Stratigraphic Chart 1
1983

Nomenclature for Cenozoic rocks of northeast Mogollon–Datil volcanic field, New Mexico

by Glenn R. Osburn and Charles E. Chapin

Type sections–reference section–type areas

Tables 2–8 describe type sections measured by the authors for Blue Canyon Tuff, Chavez Canyon Member of the Spears Formation, Datil Well Tuff, Hells Mesa Tuff, Rincon Windmill Member of the Spears Formation, Rock House Canyon Tuff, and South Crosby Peak Formation. The measured type section of Hells Mesa Tuff (table 5) is a redefinition of that unit. Tonking's (1957, p. 56) type section included the Hells Mesa Tuff of this report plus La Jencia and Vicks Peak Tuffs. Also, Tonking's measured section contains a major error in the thickness of the Hells Mesa portion. Because of restrictions in space, type sections for La Jencia, Lemitar, and South Canyon Tuffs and a reference section for Vicks Peak Tuff, all previously described in theses, are listed with location and reference but not redescribed here. Type areas are described for units whose great thickness and/or variability make measurement of a type section impractical. These are the Dog Springs Member of the Spears Formation, Luis Lopez Formation, Magdalena Peak Rhyolite, Sawmill Canyon Formation, and Socorro Peak Rhyolite.

All theses cited in this section for descriptions of measured sections or type areas are available as open-file reports at the New Mexico Bureau of Mines and Mineral Resources. Photocopies of the texts and blue-line copies of the maps may be purchased from the Publications Office.

TABLE 2—TYPE SECTION FOR BLUE CANYON TUFF IS LOCATED IN THE DATIL MOUNTAINS. Location is approximately 7 mi (11 km) north of Datil and 1.1 mi (1.8 km) northeast of the junction of Cibola National Forest road 14 and the road up Blue Canyon, approximately 300 ft (90 m) north of the southern boundary of the Cal Ship Mesa 7½-min quadrangle; NE¼ SE¼ sec. 1, T. 1 S., R. 10 W.; measured up the northwest side of Main Canyon. Access is by forest roads 100 and 14 from US-60 northwest of Datil. The section was measured in January 1982 by C. E. Chapin and G. R. Osburn using a Brunton compass and tape.

Unit	Lithology	Thickness (equivalents) ft	(*m*)
	Datil Group (Oligocene). The type area for the Datil Group is located in the Datil Mountains and northwest Gallinas Mountains. See glossary for a discussion of the evolution of the term "Datil" and its new definition.		
	Overlying unit is Rincon Windmill Member of Spears Formation (Oligocene); not measured at this location. Volcaniclastic sandstone, light-brownish-gray (light-brown-weathering), coarse to granule; pebbly, noncalcareous cement; well stratified and well indurated; forms 2-ft (0.6-m) ledge then grassy slope with scattered piñon-juniper growth that rises gently northwestward for approximately 300 ft (90 m) to where a down-to-the-east normal fault juxtaposes Blue Canyon Tuff against the Rincon Windmill Member.		
	Blue Canyon Tuff		
3	Covered interval.	9	(*2.7*)
2	Ash-flow tuff, light-brownish-gray to light-purplish-gray (light-brown-weathering), unwelded to poorly welded, moderately crystal rich; phenocrysts mainly sanidine and biotite with traces of plagioclase and quartz; abundant black to bronze biotite; sparsely to moderately abundant andesitic lithic fragments; pumice poor but weathering of widely spaced large pumice imparts a crude eutaxitic foliation. The Blue Canyon Tuff forms a light-brown, massive cliff with crude columnar joints that stands out as a distinctive ledge between slope-forming volcaniclastic rocks above and below. The unit dips approximately 5° to the southwest.	31	(*9.4*)
	Total thickness of *Blue Canyon Tuff*.	40	(*12.1*)
1	Covered interval.	7	(*2.1*)
	Underlying unit is Rincon Windmill Member of Spears Formation (Oligocene); not measured at this location. Volcaniclastic sandstone, light-greenish-gray (light-brownish-gray-weathering), medium to very coarse, conglomeratic; contains thin lenses of pebble to small-boulder volcanic conglomerate; noncalcareous cement; well stratified and well indurated; planar bedding and low-angle crossbedding; weathers to steep, rounded slopes. A prominent monolith of these volcaniclastic rocks is present near the base of the slope.		

TABLE 3—TYPE SECTION FOR CHAVEZ CANYON MEMBER OF SPEARS FORMATION IS LOCATED IN THE NORTHWEST GALLINAS MOUNTAINS. Location is approximately 17 mi (27 km) northeast of Datil and 0.6 mi (1 km) north of Chavez well; S½ sec. 27, T. 2 N., R. 8 W., unsurveyed, Dog Springs 7½-min quadrangle; measured southward along the bottom of Chavez Canyon, thence southeastward up a steep tributary gully; 5° dip obtained from geologic map and from sighting across canyon; dips on outcrops vary from 5° to 20° because of low-angle cross-stratification. Access is by private roads from Long Canyon on the J. Taylor Ranch (permission required). The section was measured in February 1982 by C. E. Chapin and G. R. Osburn using a Brunton compass and Jacob's staff.

