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1994, pp. 113-115. https://doi.org/10.56577/FFC-45.113

in:

Mogollon Slope (West-Central New Mexico and East-Central Arizona), Chamberlin, R. M.; Kues, B. S.; Cather, S. M.; Barker, J. M.; McIntosh, W. C.; [eds.], New Mexico Geological Society 45th Annual Fall Field Conference Guidebook, 335 p. https://doi.org/10.56577/FFC-45

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SUPPLEMENTAL ROAD LOG, TEJANA MESA (EL PORTICITO) TO US-60 VIA ZUNI SALT LAKE MAAR

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SUMMARY

Tejana Mesa is capped by a late Tertiary basalt flow that has yielded a K-Ar date of 6.7 ± 0.2 Ma (Dethier et al. 1986). The main vent for this flow lies 0.2 mi north of NM-601, as indicated by the dramatic increase in thickness of the flow. The vent area, called El Porticito, lies on a N25° to 35°E trending chain of vents, as much as 10 mi long. New $^{40}Ar/^{39}Ar$ data indicate an age of 7.92 ± 0.20 Ma for the intrusive rock at El Porticito (McIntosh and Cather, this volume). Thus the Tejana Mesa vent complex may represent multiple episodes of eruption in late Miocene time.

At the latitude of Tejana Mesa (35°25'N), two important changes affect topography and landform. First, here, near the southern margin of the Colorado Plateau, we are also at the southern limit of continuous exposure of Cretaceous and older Mesozoic rocks. Second, from this latitude southward, Neogene volcaniclastic sediments (Fence Lake Formation) and pre-volcanic sediments of late middle Eocene age (Baca Formation) comprise most of the surface rock. In addition, the area southward is characterized by late Oligocene and Miocene basalt and andesite flows, by ignimbrites of Oligocene age, and volcaniclastic sedimentary rocks of late Eocene age.

Mileage

0.0 Milepost 5, on NM-601. At 3:00, note exposures on the flanks of Tejana Mesa, which consist of the Baca Formation (reddish color), and the overlying coarse-grained Fence Lake Formation, approximately 100 ft thick locally, in turn overlain by the 6.7 Ma basalt flow. Proceed northwest on NM-601. **0.3**

0.3 Cross cattleguard; **0.5**

0.8 Crest of hill; at 1:00 note fluvial channel sandstones of the Upper Cretaceous Moreno Hill Formation capping small hill. The Moreno Hill Formation consists of sandstone, shale, carbonaceous shale and thin coal beds deposited in a coastal plain and deltaic environment during middle Turonian to Coniacian time. **0.2**

1.0 Cattleguard; road to left leads to Mesa Ranch. Mesa behind the ranch consists of Baca Formation capped with a Miocene basalt flow, presumably of similar age to the flow capping Tejana Mesa. **0.2**

1.2 Roadcut on left and brown ledgy sandstones to the right of road are outcrops of Moreno Hill Formation. **0.6**

1.8 Bridge over tributary of Largo Creek; at 2:00 note fluvial channel sandstone in Moreno Hill Formation. **0.3**

2.1 Roadcut at crest of hill exposes typical overbank-floodplain deposits in Moreno Hill Formation; the dusky yellow colors are characteristic of the finer-grained facies often associated with carbonaceous zones. **0.1**

2.2 At 10:30-11:00 note excellent outcrops of Moreno Hill Formation on slope of hill. **0.4**

2.6 Cross culvert; the flat-topped mesa at 12:00 to 1:00 in the distance is Santa Rita Mesa; it is capped by a coarse-grained facies of the Fence Lake Formation (Miocene) above strata of the Moreno Hill Formation. **0.4**

3.0 Milepost 8; the sandstone bench north of the road is developed in the Moreno Hill Formation. **0.6**

3.6 Junction; **follow main road to left**. The prominent notch in Tejana Mesa at 2:30 is Augustine Canyon. **0.2**

3.8 Cattleguard. **0.4**

4.2 At 2:00 note small west-facing cliff and bench formed by typical fluvial channel sandstone of Moreno Hill Formation. **1.1**

5.3 Cross culvert; road now ascends onto dip slope developed on the middle sandstone member of the Moreno Hill Formation. The very coarse-grained facies in the middle sandstone plus its stratigraphic position strongly suggest that it is correlative with the Torrivio Member of the Gallup Sandstone. **0.7**

6.0 Crest of hill; milepost 11; at 2:30 in the distance the dark-colored hill is Cerro Prieto, a basaltic andesite neck. The northwest end of Tejana Mesa is also visible on the right; just below the edge of Tejana Mesa is the site of the Salt River Project and proposed Fence Lake Coal Mine. The geology and coal resources of the area immediately to the north were described by Campbell (1989). **0.3**

