FRIENDS OF THE PLEISTOCENE, ROCKY MOUNTAIN CELL, 45TH FIELD CONFERENCE

PLIO-PLEISTOCENE STRATIGRAPHY AND GEOMORPHOLOGY OF THE CENTRAL PART OF THE ALBUQUERQUE BASIN

THIRD-DAY ROAD LOG, OCTOBER 14, 2001

Geology of Los Lunas volcano

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The following trip presents an overview of the regional setting of Los Lunas volcano(es), some history of geologic work in the area, results of recent geochemistry and geochronology of the eruptives, the relation between the volcanoes and basin fill, deformation associated with the volcanoes, and post-eruption erosion and piedmont deposition. The trip consists of a drive from Isleta Lakes to the flanks of El Cerro de Los Lunas where some vehicles will be parked and orientation/background presented. High clearance vehicles will shuttle the group higher onto the side of the volcano and the group will hike down into a steep canyon and back to the lower vehicles. Along the way the group can examine two spectacular angular unconformities between three packages of basin fill, a disconformity at the base of San Clemente graben-fill, Pliocene fluvial beds with pumice, obsidian, and Blancan fossils, thick and thin-skinned deformation involving tephra of Los Lunas volcano, and post-eruptive piedmont and eolian deposits with multiple soils. Permission from the Huning Land Trust in Los Lunas must be obtained before attempting this trip apart from the Friends of the Pleistocene, October 14, 2001.

Colleague-contributors who helped advance knowledge of the volcano and deserve acknowledgement and thanks (but bear no blame for the field trip leaders mistakes): Charles Reynolds, John Hawley, Rick Lozinsky, Nelia Dunbar, Bill McIntosh, Bruce Hallett, Kurt Panter, Chris McKee, John Young, Bert Kudo, Bill Hall, Jacques Renault, Jim Casten, Becky Thompson, Tad Niemyjski, Bill Haneberg, and Tien Grauch.

Mi.	Description
0.0	Isleta Lakes Store. Follow previous road logs to NM 47 and I-25 south. **0.4**
0.4	Cross railroad; golf course on right. **0.5**
0.9	Stop light with NM-47. **Turn left** and **keep in left lane**. **Prepare to turn left**. **0.5**
1.4	Cross under I-25 overpass, **keep in left lane**. **0.2**
1.6	**Turn left and head south** on NM-47 (South Broadway). **0.1**
1.7	South Broadway. **Get into right lane. 0.1**
1.8	**Turn right** onto southbound I-25 entrance ramp. **0.3**
2.1	**Merge** with I-25 south (headed west). **0.5**
2.6	East abutment of I-25 bridge over Rio Grande. Rio Grande channel ahead. **0.4** Milepost 214. West bridge abutment. **0.5**
3.5	Entering Isleta Reservation. Overpass of drain and location of Isleta-Black Mesa piezometer, which encountered 73 ft (22 m) of sandy fluvial deposits underlying the Rio Grande floodplain (Los Padillas Fm of Connell and Love, *this volume*). Deposits are associated with the last incision/aggradation episode of the Rio Grande. Incision probably occurred during latest-Pleistocene time, and entrenched 100 m below the highest inset terrace deposit of the Lomatas Negras fm. **0.6**
4.4	Crossing bridge over Old Coors Road, which follows a former course of the Rio Grande cut through the lava flow of Black Mesa. Roadcut to right shows the edge of the 2.68±0.04 Ma (^{40}Ar/^{39}Ar, Maldonado et al., 1999) Black Mesa flow overlying cross-bedded pebbly sands of the Arroyo Ojito Fm and base-surge deposits from Isleta volcano. The tholeiitic Black Mesa flow has no outcrop connection with, and is slightly younger than Isleta volcano, which forms the dark, rounded hill ahead and to the right of the highway. A buried vent for the Black Mesa flow is suspected in the floodplain area to the northeast (Kelley et al., 1976; Kelley and Kudo, 1978). **0.3**

ELEVATIONS OF GEOLOGIC FEATURES, WIND MESA, ISLETA, MESA DEL SOL (SOUTH), BETWEEN I-25 MILE POSTS 212 AND 210

Elevations are in feet above mean sea level as measured from USGS 7.5-minute topographic maps

Arrows point to described features and elevations to your left (east) and right (west) in decreasing order of elevation.

