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Occurrence of Bishop Ash near Grama, New Mexico

by *Curtis P. Kortemeier*, Industrial Minerals Exploration, Anaconda Minerals Company, Denver, CO

At least three principal centers of rhyolitic volcanism were extant during Pleistocene time in the western United States. These three caldera complexes, with associated tephra units and outflow sheets, are: Yellowstone volcanic complex in Wyoming and Idaho, producing the Pearlette family ashes; Valles caldera, northern New Mexico, with the Tsankawi and Guaje pumice beds; and Long Valley caldera, eastern California, producing the Bishop Ash (Izett and others, 1972). These airborne pyroclastic deposits, forcibly ejected simultaneously with the eruption of outflow sheets, are widely used today as marker beds. In order to serve as marker beds these deposits must be identifiable and stratigraphically unique.

While attempting to identify an isolated outcrop of volcanic ash in the southern part of the Jornada del Muerto of south-central New Mexico, I investigated the criteria of various workers in volcanic ash correlation for the purpose of establishing a standard set of criteria for ready identification of Pleistocene ash beds. This particular outcrop was first brought to my attention by G. O. Bachman, formerly of the U.S. Geological Survey. Much assistance in this study was given by J. W. Hawley of the New Mexico Bureau of Mines and Mineral Resources.

Stratigraphy and regional geology

An outcrop of white, friable volcanic ash is located approximately 8 mi north of Rincon, New Mexico, in an arroyo at the Grama siding of the Atchison, Topeka, and Santa Fe railroad (fig. 1). The bed ranges in thickness from 0.5 to 1.1 ft (0.15–0.35 m). This ash has been informally identified variously as Pearlette-like by Seager and Hawley (1973, fig. 6) and as the Bishop Ash by Izett, (personal communication, 1980). The bed is preserved in sediments of the Camp Rice Formation and has been assigned a Pleistocene age on the basis of paleontology (Strain, 1966).

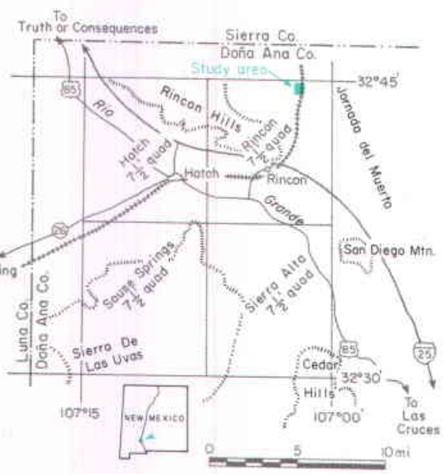

FIGURE 1—Location map showing area of isolated outcrop of Bishop Ash in south-central New Mexico.

Camp Rice Formation—In the base of Grama Gully, fine-grained sediments of the Camp Rice Formation are exposed (fig. 2), representing a distinct basin-floor facies of deposition. Fossil fauna from the Camp Rice have been dated paleontologically as Pleistocene in age (Blancan and Irvingtonian) by Strain (1966) and Hawley (1978, correlation chart 2).

The bulk of Camp Rice Formation is considered to have been deposited through much of Pleistocene time by river distributaries which fanned out from a narrow basin in the Palomas Basin above Hatch. The locus of active deposition during Camp Rice time seems to have wandered widely across the broad central plain of the southern Jornada del Muerto (Seager and Hawley, 1973).

A subfacies of the Camp Rice basin floor preserves the ash bed (fig. 3). This subfacies consists of 1–3 ft (0.3–1 m) of reddish-brown clay, overlain by 1–2 ft (0.3–0.6 m) of light greenish clay which is interbedded with and overlain by a bed of white, friable, biotitic volcanic ash. The ash ranges in thickness from 0.5 to 1.1 ft (0.15–0.35 m). This extremely fine-grained subfacies is indicative of a low-energy environment of deposition and rapid aggradation. This is interpreted as an overbank deposit laid down in the final stages of aggradation of the ancestral Rio Grande. Both the upper and lower contacts of the overbank subfacies with the basin-floor facies are conformable or paraconformable.

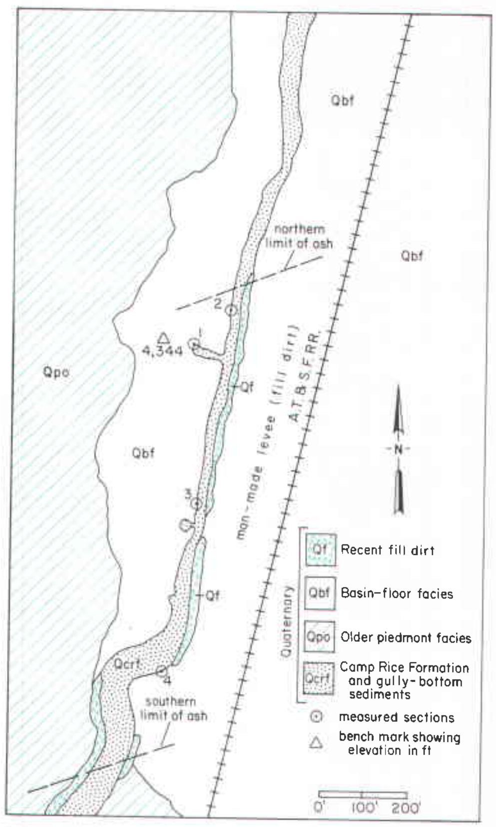

FIGURE 2—Location of measured stratigraphic columns and surficial geology of Grama Gully.