6.3 Road curves to the left; at 2:30 to 3:00 the prominent bench is defended by the middle sandstone member of the Moreno Hill Formation. **0.2**

6.5 From 12:00 to 2:00 is Santa Rita Mesa in the distance. The south and east flanks of the mesa offer excellent exposures of the entire thickness of the Moreno Hill Formation, which locally exceeds 800 ft; type section of the Moreno Hill Formation is on the south end of the mesa at Moreno Hill. **1.1**

7.6 Hills and mesas from 9:00 to 12:00 are capped by Neogene and, locally, perhaps Quaternary basalts or basaltic andesites. These overlie Tertiary sediments of the Fence Lake Formation, which here contains abundant well-rounded siliceous cobbles derived from the Baca Formation that are mixed with subrounded volcanic clasts. **0.4**

8.0 Milepost 13. **0.8**

8.8 Cross cattleguard. **1.5**

10.3 Hubble Draw at 1:30 to 2:00 is the major drainage line in area. Outcrops to right beyond the windmill are Moreno Hill Formation. **0.5**

10.8 Crest of hill; at 1:00 in distance the Dakota Sandstone (Upper Cretaceous) is visible overlying the red mudstones and sandstones of the Upper Triassic Painted Desert Member of the Petrified Forest Formation (Chinle Group). **0.3**

11.1 After crossing cattleguard note the increase in eastward dip in Moreno Hill Formation strata at 3:00. Volcanic cinder derived from Zuni Salt Lake maar now begins to appear on both sides of road. **0.7**

11.8 Low mound on right and much of the immediate countryside is draped with volcanic cinder from Zuni Salt Lake Maar. **1.1**

12.9 Road forks; **bear left and leave NM-601;** at 1:00 is a

good view of the Petrified Forest Formation (Upper Triassic) overlain by the Dakota Sandstone. For a detailed measured section of the Painted Desert Member of the Petrified Forest Formation at this locality, on the north side of Hubbell Draw, see Lucas and Hayden (1989). **0.1**

13.0 Junction, **bear left** and descend into Zuni Salt Lake maar. **0.2**

13.2 Stop and park. Zuni Salt Lake occupies the northern half of the crater, which is approximately 1 mi in diameter (Fig. S1.1). Three small cinder cones can be seen rising from the floor of the southern half of the crater; the largest of these cones has its own, more concentrated, brine lake.

A maar is defined as a coneless volcanic crater formed by a single eruptive event and is commonly filled with water. The view from this stop makes it obvious that Zuni Salt Lake fits the definition of a maar. This crater is the result of a phreatomagmatic eruption, meaning that significant steam was involved as well as the common magmatic gases. The source of the steam was magma contact with groundwater, specifically a good aquifer. These conditions are commonly met where a magma conduit develops in an area of porous, flat lying sedimentary rocks such as we have here in the form of Upper Cretaceous sandstones. Zuni Salt Lake maar has been dated at 22,900 ± 1400 yrs by ^{14}C (Bradbury, 1966). Recent $^{40}Ar/^{39}Ar$ data (McIntosh and Cather, this volume), however, indicate activity near 100,000 yrs, 114 ± 38 ka for a juvenile bomb, and 86 ± 31 ka for a ring intrusive. For more information on the origin of this crater see Baldridge et al. (1989, p. 218).

The crater has been determined by recent geologic mapping (Anderson, 1994) to lie on a northeast-trending normal fault. The fault is down to the southeast as much as 600 ft, although the throw varies considerably along strike. It can be traced southwestward for 18 mi to the state line, but beyond that point it is concealed by Neogene basalt flows. The fault cannot be demonstrated to cut the Fence Lake Formation (Miocene) anywhere along its trace. Thus, we assume the faulting is related to mid-Tertiary crustal extension, the onset of which has been determined to be approximately 31 Ma (Baldridge, et. al., 1989, p. 187). There is little reason to speculate an older, classic Laramide, age for the fault, as the apparent style of deformation does not fit well with a model of northeast-directed compression.

The throw on the Zuni Salt Lake fault can be calculated on the basis of the stratigraphic units juxtaposed. Contrary to what is shown on the New Mexico State Geologic map (Dane & Bachman, 1965) no Mesaverde Group (Upper Cretaceous) units are present. Instead, the Atarque Sandstone (middle Turonian) is downfaulted against the lower Rio Salado Tongue of the Mancos Shale. This suggests up to 350 ft of stratigraphic separation at this location.

Large blocks of Atarque Sandstone occur in the northeastern rim of the crater, 600 ft. west of the road descending to the north shore of the lake. Fossils present in the Atarque here (UTM 38140725N, 704665E, zone 12) include *Pleuriocardia pauperculum, Crassatella excavata, Trigonarca* sp., *Phelopteria* sp., *Inoceramus* sp., *Plicatula ferryi, Ostrea* sp., *Parmicorbula* sp., *Gyrodes* sp., *Rostellites ambigua* and locally *Collignoniceras woolgari;* all indicate a middle Turonian age.