EAST	WEST
	top of east horst of Wind Mesa 5730→
	"bath-tub ring" of gravel, east side of Wind Mesa 5500 →
	top of Isleta volcano 5387 →
← 5340 base of Western Hubbell Spring fault scarp	
← 5240 top of Mesa del Sol	
	east edge of Llano de Albuquerque (down-faulted block) 5240 →
← 5230 top of gravel with Bandelier boulders	
← 5210 base of Rio Grande gravelly sand capping Mesa del Sol	
← 5205 tilted Arroyo Ojito Fm under Mesa del Sol containing Pliocene pumice	
← 5195 Pliocene Isleta (?) basaltic tephra in Arroyo Ojito Fm; 1.58 Ma pumice overlying it.	
← 5130 local top of Pliocene thick reddish-brown sandy clay of Arroyo Ojito Fm	
	top of upper terrrace gravel west of Isleta volcano 5100 →
← 5050 base of thick reddish-brown clay (Pliocene) of the Arroyo Ojito Fm	
	upper edge of lava lake within tuff ring 5050 →
	top of Los Duranes Fm 5020 →
← 4960 Pliocene pumice gravel	
	top of Rio Grande terrace inset against Isleta volcano 5000 →
	basaltic edifice southeast of Isleta volcano with strath terrace at top 4910-4970 →
	base of Rio Grande terrace inset against Isleta volcano 4910 →
← 4910 Pliocene pumice gravel 1.68 Ma	
	Base of lava flow east of Highway 85, 4900 →
← 4885 Isleta (?) tephra 4895 →	
← 4892 Pliocene pumice gravel	
← 4890 Rio Grande flood plain→	
← 4885 Rio Grande floodway channel →	
← 4805 base of Rio Grande paleovalley →	

4.7 Base-surge deposits of tuff cone associated with emplacement of Isleta volcano in outcrops on both sides of route. **0.5**

5.2 Change in primary dip direction of base-surge deposits at crest of tuff ring on right. Overlying alkali-olivine basalt flows fill tuff ring and extend southeast beyond Isleta volcano. Radioisotopic dates ($^{40}Ar/^{39}Ar$ method) indicate that oldest flow is 2.75±0.03 Ma and the second is 2.78±0.06 Ma (Maldonado et al., 1999). Basaltic cinders correlated to the Isleta volcano flows are recognized in the Arroyo Ojito Fm exposed along the eastern margin of the Rio Grande valley. These cinder-bearing deposits are about 70 m (estimated) stratigraphically below exposures of lower Pleistocene, Lower-Bandelier-Tuff bearing sand and gravel of the ancestral Rio Grande facies of the Sierra Ladrones Fm. This stratigraphic relationship indicates that deposition of the Arroyo Ojito Fm continued after 2.72-2.78 Ma, thereby constraining the age of the mesa capping Llano de Albuquerque to between 2.7 and 1.25 Ma. Based on local stratigraphy on both sides of the present valley, it is likely that the Llano de Albuquerque was abandoned as an active fluvial fan prior to deposition of Lower Bandelier ash and pumice gravel at *ca*. 1.6 Ma. Locally, the cinders of Isleta Volcano on the east side of the valley have experienced over 100 m of uplift with consequent erosion of the overlying units before final deposition by the Rio Grande to form the Sunport Surface. Because early Pleistocene terraces of the Rio Grande pass west of Isleta volcano at high levels, the volcanic edifice probably was exhumed during middle and late Pleistocene time (Love et al., 2001). **0.1**

5.3 Entering cut exposing basalt flow of Isleta volcano over base-surge unit (see cross section, Day 2). Shell Isleta #2 well is about 1 mi. to the west, where it reached a depth of 6482 m and ended in Eocene rocks. Lozinsky (1994) reports that the Santa Fe Group is 4407 m thick at the Isleta #2 well and is underlain by 1787 m of the Eocene-Oligocene unit of Isleta #2, which overlies more than 288 m of sediments correlated with the Eocene Baca or Galisteo fms. **1.8**

ELEVATIONS OF GEOLOGIC FEATURES, SAN CLEMENTE TO LOWER HELL CANYON, BETWEEN I-25 MILE POSTS 205 AND 206

Elevations are in feet above mean sea level as measured from USGS 7.5-minute topographic maps

Arrows point to described features and elevations to your left (east) and right (west) in decreasing order of elevation.