Unit	Lithology	Thickness (equivalents) ft	(*m*)
	Spears Formation of the Datil Group (Oligocene)		
	Overlying unit is Rock House Canyon Tuff of the Datil Group (Oligocene); not measured at		

Unit	Lithology	Thickness (equivalents) ft	(*m*)
	this location. Ash-flow tuff, light-gray (light-orange-tan-weathering), poorly welded, crystal-poor; phenocrysts mainly sanidine with traces of plagioclase, biotite, and quartz; moderately pumiceous; forms prominent ledge at head of gully.		
	Chavez Canyon Member		
14	Talus from overlying Rock House Canyon Tuff.	15	(*4.5*)
13	Volcaniclastic sandstone, light-brown (brown-weathering), medium to very coarse, conglomeratic; contains thin lenses of pebbly sand and pebble to cobble conglomerate; consists mainly of varicolored tan, red-brown, purple, and gray andesitic clasts.	15	(*4.5*)
12	Covered interval.	13	(*4.0*)
11	Volcaniclastic conglomerate, reddish-brown (same-weathering); pebble to small-boulder conglomerate; matrix of coarse sand and small pebbles; subrounded to well-rounded clasts; west-northwest transport indicated by imbricated clasts; consists mainly of varicolored tan, red-brown, purple, and gray clasts of various andesites including a plagioclase porphyritic turkey-track type.	12	(*3.6*)
10	Volcaniclastic sandstones and conglomerates; thin sedimentation units of varying grain size, light-gray (same-weathering), medium to very coarse; conglomeratic sandstones containing thin lenses of pebble to cobble (to 6 inches, 15 cm) conglomerate, pebbly sandstone, and pebble conglomerate; intermittent exposures along gully bottom.	18	(*5.5*)
9	Covered interval.	21	(*6.4*)
8	Volcaniclastic sandstone, light-gray (same-weathering), medium to very coarse, well-indurated; noncalcareous cement; abundant small balls of tightly cemented sand.	10	(*3.0*)
7	Covered interval.	25	(*7.6*)
6	Volcaniclastic sandstone, light-gray (light-brownish-gray-weathering), medium to granule; abundant pebbles to 2¾ inches (7 cm); occasional matrix-supported cobble or small boulder; well indurated; noncalcareous cement; some balls of tightly cemented sand; ledgy outcrops; beds from 8 inches (20 cm) to 4 ft (1.2 m) thick; includes a few thin beds of clean sandstones similar to underlying unit; north-northwest transport indicated by imbricated clasts; normal fault with 6.5 ft (2 m) of down-to-the-north displacement cuts this unit.	22	(*6.7*)
5	Covered interval.	20	(*6.1*)
4	Volcaniclastic sandstone, light-gray (light-brownish-gray-weathering); salt-and-pepper texture formed by very abundant grains of biotite and hornblende and other dark minerals; dark minerals also concentrated on laminae; moderately well sorted beds of fine to medium, medium to coarse, and granule sand; induration varies from poor to very good with a noncalcareous to slightly calcareous cement; beds range from laminae to 5 ft (1.5 m) thick and average approximately 3 ft (1 m); bedding varies from planar to low-angle trough crossbedding; occasional matrix-supported, isolated cobble or small boulder to 2 ft (0.6 m); unit is distinctive because of its moderately good sorting, light-gray color, and general lack of either mud drapes or coarse clasts. Abundant fracture-controlled caliche approximately 20 ft (6 m) below top.	165	(*50.0*)
3	Volcaniclastic sandstone, light-gray (light-brownish-gray-weathering), medium to very coarse, conglomeratic, becoming finer and better sorted upward; interbedded thin lenses of pebble conglomerate; bedding thickens upward to maximum of 5 ft (1.5 m); moderately well indurated with noncalcareous cement; partly covered but with intermittent exposures in small gullies.	75	(*23.0*)
2	Volcaniclastic sandstone, light-gray (light-brownish-gray-weathering); salt-and-pepper texture due to abundant biotite and hornblende grains; medium to very coarse, conglomeratic; contains thin lenses of pebble conglomerate with some cobbles and boulders to 14 inches (36 cm); outcrop approximately 65% sandstone and 35% conglomerate; moderately well indurated with noncalcareous cement; well stratified; planar bedding and low-angle crossbedding; moderately thin bedding from 6 inches (15 cm) to 2 ft (0.6 m) with frequent variation in grain size; some shallow cut-and-fill structures; transport direction N. 10°–20° W. as indicated by clast imbrication and channel axes; large outcrop at right-angle bend in stream bed.	5	(*1.5*)
	Total thickness of *Chavez Canyon Member*.	416	(*126.4*)
1	Covered interval (a few isolated exposures of the Dog Springs Member are present in small gullies along the east side of Chavez Canyon). The base of the Chavez Canyon Member is near the top of the covered interval.	65	(*20.0*)
	Underlying unit is Dog Springs Member of Spears Formation (Oligocene); not measured. Mudflow deposit, buff (same-weathering), heterolithic, epiclastic; approximately 75% matrix of unsorted sand, silt, and clay; abundant black biotite and hornblende grains in matrix; angular clasts range from small pebbles to boulders 18 inches (46 cm) across; clast lithologies are various intermediate rock types ranging from tan to gray, greenish gray, and reddish brown; some clasts contain mainly pyroxene phenocrysts, others mainly hornblende; some large boulders (to 10 ft, 3 m) of light-greenish-gray to reddish-brown monolithic breccias (section measured southward up stream bed in Chavez Canyon from the good outcrop of mudflow breccia described above).		