The Camp Rice then marks the final stages of aggradation of the Pleistocene Jornada del Muerto Basin (Seager and others, 1975). The constructional Rincon surface was stabilized soon after the deposition of the ash marker bed and represents the cessation of aggradation for this part of the Jornada del Muerto Basin (Seager and Hawley, 1973).

Younger deposits—Younger deposits in the area overlie the Camp Rice Formation disconformably and are divided into two distinct facies. A piedmont-slope facies (*Qpo* of fig. 2), consisting typically of gravelly coarse-grained sediments, forms a thin veneer over the Camp Rice Formation. Thickness of the piedmont-slope sediments is generally less than 10 ft (3 m). A younger basin-floor facies is also present, located along the present-day axis of the basin. It is comprised of fine-grained loamy sediments (fig. 2) of unknown maximum thickness. These surficial deposits are correlative to the Jornada II and the Petts Tank morphostratigraphic units (Seager and Hawley, 1973).

Correlation and dating

Any correlations between volcanic ashes must be attempted using as many physical parameters as possible. While this seems intuitively obvious, realizing that any correlation is by nature permissive is extremely important; that is, a correlation is permitted if the physical properties match, never demanded. The physical parameters that correlations are based on typically include: chemical composition, age, petrography, and, tentatively, shard morphology. Of these, greatest credence usually is given to the absolute age and chemical analysis.

Whole-rock analysis of the ash from Grama Gully was made using X-ray fluorescence methods. Table 1 shows the results of this analysis and compares the analysis of the ash from Grama Gully with analyses of the Bishop Ash, the Bishop Tuff, and the Pearlette type-O ash. Visually, the composition of the ash from Grama Gully apparently is closer chemically to both of the Bishop volcanics than to the Pearlette type-O ash. This visual inspection is not conclusive.

Statistical treatment of the data (after Borchardt and others, 1971; Borchardt and others, 1972; and Sarna-Wojcicki, 1976) shows that the ash from Grama Gully is chemically very similar to both the Bishop Ash and the Bishop Tuff of Long Valley, California. Table 2 shows the various statistical parameters calculated. These statistical parameters have been developed empirically from ash samples known to correlate. The critical values of these parameters are: X-Bar = 1.00 ± 0.20, Percent Coefficient of Variation = 25%, and Coefficient of Similarity = 0.8. Using these criteria, one can see that apparently the ash from Grama Gully has close chemical affinities to both the Bishop Tuff and the Bishop Ash. It is

TABLE 1—CHEMICAL ANALYSES OF BISHOP ASH AND PEARLETTE TYPE-O ASH WITH ASH FROM GRAMA GULLY. 1, analysis by XRF Ted Bornhorst, personal communication, 1980 (whole rock); 2, Borchardt and others, 1972 (glass separates only); 3, Izett and others, 1970a (glass separates only); 4, Wes Hildreth, personal communication, 1979 (whole rock); and 5, Izett and others, 1970b (glass only).

	Grama Ash[1]	Bishop Ash[2]	Bishop Ash[3]	Bishop Tuff[4]	Pearlette type-O[5]
			percent		
SiO_2	77.9%	—	72.3 %	77.4 %	72.63%
TiO_2	0.11%	—	0.06%	0.07%	0.12%
Al_2O_3	13.4 %	—	12.5 %	12.3 %	11.71%
Fe_2O_3	1.0 %	0.7%	—	—	0.57%
FeO	—	0.5%	—	0.7 %	1.40%
MgO	0.4 %	—	0.05%	0.01%	0.17%
CaO	0.6 %	—	0.45%	0.45%	—
Na_2O	3.4 %	3.4%	—	3.9 %	2.0 %
K_2O	5.1 %	4.9%	—	4.8 %	5.44%
P_2O_5	—	—	—	0.01%	0.02%
Na	—	2.5%	—	—	—
K	—	4.1%	—	—	—
			parts per million		
Rb	183 ppm	160 ppm	150 ppm	190 ppm	230 ppm
Ba	109 ppm	50–100 ppm	—	10 ppm	—
La	35 ppm	16–27 ppm	—	19 ppm	—
Zr	87 ppm	80 ppm	—	—	—
Sc	3 ppm	2.4 ppm	5 ppm	3.0 ppm	—
Sr	57 ppm	—	135 ppm	—	—
Pb	56 ppm	—	40 ppm	—	—
Y	22 ppm	—	35 ppm	25 ppm	—