EAST **WEST**

base of 100,000-year-old basalt flow 1 of Cat Mesa resting on top of San Clemente graben fill 5315 →
← 5310 top of eastern piedmont aggradation, footwall of western Hubbell Spring fault
Upper Bandelier pumice in cross-bedded sand, San Clemente graben 5300 →
← 5280 Lower Bandelier pumice in ancestral Rio Grande unit, footwall of western Hubbell Spring fault
encroaching piedmont from Los Lunas volcano on graben-fill (1.1 km south) 5280 →
Los Lunas volcano tephra (1.25 Ma) at top of San Clemente section (2.2 km SE) 5260 →
← 5260 top of ancestral Rio Grande deposits bearing Upper Bandelier boulders, north side of Hell Canyon
Blancan fossil camel bones in section tilted 6 degrees SW, east of San Clemente graben 5240 →
thick soil at base of San Clemente graben section 5220 →
pumice in tilted section, east of San Clemente graben 5215 →
← 5140 top of Rio Grande gravel east of Palace-Pipeline fault, south of Hell Canyon
← 5100 top of Rio Grande gravel west of Palace-Pipeline fault
← 5065 top of Hell Canyon gravel and soil, mouth of Hell Canyon
← 5060 top of Rio Grande gravel in section at mouth of Hell Canyon
← 5000 Cerro Toledo (c.a. 1.5 Ma) ash in Janet Slate section , mouth of Hell Canyon
top of Los Duranes Fm 4985 →

←4915 base of exposures of ancestral Rio Grande with Lower Bandelier pumice and ash
← 4865 Rio Grande floodplain →
← 4863 Rio Grande floodway channel →

7.1 Exit 209 overpass to Isleta Pueblo. Road now on upper constructional surface of the Los Duranes Fm, a middle to upper(?) Pleistocene inset fluvial deposit of the ancestral Rio Grande named by Lambert (1968) for exposures in NW Albuquerque. The Los Duranes Fm is inset against middle Pleistocene fluvial deposits correlated to the Lomatas Negras fm, which contains an ash that was geochemically correlated to the 0.60-0.66 Ma Lava Creek B ash, from the Yellowstone area in Wyoming (N. Dunbar, 2000, written commun,; A. Sarna-Wojcicki, 2001, written commun.). At 3:00 is a low dark hill of the 4.01±0.16 Ma Wind Mesa volcano (Maldonado et al., 1999). The late Pleistocene Cat Hill volcanoes between 2:00-3:00. Hell Canyon Wash is at 9:00 on the eastern margin of the Rio Grande Valley. **1.1**

8.2 Railroad overpass. A soil described in exposures of the uppermost Los Duranes Fm indicate that soils are weakly developed with Stage I and II+ pedogenic carbonate morphology (S.D. Connell, and D.W. Love, unpubl. data). **0.8**

9.0 Milepost 208. Between 1:00-2:00 is the rift-bounding uplift of Mesa Lucero, which is about 30 km west of here. **0.6**

9.6 Valencia County Line. **0.4**

10.0 Milepost 207. Late Pleistocene basalt flow of the Cat Hills volcanic field overlies the Los Duranes Fm at 3:00. This flow is the oldest of the Cat Hills seven flows and yielded two $^{40}Ar/^{39}Ar$ dates of 98±20 ka and 110±30 ka (Maldonado et al., 1999). The Albuquerque volcanoes (dated using $^{238}U/^{230}Th$ method at 156±29 ka, Peate et al., 1996) overlie the Lomatas Negras fm and locally interfinger with the top of the Los Duranes Fm in NW Albuquerque. These dates constrain the upper limit of deposition of this extensive terrace deposit to between 98-156 ka, which spans the boundary of marine oxygen isotope stages 5 and 6 (Morrison, 1991). These dates and stratigraphic constraints indicate that much of the deposition of the Los Duranes Fm occurred prior to the interglacial of marine oxygen isotope stage 5. **1.0**

11.0 Milepost 206. Descend possible fault scarp in Los Duranes Fm. Beneath rim of Cat Hills lava flows about 6 km (4 mi.) west of here is the San Clemente graben. It extends northward from near Los Lunas volcano to a graben that splits Wind Mesa (Maldonado et al., 1999). The Arroyo Ojito beds and thick stage III soil beneath the graben-fill near San Clemente are deformed into a flat-floored syncline. At least 37 m of fine sand, silt, and clay with a few coarser pebbly sand units accumulated in this graben where we found a bed of fluvially recycled pumice pebbles about 29 m above the base of the graben-fill section. These pumice pebbles have been geochemically correlated to the Bandelier Tuff and have been dated 1.21±0.03 Ma. Farther south near NM-6, tephra from Los Lunas volcano (*ca*. 1.25 Ma) overlies correlative graben-fill sediments, which lie only a few meters above a stage III soil that is interpreted to mark a break in deposition of the Arroyo Ojito Fm along the easternmost edge of the Llano de Albuquerque. **1.1**

12.1 Southern boundary of Isleta Reservation. El Cerro de Los Lunas between 1:00-2:00. Northwest of the volcano, northwest-tilted beds of the Arroyo Ojito Fm contain multiple layers of pumice pebbles. A pumice pebble collected in the middle of the section of the Arroyo Ojito Fm here has been geochemically correlated to a pumice unit which was $^{40}Ar/^{39}Ar$ dated at 3.12±0.10 Ma in the Arroyo Ojito Fm exposed beneath the Llano de Albuquerque in the valley of the Rio Puerco on the Dalies NW quadrangle (Maldonado et al, 1999). This pumice has been geochemically correlated to a pumice pebble at Day 1, Stop 7 in Rio Rancho. **0.7**