TABLE 4—TYPE SECTION FOR DATIL WELL TUFF IS LOCATED IN THE DATIL MOUNTAINS. Location is on the northeast side of White House Canyon 1.2 mi (1.9 km) northwest of junction of US-60–US-12 in town of Datil; NW¼SW¼ sec. 2, T. 2 S., R. 10 W., Datil 7½-min quadrangle. Measured from small outcrop of andesite of White House Canyon poorly exposed on steep talus-covered slope approximately 200 ft (60 m) southeast of west corner of mesa and just northwest of large juniper tree, thence N. 70° E., parallel to strike, up steep slope and low cliff of Datil Well Tuff and across wide bench to first exposure of overlying volcaniclastic sandstones. The section was measured in February 1982 by C. E. Chapin and L. A. Brouillard using direct measurement on the cliffy outcrop and eye-height method parallel to strike in crossing the wide bench. *Because the changes in the Datil Well Tuff are gradational, the section is described at a series of points whose elevations above the base are given instead of the usual thickness of beds.*

Unit	Lithology	Elevation (above base) ft	(*m*)
	Datil Group (Oligocene). The type area for the Datil Group is located in the Datil Mountains and northwest Gallinas Mountains. See glossary for a discussion of the evolution of the term "Datil" and its new definition.		
	Overlying unit is upper part of Chavez Canyon Member of Spears Formation (Oligocene); not measured at this location. Volcaniclastic sandstone, red-brown, poorly sorted; coarse sand and granules with abundant pebbles (interbedded lenses of pebble to cobble volcaniclastic conglomerate inferred from float); well indurated; angular to subrounded clasts; contact with Datil Well Tuff not exposed but inferred to be near change in slope on northeast side of wide bench formed by Datil Well Tuff; top of mesa is capped by Rock House Canyon Tuff.		
	Datil Well Tuff		
7	First exposure of volcaniclastic sandstones near change in slope at northeast side of soil-covered bench.	31.5 (above base)	(*9.5*)
6	Southwest edge of 400-ft (120-m) wide, soil-covered bench held up by Datil Well Tuff.	19.5 (above base)	(*5.9*)
5	Ash-flow tuff, pink and purple, very streaky and flaggy, densely welded, moderately crystal rich.	15.8 (above base)	(*4.8*)
4	Ash-flow tuff, pink and purple, mottled and streaky (flow-banded?), densely welded, moderately crystal rich; phenocryst mineralogy as below; moderately abundant green pyroxene phenocrysts; sparse very small andesitic lithic fragments; sparse white pumice.	10.9 (above base)	(*3.3*)
3	Ash-flow tuff, light-pinkish-gray, faintly streaky, densely welded, moderately crystal rich; phenocryst mineralogy as below; moderately abundant small red and gray andesitic lithic fragments; very pumice poor; transition between massive and flaggy zones.	8.2 (above base)	(*2.5*)
2	Ash-flow tuff, light-purple-gray (light-brown-weathering), massive, densely welded, moderately crystal rich; phenocrysts mainly sanidine with approximately 1% each of biotite and a green, considerably altered pyroxene; traces of plagioclase and quartz; moderately abundant small andesitic lithic fragments and a few pebble-size fragments of the underlying andesite of White House Canyon; very pumice poor.	3.5 (above base)	(*1.1*)
	Total thickness of *Datil Well Tuff.*	31.5	(*9.5*)
1	Covered interval. Measurement reflects thickness of interval in feet and meters.	24	(*7.3*)
	Underlying unit is andesite of White House Canyon, an informal member of Spears Formation (Oligocene). Basaltic-andesite flow, purplish-gray (same-weathering), coarsely porphyritic with abundant large (¾ inch, 1 cm) laths of plagioclase and abundant greenish-black pyroxene phenocrysts in a purplish matrix, crystal-rich; scattered amygdules of quartz and calcite; small (10 ft long by 5 ft high [3 m long by 1.5 m high]) outcrop on northwest side of large juniper tree 55 ft (16.7 m) downslope from base of Datil Well cliff.		

The type area for the *Dog Springs Member* of the Spears Formation is located in the northwest Gallinas Mountains. The location is approximately 20 mi (32 km) northeast of Datil in Dog Springs Canyon and its major tributaries, Chavez Canyon and Old Canyon; S½, T. 2 N., R. 8 W. and north edge of T. 1 N., R. 8 W., D Cross and Dog Springs 7½-min quadrangles. Access is by driving up Dog Springs Canyon from the Martin Ranch (permission required). For descriptions of the Dog Springs Member in its type area see Coffin (1981, p. 17–87, pl. 1), Harrison (1980, p. 15–43, pl. 1), and Robinson (1981, p. 92–98, pl. 1).

