Fort Wingate, McKinley Co., New Mexico. (4) Mass., bright red, red-br., and red-oran., x-bed. ss., siltst., and sh. (100'-600'). (5) Basal fm. of Glen Canyon Group. Conf. on Chinle Fm. in places; disconf. in others. In Arizona, overlain disconf. by Kayenta Fm. or by Moenave Fm. In the Navajo country, the now-restr. Wingate compr. two mappable units (ascend.): Rock Point Mem. and Lukachukai Mem. In 1947, Baker, Dane, and Reeside, A.A.P.G. Bull., v. 31, p. 1664-1668, admittedly violated rules of priority by ext. the name Entrada Ss. from Utah into New Mexico, and recomm. that the orig. type loc. of the Wingate be aband. However, ten years later, Harshbarger, Repenning, and Irwin, 1957, U.S.G.S. P.P. 291, p. 8, sugg. that the name Wingate be restricted to the low. half of Dutton's type sec. Thus, the basal 355' of Dutton's 658' sec. may still be called Wingate; the up. 303' of Dutton's sec. may be called Entrada. Voluminous literature!

#### WINSOR FORMATION (of San Rafael Gr.)U. Jurassic

(1) C-S Utah. (2) H. E. Gregory, 1950, U.S.G.S. P.P. 220, p. 96-98. (3) Winsor Cove, 3 mi. S of Mount Carmel, Kane Co., Utah. (4) Thin, even-bed. wh. to ylw.-wh., red ss.; a few cgl. lenses (180'-300' in Zion Park region; 450'-800' in Paria Valley). (5) Disconf. or unconf. on Curtis or Entrada; overlain disconf. or unconf. by Dakota. Cow Springs Ss. may be equiv. in pt. of Winsor Fm.

#### WOLFCAMPIAN PROVINCIAL SERIES.L. Permian

(1) W Texas and New Mexico. (2) J. A. Udden, 1917, Univ. Texas Bull. 1753, p. 41; P. B. King, 1937, U.S.G.S. P.P. 187, p. 94-97. (3) Named for a place just S of the two buttes loc. 6.5 mi. E and 2 mi. N of E of Leonard Mt. Wolf Camp Hills are at base of S face of Glass Mts., 12-14 mi. NE of Marathon, Brewster Co., Texas. (4) Lowermost series of Permian; orig. simply a fm. J. E. Adams et al., 1939, A.A.P.G. Bull., v.23, p. 1674-1677, raised to series rank. Overlain by Leonardian Series.

**WUPATKI MEMBER (of Moenkopi Fm.)—L. Triassic**

(1) NE Arizona. (2) E. D. McKee, 1951, N.M.G.S. 2d Gdbk., p. 86-87; 1954, G.S.A. Mem. 61. (3) Wupatki Pueblo and Nat. Mon., Winslow-Holbrook area, Arizona. (4) Red mass. ss., thin-bed. siltst., and mudst. (0-119'). (5) Basal mem. of Moenkopi Fm. Unconf. on Kaibab Ls.; overlain conf. by Moqui Mem. of Moenkopi.

**YALE POINT SANDSTONE (of Mesaverde Gr.)---U. Cretaceous**

(1) NE Arizona. (2) G. A. Kiersch, 1955, Mineral resources, Navajo-Hopi Reserv., Arizona-Utah (Univ. Arizona Press), v. 2, p. 4, 7; C. A. Repenning and H. G. Page, 1956, A.A.P.G. Bull., v. 40, p. 271-281. (3) Near Yale Point of Black Mesa, Apache Co., Arizona. (4) Ylw.-gry. mass. ss., some x-bed.; thin silty units; minor coal (204'-300'). (5) Unit caps Black Mesa. Overlies and intertongues with Wepo Fm.; thins S-ward.

**ZUNI PEBBLE ZONE Oligocene or Miocene**

(1) NE Arizona and NW New Mexico. (2) P. W. Howell, 1959, Dissert. Abs., v. 20, no. 2, p. 641. (3) In Chetoh country, a sec. of Colorado Plateau N of Little Colorado River, ext. from Zuni uplift W-ward to Painted Desert. (4) Younger than Zuni erosion surface; older than the Miocene-early Pliocene Chetoh Fm.

**ZUNI SANDSTONE U. Jurassic**

(1) NW New Mexico and NE Arizona. (2) C. E. Dutton, 1885, U.S.G.S. 6th Ann. Rept., p. 137. (3) Along SW flank of Zuni Plateau, between Zuni Pueblo and Fort Wingate, New Mexico. (4) Varieg. band. to mass. ss. and sdy. sh.; occas. gyp. beds; "wonderfully banded" (800'-1,300'). (5) Later assigned to various units of Morrison Fm. and San Rafael Gr. from Cow Springs through Todilto. At first aband., the term Zuni Sandstone was later restored for use in the type area.