12.8 Borrow pit to right exposes weakly developed soil in Los Duranes Fm. **0.6**

13.4 **Take Exit** 203 to Los Lunas and NM highway 6 to west. **0.3**

13.7 **Turn right** (west) on NM 6. This road was an early alignment of Route 66. El Cerro de Los Lunas at 10:00 consists of several eruptive centers of trachyandesite to dacite. The earliest eruption consisted of andesitic and dacitic vent breccias and lava flows that have an $^{40}Ar/^{39}Ar$ age of 3.81±0.1 Ma (McIntosh, unpubl; Panter et al., 1999). The north edifice with the "LL" on it is a trachyandesite with an $^{40}Ar/^{39}Ar$ age of 1.25±0.1 Ma (McIntosh, unpubl; Panter et al., 1999). A separate, undated vent at the top of the mountain produced red and gray scoraceous tephra that extended over several km^2 to the north, east, and southeast of the volcano. The underlying flow and scoria were then cut by several north-south faults. The scoria vent, underlying flow, and Santa Fe Group strata were tilted and uplifted more than 150 m above the surrounding landscape and rapidly eroded, forming a piedmont apron to the west and northwest. An eroded fault scarp on the east side of the peak has dip-separation of 56 m on the base of the lowest 1.25 Ma flow. The next set of eruptions issued along the fault scarp and buried talus from the scarp. Between eruptions, minor amounts of talus and eolian sand buried the lava flows. The final vent produced at least three lava flows that descended eastward toward the valley. V. Grauch (personal commun., 1999) suggests that the magnetic polarity of these flows is reversed, indicating that they predate the Brunhes chron (older than 780 ka). McIntosh (unpubl.) obtained ages of 1.25±0.1 Ma on some of these upper flows, indicating that the eruptions and concurrent deformation took place in less than twenty thousand years.. **0.5**

14.2 Pass Los Morros Road to business park to your right. **0.2**

14.4 Pass Sand Sage Road and ascend alluvial apron prograded over the Los Duranes Fm. Relict landslide on north side of "LL" edifice at 9:30. **0.6**

15.0 Exposures of northwest-tilted Arroyo Ojito deposits below skyline to the southwest of NM 6. Tilting of the section is due to deformation during emplacement of two batches of magma. An older, more tilted succession is not visible from the highway, but will be visited during a hike from **Stop 3-1**. **0.9**

15.9 V-shaped gray syncline developed in Los Lunas tephra in slopes up drainage to southwest. **1.1**

17.0 Hill to right is eolian falling dune covering reworked piedmont of Los Lunas volcano. **0.1**

17.1 Los Lunas tephra exposed in road cuts at eye level. **0.3**

17.4 Contact between Los Lunas tephra and San Clemente graben fill near elevation of gate to your right (north). **0.1**

17.5 Piedmont alluvium from Los Lunas volcano exposed in road cuts. Stage III calcium carbonate soil horizon near top. **0.3**

17.8 **Turn left** (south) on "AT and T" Road. **0.6**

18.4 **Turn left** just past power pole and before houses. Water table for this housing development at a depth of more than 900 feet. Head east on two-track dirt road. **0.3**

18.7 Pass "No Trespassing" Sign on Huning Ranch and **head southeast**. Permission must be obtained from the Huning Land Trust in Los Lunas prior to entering ranch lands. **0.1**

18.8 **Turn left** on two-track road to east and prepare to leave vehicle. **0.1**

18.9 Separate vehicles to be left here from four-wheel drive, high clearance vehicles that will continue after **Stop 3-1**. Park on left side of road near edge of badlands. *GPS, N: 3,854,000 m; E: 333,819 m, Z013S, NAD83, Dalies 7.5' quadrangle.*

Discussion at Stop 3-1 will address seven items of interest: (1) where are we? (2) who has done work here? (3) what about those volcanoes? (4) what relation does the basin fill have to the volcanoes? (5) what's happened since the last eruption in the way of erosion of the volcano and consequent piedmont deposition? (6) what's the history of post-piedmont erosion on the north, south, and southwest flanks of the piedmont? And most importantly, (7) where do we go from here, what do we see, how long will it take, and what should participants take with them?

1) Where are we?