TABLE 5—TYPE SECTION FOR HELLS MESA TUFF IS LOCATED AT NORTH END OF BEAR MOUNTAINS. Location is approximately 17 mi (27 km) north-northwest of Magdalena, approximately 3.6 mi (5.7 km) northwest of Hells Mesa, and approximately 0.3 mi (0.4 km) southwest of Bluff Spring; center of side common to sec. 36, T. 2 N., R. 5 W. and sec. 31, T. 2 N., R. 4 W., Mesa Cencerro 7½-min quadrangle. Measured southwest up sharp ridge on south side of Cañon del Alamito; ridge is at east end of prominent cliff. Base of Hells Mesa Tuff is near brass quarter-section monument and approximately 80 ft (24 m) above canyon bottom. A jeep trail up Cañon del Alamito provides access to near Bluff Spring. Tonking (1957, p. 56) apparently measured the type section of his Hells Mesa Member of the Datil Formation in this vicinity; however, his Hells Mesa Member included the Hells Mesa Tuff plus La Jencia and Vicks Peak Tuffs of this report. The thickness reported for the Hells Mesa portion by Tonking is only approximately half the thickness as measured in March 1982 by the authors, C. E. Chapin and G. R. Osburn, using a Brunton compass and tape. The authors, therefore, redefine the section as described below. *Because the changes in the Hells Mesa Tuff are gradational, the section is described at a series of points whose elevations above the base are given instead of the usual thickness of beds.*

Unit	Lithology	Elevation (above base) ft	(*m*)
	Overlying unit is La Jencia Tuff; not measured. Ash-flow tuff, 2 ft (0.6 m) of lavender-gray (brown-weathering), densely welded, crystal-poor; pumice-poor tuff grading abruptly upward in welded transition to orange-brown (brown-weathering), densely welded, crystal-poor, very pumiceous tuff that forms a 30-ft (9.1-m) cliff. La Jencia Tuff is crystal poor with sanidine being the dominant phenocryst followed by approximately 0.5% quartz and traces of plagioclase and biotite.		
	Hells Mesa Tuff		
10	Contact of Hells Mesa Tuff and La Jencia Tuff.	233 (above base)	(*70.5*)
9	Ash-flow tuff, pale-pinkish-white (very light brown weathering), poorly welded, very crystal rich, very quartz rich; other phenocrysts are sanidine, plagioclase, and biotite; sparse gray and red-brown andesitic lithic fragments; sparse cream-colored, crystal-rich pumice to 3 inches (8 cm); forms rounded, light-colored ledge approximately 8 ft (2.4 m) high.	223 (above base)	(*67.5*)
8	Ash-flow tuff, light-pinkish-gray (light-brown-weathering), moderately welded, crystal-rich with very bronzy biotite; other phenocrysts as below; pumice less abundant; forms bench of smooth, spheroidally weathering slabs.	199 (above base)	(*60.3*)
7	Ash-flow tuff, pale-pink (brown-weathering), moderately welded, crystal-rich but less than below; mineralogy same as below; bronzy biotite; moderately abundant, small, highly flattened, red-brown pumice with spherulitic texture.	175 (above base)	(*53.0*)

Unit	Lithology	Elevation (above base) ft	(m)
6	Ash-flow tuff, brownish-pink (brown-weathering), densely welded, crystal-rich; mineralogy same as below except more quartz and bronzy biotite; almost no pumice.	135 (above base)	(41.0)
5	Ash-flow tuff, brownish-pink (brown-weathering), densely welded, crystal-rich; abundant quartz and bronzy biotite; sanidine and plagioclase approximately equal; fewer lithic fragments and pumice than below.	73 (above base)	(22.1)
4	Ash-flow tuff, light-lavender (brown-weathering), densely welded, crystal-rich, two-feldspar; abundant black biotite; sparse large quartz grains; sparse small brown and gray aphanitic lithic fragments; abundant small (0.5–1.5 cm) light-colored pumice.	19 (above base)	(5.8)
3	Base of densely welded zone.	12 (above base)	(3.6)
2	Brass monument marking quarter section.	11 (above base)	(3.3)
1	Ash-flow tuff, pink, poorly welded, crystal-rich, two-feldspar; abundant black biotite; minor quartz; abundant red, gray, and purple andesitic lithic fragments; abundant small (0.5–1.5 cm) light-colored pumice; weathers with platy fracture and forms slope that is often covered by talus from more resistant tuff above; good exposure of Spears–Hells Mesa contact and much thicker basal zone in gully approximately 100 ft (30 m) east of section.	6 (above base)	(1.8)
	Total thickness of *Hells Mesa Tuff.*	233	(70.5)
Underlying unit is Spears Formation of the Datil Group (Oligocene). Volcaniclastic sandstone, light-brown to red-brown (same-weathering), poorly sorted; medium to very coarse sand with abundant pebbles; some thin lenses of pebble conglomerate; well indurated; noncalcareous cement; planar bedding from 2 inches (5 cm) to 3 ft (1 m) thick; minor cut-and-fill structure.			

The type section for *La Jencia Tuff* is located in the southern Bear Mountains. The location is on the west side of La Jencia Basin approximately 6.5 mi (10.5 km) north of Magdalena and 1.8 mi (2.9 km) southeast of Bear Springs on the east slope of a west-dipping hogback just south of Cibola National Forest road 506; NW¼ sec. 22, T. 1 S., R. 4 W., Magdalena NW 7½-min quadrangle. Access is by forest roads 354 and 506 from Magdalena. La Jencia Tuff is the lower cooling unit of Brown's (1972) tuff of Bear Springs. For a description of the type section of La Jencia Tuff see Brown (1972, p. 31–42, pl. 1). Brown measured 507 ft (155 m) of La Jencia Tuff and reported modal mineralogy for 23 samples collected along the line of section.