FIGURE S1.1. Aerial view to east of Zuni Salt Lake (left center) and Tejana Mesa (middle ground). Low rim of Zuni Salt Lake maar is approximately 1 mi in diameter. Note dark cinder cones in maar to the right of the salt lake. El Porticito vent at the south end of Tejana Mesa (far right) is location of Stop 2 on second day.

Return to main road. 0.2

13.4 Junction with main road; **bear left and proceed southward** along west side of maar. **0.4**

13.8 Tracks to left lead to west rim of the maar, for a good photo opportunity. Road is very near the trace of the Zuni Salt Lake fault, with poorly exposed lower Rio Salado Tongue of the Mancos Shale on the right, and the Moreno Hill Formation (which overlies the Atarque) on the left. **0.4**

14.2 Crater in the cinder cone at south end of the lake has its own small lake with more highly concentrated brine than main lake. The plumbing system responsible for the brines is not well understood, but it likely is tapped into the evaporite and brine-bearing Supai Formation (Yeso equivalent) which may lie as shallow as 600-700 ft on the footwall block. **1.0**

15.2 Crest of hill; road on cinders from Zuni Salt Lake maar. Tree-covered hills ahead are developed on Moreno Hill Formation. **1.5**

16.7 Cattleguard. **0.3**

17.0 At 10:00, closed depression is frequently inundated and is known as Cheap John Lake (Zuni Salt Lake USGS 7.5' quadrangle). The depression would not appear to be a deflation basin, and thus some karsting or structural control is likely. **1.7**

18.7 Cattleguard. **0.1**

18.8 Pass under power line. **0.6**

19.4 At 10:00 note Cerro Pomo, a Quaternary cinder cone, breached on the north side. **0.6**

20.0 Cattleguard and Cox Ranch; outcrops and toreva blocks on right consist of Moreno Hill Formation. **0.4**

20.4 On right, note the vertical stacking of fluvial channel sandstones in Moreno Hill Formation. **1.6**

22.0 On right at 4:00, note outcrops of fine-grained overbank and floodplain facies in Moreno Hill Formation. **2.0**

24.0 Ranch on right; low sandstone ledges around ranch are in lower part of Moreno Hill Formation. Immediately to the northwest of the ranch the top of the fossiliferous Atarque Sandstone is exposed. **0.1**

24.1 Cross Agua Fria Creek. **0.7**

24.8 Note carbonaceous shales of the lower Moreno Hill Formation in roadcuts on left as we proceed southward. Prominent mesa on right (to west) is capped by Neogene basalt flow. **0.4**

25.2 Cattleguard. **1.7**

26.9 Quaternary Red Hill cinder cone visible at 2:30; mesas on both sides of road ahead are Moreno Hill Formation capped with residual gravels derived from Baca Formation (Eocene). **1.4**

28.3 Cattleguard. **0.5**

28.8 Road curves to left; note good exposures of Moreno Hill Formation sandstone beds on left. **0.4**

29.2 Crest of hill; at left the gentle slopes are developed on erosional remnants of the Baca Formation resting on Moreno Hill Formation. At 1:00 to 2:00 is Cimarron Mesa, which is underlain by both Baca and Fence Lake Formations, at least in places, and is capped by a Miocene basalt flow. Straight ahead is the shallow, late Neogene Red Hill basin, which contains a thin, poorly exposed section of recycled older Tertiary rocks. With respect to several criteria, we are here leaving the Colorado Plateau and entering the Mogollon Datil volcanic field (or subprovince). The criteria are (1) disappearance of flat-lying Mesozoic rocks, (2) volcanic features from this area southward dominate or strongly influence the landscape, (3) thick sequences of volcaniclastic sediments may be present, and (4) generally higher heat flow values southward, however, regional trends in the transition zone at the southern margin of the Colorado Plateau are not profound (Minier, 1987). **0.2**

29.4 At 11:00 in the distance is Escondido Mountain, thick Bearwallow Mountain Andesite (late Oligocene) overlying Spears Group sediments. **1.3**

30.7 Crest of hill; to left thin, poorly sorted, basin-fill deposits of Late Tertiary to Pleistocene age conceal Baca Formation southward into the shallow Red Hill basin (see McIntosh and Cather, this volume). **1.1**

31.8 Cattleguard; at 2:00 note the small notch in east face of Cimarron Mesa which exposes the reddish Baca Formation beneath the basalt cap. **1.6**

33.4 Intersection with US-60. End of supplemental log; corresponds with mile 76.4 of Day 2 road log.