Regional setting of Los Lunas volcano: Topics and visual aids to cover--position near center of Albuquerque basin, visual landmarks around basin and margins of basin; Mid-basin rift setting—Maldonado et al draft map; Aeromagnetic maps; gravity map; tops of basin fill—Llanos: Albuquerque, Sunport, Manzano, San Clemente, Los Lunas volcano piedmont. Basin fill thickness—Shell Isleta # 2: 6,482 m deep; Santa Fe Group 4,407 m or 4,941m Shell Isleta # 1: 2,679 m of Santa Fe Group/Cretaceous at 3,670 m TransOcean 1,536 m of Santa Fe Group (TD in Precambrian at 3,163 m) Long-Dalies 2,589 m of Santa Fe Group; Harlan 864 m of Santa Fe Group. Sources of basin fill—west, north, northeast (Rio Grande), east (piedmont of Manzano Mountains not found here). Where was the Rio Grande? Post-Santa Fe development of Rio Grande valley in inset steps.

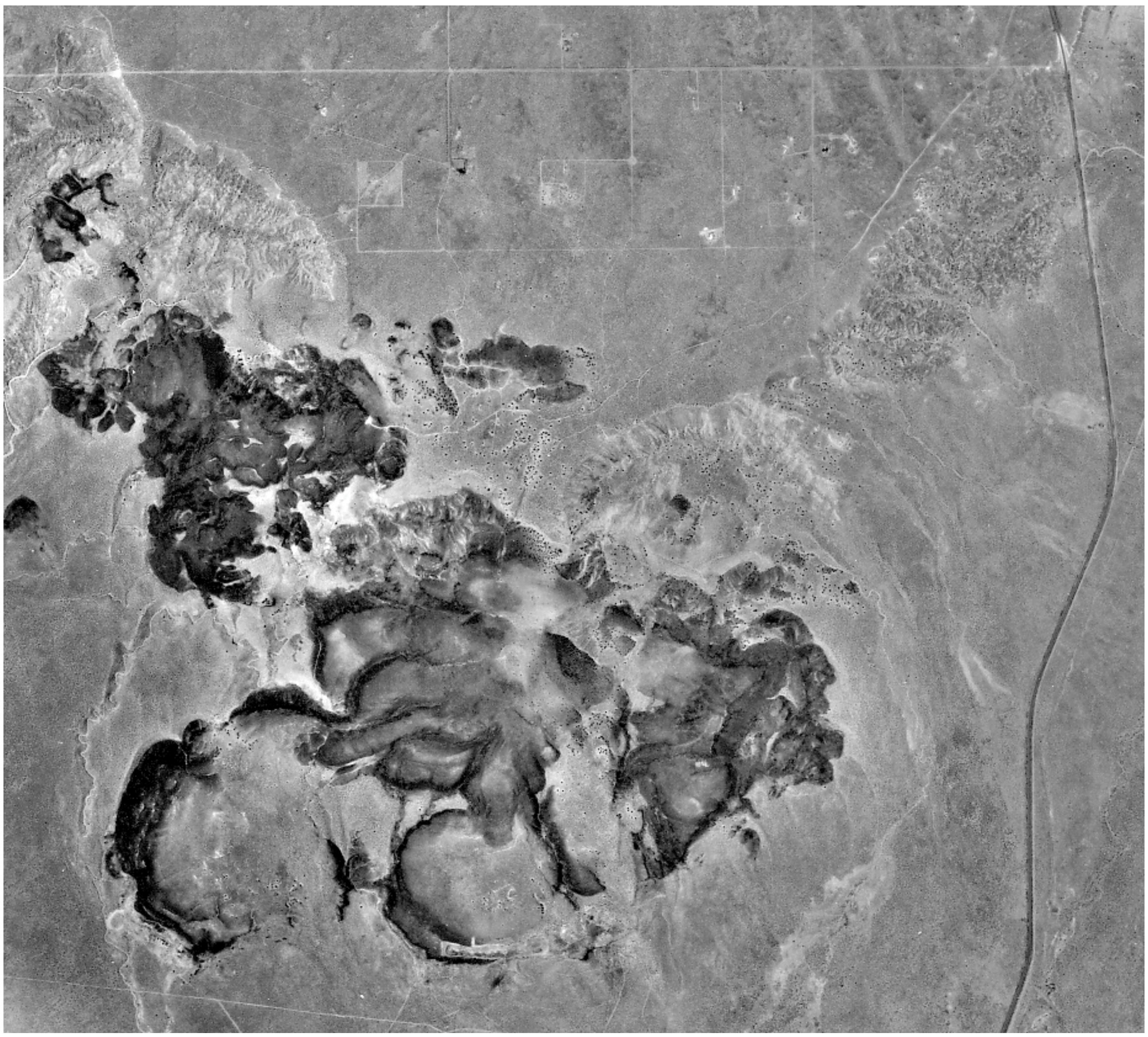

Figure 3-1. Aerial photograph of El Cerro de los Lunas and vicinity. North is to the right (U.S. Geological Survey air photo, 1990, GS-VFN, No. 2-83).