The type section for the *Lemitar Tuff* is located in the Lemitar Mountains. The location is approximately 8 mi (13 km) northwest of Socorro in a tributary canyon on the north side of Cañoncito del Puertecito del Lemitar (Corkscrew Canyon); NW¼SE¼SE¼ sec. 12, T. 2 S., R. 2 W., Lemitar 7½-min quadrangle. Access is by jeep trail up Corkscrew Canyon through the J. B. Kelly Ranch (permission required). For a description of the type section of the Lemitar Tuff see Chamberlin (1980, p. 92–97, fig. 13, tables 3 and 4, and appendix A, p. 481–490). Chamberlin measured 126 ft (38 m) of Lemitar Tuff and reported modal mineralogy for five samples and chemical compositions for eight samples collected along the line of section.

The type area for the *Luis Lopez Formation* is located in the central Chupadera Mountains. The location is at the south end of the Luis Lopez manganese district approximately 11 mi (18 km) southwest of Socorro and 7 mi (11 km) southwest of the village of Luis Lopez. Here, the Luis Lopez Formation is well exposed along the east side of the Chupadera Range from approximately 2.5 mi (4 km) north of Nogal Canyon to 3.3 mi (5.3 km) south of Nogal Canyon; secs. 20, 29, 31, 32, T. 4 S., R. 1 W.; secs. 4, 5, 6, 8, 9, T. 5 S., R. 1 W., Luis Lopez 7½-min quadrangle. Access is via a road that leads westward up Nogal Canyon from I-25 at the San Antonio interchange (4-wheel-drive vehicle advised) and by the Red Canyon (M.C.A.) mine road. Chamberlin (1980) named the Luis Lopez Formation for exposures at the north end of the Chupadera Range; however, stratigraphic relationships are better demonstrated in the Nogal Canyon area, herein designated the type area. For descriptions of the Luis Lopez Formation in its type area see Eggleston (1981, p. 41–62, fig. 9, pl. 1).

The type area for *Magdalena Peak Rhyolite* is located on and south of Magdalena Peak. The location is approximately 1.25–5 mi (2–8 km) south of the village of Magdalena on Magdalena Peak and along Hop and Agua Frio Canyons; sec. 34, T. 2 S., R. 4 W. and secs. 2, 3, 10, 11, 14, 15, T. 3 S., R. 4 W., Magdalena SW 7½-min quadrangle. Access is from Magdalena via the Hop Canyon Road (Cibola National Forest road 101) or NM-107. For descriptions of the Magdalena Peak Rhyolite in its type area see Allen (1979, p. 71–89, pl. 1) and Bobrow (1983).

TABLE 6—TYPE SECTION FOR RINCON WINDMILL MEMBER OF SPEARS FORMATION IS LOCATED IN THE NORTHEAST DATIL MOUNTAINS. Location is approximately 14 mi (22.5 km) northeast of Datil and 1.25 mi (2 km) north-northwest of Rincon windmill; NW¼NW¼ sec. 18, T. 1 N., R. 8 W., unsurveyed, Dog Springs 7½-min quadrangle; measured northeastward up a steep gully on the southwest corner of mesa 8390; 7° dip taken from geologic map; dips on outcrops are variable because of low-angle cross-stratification. Access is by private roads leading to either Rincon windmill or John Henry windmill on the J. Taylor Ranch (permission required). The section was measured in February 1982 by C. E. Chapin and L. A. Brouillard using a Brunton compass and Jacob's staff.

Unit	Lithology	Thickness (equivalents) ft	(m)
Spears Formation of the Datil Group (Oligocene)			
	Overlying unit is Hells Mesa Tuff; not measured at this location. Ash-flow tuff, white (light-brownish-gray-weathering), unwelded, crystal-rich; phenocrysts of sanidine, plagioclase, quartz, and biotite; abundant pumice lapilli; forms prominent light-colored cliff, the lower part of which shows some internal stratification.		
	Rincon Windmill Member		
8	Volcaniclastic sandstone, aeolian, brown, fine to medium, very well sorted, poorly consolidated, laminated and crossbedded, poorly exposed in gully just north of traverse.	35	(10.6)

Unit	Lithology	Thickness (equivalents) ft	(*m*)
7	Volcaniclastic sandstone, light-brownish-gray (light-brown-weathering), fine to medium, clean and well-sorted with no pebbles, moderately indurated, very porous; concretionary cementation common; planar bedding and low-angle crossbedding; beds from laminae to 2 ft (0.6 m) thick; approximately 2 ft (0.6 m) of relief on base of unit with the lows filled with structureless bimodal sand (coarse sand and granules and a few pebbles floating in matrix of fine to medium sand); uppermost 8 ft (2.4 m) of unit is less well sorted, fine to coarse sandstone, very poorly indurated with spectacular low-angle crossbedding and concretionary cementation.	50	(*15.2*)
6	Volcaniclastic sandstone, light-brownish-gray (light-brown-weathering); medium to granule sand with sparse andesitic (gray, red-brown, purple) small pebbles and an occasional cobble; well indurated; noncalcareous cement; well stratified; planar bedding and low-angle crossbedding; beds average 1–2 ft (0.3–0.6 m) thick but range from laminae marked by concentrations of heavy minerals to beds 6 ft (2 m) thick; occasional thin lenses of pebble conglomerate or pebbly sandstone; N. 10° E. transport direction from imbricated pebbles.	97	(*29.4*)
5	Blue Canyon Tuff, light-gray (light-brown-weathering), unwelded, moderately crystal rich; phenocrysts mainly sanidine and biotite with traces of plagioclase and quartz; abundant black biotite; moderately abundant small andesitic lithic fragments (gray, red-brown, purple) and a few pebbles from underlying sediments; sparse moderately large (⅜–2 inches [1–5 cm]) light-brown pumice, which weathers out and imparts a crude foliation to the cliffy outcrop; soft, clayey, altered zones at base (1–5 ft [0.3–1.5 m] thick) and top (4 ft [1.2 m] thick) of unit.	23	(*7.0*)
	Note: line of section offset 50 ft (15.2 m) to north along base of Blue Canyon Tuff to avoid a minor fault.		
4	Volcaniclastic sandstones and conglomerates, light-brownish-gray (same-weathering); coarse to granule sandstones with thin (3–18 inches [7–46 cm]) lenses of pebble to cobble conglomerate that contain a few small boulders; planar bedding and low-angle crossbedding; moderately well indurated; forming ledgy outcrops; north-northeast transport direction based on pebble imbrications; granule to 1 inch (2.5 cm) pumice abundant in sandstones; distinctive 7.5 ft (2.3 m) bed of light-cream, fine to medium tuffaceous sandstone containing abundant biotite and sparse pumice lapilli occurs 110 ft above base of interval.	171	(*52.0*)
3	Covered interval.	25	(*7.6*)
2	Volcaniclastic sandstone, light-brownish-gray (same-weathering); poorly sorted; very coarse to granule sand with sparse small pebbles and occasional cobbles; moderately well indurated but very porous (minor noncalcareous cement); well stratified; low-angle crossbedding; abundant yellow and tan granules of pumice; lithic grains are tan, gray, red-brown, and purple andesitic rock fragments.	5	(*1.5*)
1	Covered interval.	5	(*1.5*)
	Total thickness of *Rincon Windmill Member.*	411	(*124.8*)
	Underlying unit is Rock House Canyon Tuff; not measured at this location. Ash-flow tuff, light-gray (very light brown weathering), unwelded, crystal-poor; phenocrysts mainly sanidine with traces of plagioclase, biotite, and quartz; moderately abundant pumice; unit forms light-gray, smooth, rounded surfaces and low cliffs along arroyos.		

TABLE 7—TYPE SECTION FOR ROCK HOUSE CANYON TUFF IS LOCATED IN THE NORTHWEST GALLINAS MOUNTAINS. Location is approximately 15 mi (24 km) northeast of Datil and 3 mi (4.8 km) north of North Lake at the junction of Rock House Canyon and Long Canyon; SW¼ sec. 13, T. 1 N., R. 8 W., unsurveyed, Dog Springs 7½-min quadrangle. Measured from near the head of a steep gully on the south side of Long Canyon where the base of the unit is exposed, thence southwestward down a dip slope and across to the north side of Long Canyon at the east end of the box, thence southwestward to just beyond the junction of Long Canyon with Rock House Canyon. Access is by private road up Long Canyon on the J. Taylor Ranch (permission required). The section was measured in February 1982 by C. E. Chapin and G. R. Osburn using an Abbe level and Jacob's staff. *Because the changes in the Rock House Canyon Tuff are gradational, the section is described at a series of points whose elevations above the base are given instead of the usual thickness of beds.*

Unit	Lithology	Elevation (above base) ft	(*m*)
	Datil Group (Oligocene). The type area for the Datil Group is located in the Datil Mountains and northwest Gallinas Mountains. See glossary for a discussion of the evolution of the term "Datil" and its new definition.		
	Overlying unit is Rincon Windmill Member of Spears Formation (Oligocene); not measured at this location. Volcaniclastic conglomerate, variegated, poorly sorted; pebble to boulder (to 2 ft, 0.6 m) conglomerate with light-tan, medium to very coarse sandy matrix and a few thin sandy strata, well-rounded boulders, and some calcite cement; moderately well indurated; clast supported; N. 55° E. transport direction from clast imbrication; description from exposures along north bank of arroyo approximately 650 ft (200 m) west of the uppermost exposure of Rock House Canyon Tuff.		
8	Covered interval. Measurement reflects thickness of interval in feet and meters.	36	(*11.0*)
	Rock House Canyon Tuff		
7	Ash-flow tuff, light-creamy-white (light-brown-weathering), unwelded, soft, crystal-poor; sparse sanidine phenocrysts; sparse small gray lithic fragments; abundant elliptical pumice to 1½ inches (4 cm) across. (Additional Rock House Canyon Tuff, as described above, is exposed approximately 500 ft [150 m] west of the end of the measured section in the north bank of the arroyo; however, because of an apparent flattening of the dip and possible faulting beneath the intervening covered interval, this material was not included in the measured section.)	225 (above base)	(*68.6*)