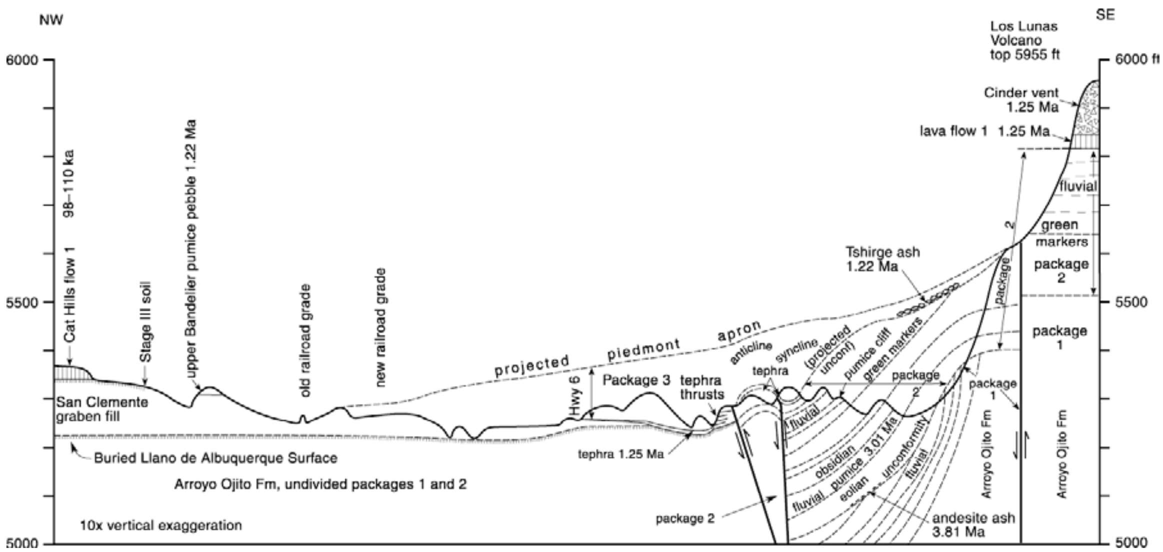

Figure 3-2. Cross section across northwestern flank of Los Lunas volcano.

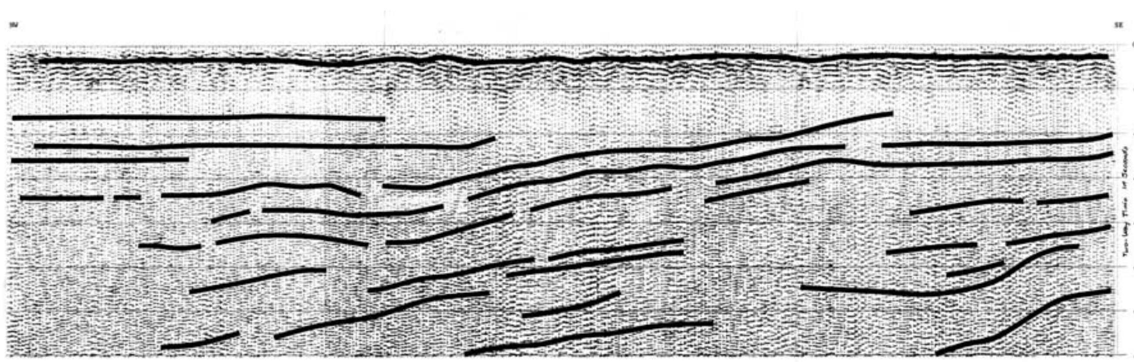

Figure 3-3. Reflection seismic profile along the northwest piedmont slope of Los Lunas volcano (C. Reynolds, unpubl. data). Note dipping reflectors and unconformities at 0.2 to 0.5 seconds two-way travel time (scale on right margin 0 to 0.7 seconds).

Figure 3-4. Photograph of the white Tshirege ash overlying blocks of the 1.25 Ma Los Lunas trachyandesite.

Figure 3-5. View to north of west-tilted Arroyo Ojito Fm (local package 2).

2) Who worked here?

T. Galusha; V. Kelley and A. Kudo; J. Kasten; J. Renault; G. Bachman & J. Mehnert; J. Hawley, R. Lozinsky, J. Young, D. Love; C. Reynolds; K. Panter and B. Hallett; W. Haneberg; N. Dunbar and W. McIntosh; C. McKee; S. L. Minchak; H. D. Southern; H. D. Rowe; J. Geissman.