Unit	Lithology	Elevation (above base) ft	(m)
6	Ash-flow tuff, very light gray (light-brown-weathering), unwelded, crystal-poor; sparse small gray and red andesitic lithic fragments; top of cliff on north side of box canyon.	175 (above base)	(53.0)
5	Ash-flow tuff, very light tan (light-brown-weathering), slightly welded, crystal-poor; sparse small gray and red andesitic lithic fragments; pumice cellular and uncompacted; at east end of box canyon approximately 100 ft (30 m) north of box.	135 (above base)	(41.0)
4	Ash-flow tuff, light-gray (light-brown-weathering), moderately welded, crystal-poor; phenocrysts mainly sanidine with traces of hornblende and quartz; grainy matrix; 10 ft (3 m) below top of ridge, traverse turns southwestward down dip slope and crosses to north side of Long Canyon at east end of box canyon.	65 (above base)	(19.7)
3	Ash-flow tuff, light-purplish-gray (purple-gray-weathering), moderately welded, crystal-poor; phenocrysts mainly sanidine but with noticeable quartz and sparse black hornblende(?); gradational increase in pumice content and degree of welding up from base; pumice well compacted and no longer spherulitic; shard structure in matrix still noticeable.	30 (above base)	(9.1)
2	Ash-flow tuff, light-pinkish-gray (weathers to gray platy grus); poorly welded but well indurated; crystal poor; phenocrysts mainly sanidine but with noticeable quartz (0.5%) and traces of biotite and a black ferromagnesian mineral that may be hornblende; sparse small gray andesitic lithic fragments; sparse uncompacted pink pumice and light-tan spherulitically devitrified pumice, shard structure conspicuous in matrix.	1 (above base)	(0.3)
	Total thickness of *Rock House Canyon Tuff.*	225	(68.6)
1	Covered interval. Measurement reflects thickness of interval in feet and meters.	10	(3.0)
	Underlying unit is Chavez Canyon Member of Spears Formation (Oligocene); not measured at this location. Volcaniclastic conglomerate, light-brownish-gray (very light brown weathering), poorly sorted; coarse sand to granules and pebbles with some cobbles; moderately well indurated; noncalcareous cement; abundant bronzy biotite; exposed in steep gully on south side of Long Canyon (first conspicuous gully east of the last outcrop of Rock House Canyon Tuff in bottom of canyon).		

The type area for the *Sawmill Canyon Formation* is located in Sawmill Canyon. The location is approximately 16 mi (26 km) southeast of Magdalena along both sides of Sawmill Canyon; secs. 3, 4, 9, 10, 11, 14, 15, T. 5 S., R. 3 W., South Baldy 7½-min quadrangle. Access is via Cibola National Forest road 472 and trail 19. For descriptions of the Sawmill Canyon Formation in its type area see Roth (1980, p. 36–46, pl. 1) and Bowring (1980, p. 28–41, pl. 1). The Sawmill Canyon Formation is Roth and Bowring's unit of Sixmile Canyon.

The type area for the *Socorro Peak Rhyolite* is located on and south of Socorro Peak. The location is approximately 3 mi (5 km) west and southwest of Socorro in a belt extending from the summit of Socorro Peak southward to the Grefco perlite mine; secs. 5, 8, 16, 17, 21, 28, T. 3 S., R. 1 W., Socorro 7½-min quadrangle. Access is via Blue Canyon Road through the campus of New Mexico Institute of Mining and Technology (permission required) and by roads to Socorro Spring and the Grefco mine. For descriptions of the Socorro Peak Rhyolite in its type area see Chamberlin (1980, p. 283–339, pls. 1, 2).

The type section for the *South Canyon Tuff* is located at the mouth of South Canyon. The location is approximately 12 mi (19 km) southwest of Socorro on the northwest side of the mouth of South Canyon; SW¼ sec. 30, T. 3 S., R. 2 W., Magdalena SE 7½-min quadrangle. Access is via US-60 southwest from Socorro then by Cibola National Forest road 37. For a description of the type section of the South Canyon Tuff see Osburn (1978, p. 49–58, fig. 14, pl. 1). Osburn measured 620 ft (189 m) of South Canyon Tuff and reported modal mineralogy for 11 samples collected along the line of section.

TABLE 8—TYPE SECTION FOR SOUTH CROSBY PEAK FORMATION IS LOCATED IN THE EASTERN CROSBY MOUNTAINS. Location is approximately 4.3 mi (7 km) southwest of Datil and 1.8 mi (3 km) northeast of South Crosby Peak; NE¼ sec. 19, T. 2 S., R. 10 W., Sugarloaf Mountain 7½-min quadrangle. Forest roads 66, 196, and 510 to near Rock Cliff tank (Crosby Springs 7½-min quadrangle) provide the nearest access. Section begins approximately 25 ft (8 m) lower in elevation and approximately 75 ft (23 m) N. 30° E. of a rounded knob of Hells Mesa Tuff. The basal South Crosby Peak Formation occurs at lower elevations than the top of the Hells Mesa Tuff due to deposition in channels cut into the tuff. Because of this irregular contact and lack of exposure, the section was started at the lowest exposed sandstone and measured N. 20° W. directly upslope using a N. 75° E. strike for the beds and a 4° dip to the southeast. The section was measured in March 1982 by G. R. Osburn and D. J. Bobrow using a hand level and Jacob's staff.

Unit	Lithology	Thickness (equivalents) ft	(m)
	Overlying unit is basaltic andesite of Deep Well; not measured. Basaltic andesite, black (olive-gray-weathering) with abundant light-brown specks of oxidized ferromagnesian minerals (to 2 mm); moderately abundant plagioclase laths (to 5 mm); abundant amygdules of calcite and silica; prominent rubble zone at base of flow. The basaltic andesite of Deep Well consists of three flows separated by thin (13 ft [4 m] and 45 ft [13.6 m]) intervals of volcaniclastic conglomerate and conglomeratic sandstone and is overlain by the Vicks Peak Tuff.		
	South Crosby Peak Formation		
4	Volcaniclastic conglomerates and interbedded tuffaceous sandstones, grayish-pink (brownish-pink-weathering); dark andesitic clasts impart darker colors to cobble-rich intervals; sandstones medium to granule with variable subangular to subrounded pebbles and cobbles; maximum clast size in conglomerates approximately 8 inches (20 cm); lithic grains are varicolored, tan, reddish-brown, purple, and light-green, aphanitic, intermediate to felsic volcanic rocks; all beds are tuffaceous with abundant light-colored pumice lapilli and ash; the conglomerate/sandstone ratio increases upward in the section; the lower beds are the most tuffaceous apparently because of reworking of		

Unit	Lithology	Thickness (equivalents) ft	(*m*)
	underlying ash-flow tuff; moderately to well indurated; noncalcareous; well stratified; planar bedding from 3 inches (7 cm) to 1 ft (30 cm); minor low-angle crossbedding and small cut-and-fill structures; transport direction from pebble imbrications from N. 30° W. to N. 60° W.	451	(*137.0*)
3	Ash-flow tuff, pale-pink (brownish-pink-weathering), unwelded to poorly welded, crystal-poor; abundant lithic fragments of red, brown, purple, and light-green, aphanitic, intermediate to felsic volcanic rocks; abundant light-colored pumice to ⅜ inch (1.5 cm); weak eutaxitic foliation; lithic content varies both vertically and laterally from approximately 5% to more than 50%; unit forms moderately massive cliffs and steep slopes; the unit extends for several miles to the west and southwest but is missing immediately east of this section.	37	(*11.2*)
	Section offset 300 ft (90 m) to west along base of ash-flow tuff.		
2	Volcaniclastic sandstones and conglomeratic sandstones, tuffaceous, grayish-pink (grayish-orange-pink-weathering); medium to granule sand with some layers containing granules and pebbles to 1 inch (2.5 cm); abundant small light-colored pumice; abundant biotite; angular to subrounded clasts; moderately indurated; noncalcareous cement; well stratified; planar bedding; beds from 5 inches (10 cm) to 3 ft (1 m) thick; white pumice-rich layers along bedding planes.	22	(*6.7*)
1	Volcaniclastic sandstone, tuffaceous, grayish-orange-pink (same-weathering), medium to coarse, well-sorted; occasional pebbles; moderately to well indurated; noncalcareous cement; indistinct planar bedding; beds from a few inches to 1 ft (30 cm) thick; unit uniform from top to bottom and forms massive, gently sloping outcrops.	85	(*25.8*)
	Total thickness of *South Crosby Peak Formation.*	595	(*180.7*)
Underlying unit is Hells Mesa Tuff; not measured at this location. Ash-flow tuff, pinkish-gray (grayish-orange-weathering), poorly welded, crystal-rich, quartz-rich; subequal sanidine and plagioclase; abundant bronzy biotite; sparse andesitic lithic fragments; moderately abundant pumice; weak foliation; forms large rounded knobs and boulders.			

A reference section for the *Vicks Peak Tuff* is located in the southern Bear Mountains. The location is approximately 6 mi (9.7 km) north of Magdalena and 2.5 mi (4 km) southeast of Bear Springs on the west slope of a west-dipping hogback 0.8 mi (1.3 km) south of Cibola National Forest road 506; S½ sec. 22, T. 1 S., R. 4 W., Magdalena NW 7½-min quadrangle. Access is via forest roads 354 and 506 from Magdalena. The Vicks Peak Tuff was named by Farkas (1969) and redefined by Deal and Rhodes (1976), but a type section was not measured nor was the type locality, Vicks Peak, mapped in detail. Since the name is established in the literature and the Vicks Peak Tuff was erupted from the Nogal Canyon cauldron in the Vicks Peak area, we accept the name but herein define a reference section in an area that has been mapped in detail (1:24,000) and where the stratigraphic relationships are well exposed. For a description of the reference section of the Vicks Peak Tuff see Brown (1972, p. 42–46, table 3, fig. 12, pl. 1). The Vicks Peak Tuff is the upper cooling unit of Brown's tuff of Bear Springs. Brown measured 280 ft (85 m) of Vicks Peak Tuff and reported modal mineralogy for 15 samples collected along the line of section.