3) Los Lunas volcano(es) Elevations: Top 5955 ft (1815 m), west side 5300-5700 (1615-1737 m), east side 5050 ft (1539 m), base of badlands to south 5100 ft (1554 m), Dalies to SW 5305 ft (1617 m). High edifices—NE 1.25 Ma, central 1.25, SE scoria on NE flow 1.25 Ma; Low, tilted edifice to SW—3.8 Ma; also outliers to south that we can't see from here (Fig. 3-1)Large north-trending fault offsets first flow (59 m of displacement, down to east; other, smaller faults to east and west. Chemistry of flows—early (3.8) andesite & dacite, late (1.25) trachyandesite.

4) Relation of volcanoes to basin fill: Pre-3.8 Ma sediments (> 40 m exposed)—western-source pebbly sands and eolian; deformation by folds and faults (normal and thrusts). Flow-front deformation of sediments and tephra (normal & thrusts). Post 3.8 Ma tilting, faulting, burial first with eolian (20-40 m), then 150 m of fluvial and eolian section below 1.25 Ma tephra.

Problem with southern "intrusives"—outcrops look intrusive, but they are buried by sediments containing adjacent eroded igneous blocks—so what were these igneous bodies intruding?

1.25 Ma eruptions and deformation: first, "chocolate brown" (CB) flow and edifice; second "red and gray" scoria cone and tephra; deformation of tephra—folds, reverse faults, low-angle thrusts, normal faults, cuspate-lobate structures; normal faults with ~59 m of displacement; uplift beneath volcano of 155 m above rest of Llano de Albuquerque; talus; third edifice and late flows cover faults

5) Post-tephra erosion and piedmont deposition (~50 m of fill) Relation to San Clemente graben; local seismic profiles.

Where is "Llano de Albuquerque" (top of basin fill) in this section?

6) Post-piedmont erosion and deposition of intermediate landscape levels and current deep canyons

7) Where are we going from here? What will we see? How long will it take?

We shuttle the group with as few high-clearance vehicles as possible up slope to edge of steep canyon between us and the volcano. We look at three packages of sediments between angular unconformities. The upper package of local colluvium and alluvium and stage III soils includes fallout of Tshirge ash (upper Bandelier--1.22 Ma) in a paleovalley cut into tilted Pliocene sediments. We descend into the present canyon and see part of the middle package that includes Pliocene pumice mixed with western-margin facies and eolian sand. At the base of exposures in the canyon, we see a profound angular unconformity between an older (Pliocene?) pumice-bearing third package of sediments and the tilted beds we have just examined. Then we walk northward through the tilted section to examine the Pliocene and Pleistocene beds where it is more easily accessible. We look at deformation of sediments by faults and folds. To the north we find the 1.25 Ma tephra from the second eruption of Los Lunas volcano deformed in a syncline and anticline in the section, immediately overlain by sediments reworked from the uplifted volcano.

We will examine unusual reverse faults, cuspate and lobate structures, and low-angle thrust faults involving plates of unconsolidated sediments only a few m thick (who would have thought that unconsolidated sediments would be considered "competent" [see article by Haneberg, *this volume*]). Farther north, we see the Los Lunas tephra flatten out on top of fine-grained sediments in the San Clemente graben. Above the tephra, we walk through 50 m of alluvial sediments derived from the uplifted youngest eruption of Los Lunas volcano and Arroyo Ojito sediments on our way back to the vehicles at the lower parking lot.

We hope to complete this traverse within 4 hours. The climb down is steep, and there is a small chance of finding rattlesnakes among boulders at the bottom. The climb out is not particularly steep, but may require extra effort. Take water, food, sunscreen, and walking tools.

Selected vehicles will drive south (uphill) to upper parking area. Roadlog from lower parking area to upper parking area.

Reset odometer.

0.0 **Return** to larger dirt two-track and turn southeast (left) toward volcano. **0.1**

0.1 Route towards volcano is along the top of undissected piedmont slope covered with Holocene eolian sand dunes. **0.1**

0.2 View of highest part of Los Lunas volcano at 12:00. This consists of a red scoria cone overlying a trachyandesite flow. The volcanic units make up only the upper 40-45 m of the mountain. Underlying the flow is local package 2 of Arroyo Ojito Fm mostly exposed. Package one of Arroyo Ojito Fm is exposed in deep arroyos north and south of this summit. To the east at 11:30 is the fault with ~56 m of offset judging from the base of the trachyandesite flow on either side of the fault. Farther to the east is the "LL" edifice at 10:30 and numerous landslides from 10:30 to 10:00. **0.5**

0.7 Low black outcrops to southwest (1:00) are nearly buried tops of 3.81 Ma tilted lava flows. **0.1**

0.8 **Turn left** (east) on two track road. **0.2**

1.0 **Turn around** where possible and **park** out of roadway. Prepare to hike downslope. *GPS, N: 3,852,855 m; E: 334,640 m, Z013S, NAD83, Dalies 7.5' quadrangle.*

Outline of landscape development around Los Lunas volcano

D. Love, B. Hallett, K. Panter, N. Dunbar, W. McIntosh, J. Hawley, R. Lozinsky, J. Young, C. Reynolds, S. Connell, W. Haneberg

Los Lunas volcano consists of two sets of edifices—an older tilted one (and outliers) to the southwest at 3.81 ± 0.10 Ma, and a younger one to the northeast at 1.25 ± 0.02 Ma. The local landscape consists of the two sets of volcanic edifices, subvolcanic basin fill, piedmont apron around western side, river-cut valley and terrace to east, and erosional drainage basins to NW, S and SW.

Present drainages show influence of differential erosion of basin-fill, structure (faulting and folding), resistance of lava flows; colluvial processes (landslides, slumps, rock falls); and oriented eolian processes.

Events

- Pre-volcanic basin fill from west and north—typical western margin facies (Arroyo Ojito Fm), but deformed and exposed here;
- Deformation precedes first eruptions; faulting and dramatic tilting of Santa Fe Group beds;
- 3.81 Ma andesite and dacite eruptions:
- tephra overridden by andesite flows with concurrent deformation. Flows are tilted.
- Eolian aggradation around and over the top of the flows before fluvial western-margin gravels come back into picture. Then pumice and obsidian arrive with western-margin fluvial clasts. 150 m of section accumulates;
- Stage III soil forms at least in some areas;
- San Clemente graben forms—primarily to north and northwest. Soil develops on margins of graben, sediments accumulate in graben.

1.25 Ma eruptions of El Cerro de los Lunas

1) NE edifice with "chocolate brown" (CB) flow across landscape—on edge of San Clemente graben (some exposures have stage III soil, others just alluvium beneath first flow). Flow in SW area ponds into "lava lake" > 30 m thick.
2) cinder and red scoria edifice erupts to WSW of first edifice
3) cinder edifice is uplifted and offset 56 m along N-S fault, forms top of "El Cerro de Los Lunas"
4) cinders with blocks of first flow are folded into syncline, anticline, and faulted with reverse and thrust faults to northwest of edifice and subsequently buried by erosional debris from southeast
5) N-S faults also cut "chocolate brown" edifice to east; probably NE faults west of cinder edifice
6) talus develops on free face of major N-S fault
7) new edifice erupts along fault and produces flow 3 down east side
8) eolian sand partially covers flow 3 on east side
9) flows 4 descend down east side from edifice on fault, forming symmetrical flow lobes clearly visible in photographs

After eruptions ceased

- East side—very linear—either fault or Rio Grande truncation prior to Los Duranes sedimentation
- NW side—after eruptions and faulting, paleo-valley eroded in uplifted Santa Fe Group sediments, blocks of CB and cinders into the paleovalley, 1.22 Ma Tshirge ash of Bandelier into the valley. Up to 50 m of accumulation in the valley; extension of alluvial apron to northwest, west, and southwest; apron may interfinger with San Clemente graben fill; large eolian component to apron from SW.
- South side—early drainages off SW side of uplifted volcano, development of drainages down south side and across SE flows of volcano; transport of recycled Arroyo Ojito clasts from southwest side onto SE flow lobes, entrenchment of upper flow. Then south-side drainage gets captured to flow west and south. Eolian influence of meander courses; migrates down south-tilted dip slope.
- Creation of renewed erosional relief both north side and south side.
- Recycling of western alluvial apron into intermediate alluvial apron on north side and south side of Los Lunas volcano
- Creation of renewed erosional relief on both north side and south side.
- Recycling of western alluvial apron and intermediate alluvial apron into an even lower alluvial apron on north side and south side of Los Lunas volcano.

- Routing of hairpin turn in drainage on south side—eolian influence here too. Transport from head of SW badlands across old edifice and eastward. Definite eolian influence on west side of SE flow lobes— eolian ramp across top and into ENE area on top of (and between) flows.
- Southwest drainage hangs up on older lava flows, incises meanders with two mouths to drainage across lava, depending on NE trending faults; Far SW drainage through NE trending grabens; curved drainages along strike around uplift of older Tsf—both far southwest side and north side of Los Lunas volcano.
- Southwest drainage establishes new, lower route as badlands are stripped out.
- Landslides, slumps, Toreva blocks continue to develop on steep slopes.
- Eolian dunes, distended parabolic arms, rim dunes on NE side of SW badlands and on parts of the volcanoes on landscape now.

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