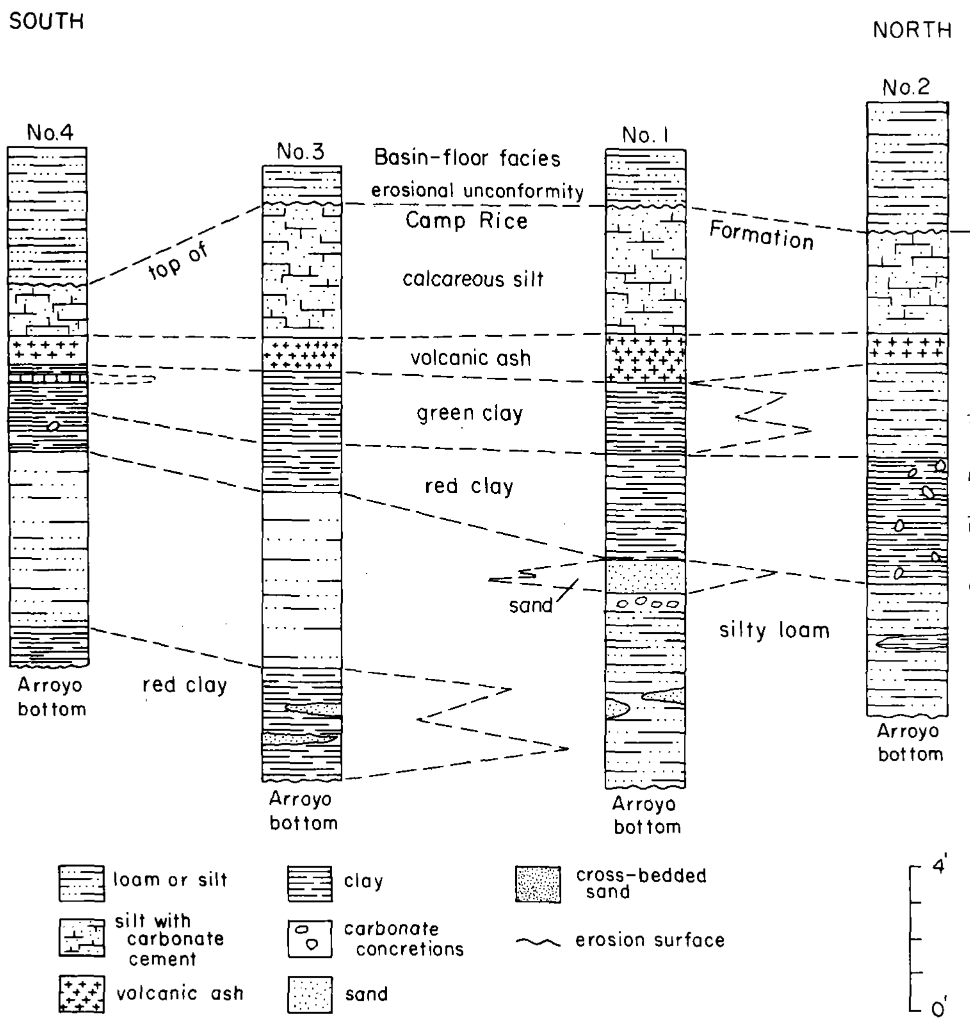

FIGURE 3—MEASURED STRATIGRAPHIC COLUMNS FROM GRAMA GULLY, showing facies correlations.

more similar to the Bishop Tuff than to the Bishop Ash. One possible explanation for this is that the analysis of the Bishop Tuff was done on the whole rock, as was the ash from Grama Gully, but the analyses from the Bishop Ash and the Pearlette type-O were performed on glass separates. Because of the small volume and simple phenocrystic assemblage, the differences between the whole-rock and glass-only analyses are expected to be small. These differences should be primarily in Fe, Mg, and Ti.

A zircon fission-track age date was obtained to verify the Pleistocene assignment of the ash and to justify its comparison to other Pleistocene ashes. Zircon microphenocrysts were extracted from a 10-kg sample of the Grama Gully ash and prepared using the methods of Naeser (1976). Approximately 10 kg of ash was sieved and separated with heavy liquids. The resulting zircon fraction was irradiated and etched. The resulting fission tracks were counted and yielded an age of 0.754 ± 0.2 m.y. with a standard deviation of 26% (table 3; fig. 4); although the standard deviation is high, it agrees well with ages previously determined for the Bishop Ash by other workers.

TABLE 2—VARIATION ANALYSES OF ASH FROM GRAMA GULLY TO OTHER ASHES.

	X-Bar	Coefficient of variability (%)	Number of species	Coefficient of similarity
Bishop Ash	1.77	31.5	15	1.37
Bishop Tuff	1.16	27.9	10	1.22
Pearlette "O"	1.26	41.82	8	1.35
Grama Ash	1.00	0.00	13	1.00

TABLE 3—CALCULATED AGE OF ASH FROM GRAMA GULLY; s/i, fossil track density/induced track density.

Fossil fission tracks	Induced fission tracks	s/i	Absolute age (m.y.)	Cumulative age (m.y.)
1	66	0.015152	.855	.855
4	346	0.011561	.664	.695
6	373	0.011561	.915	.799
3	272	0.011029	.622	.754

Age of Bishop Ash: Sample ST-05—.754 ± .2 m.y.
Standard deviation: 0 = 26.9%

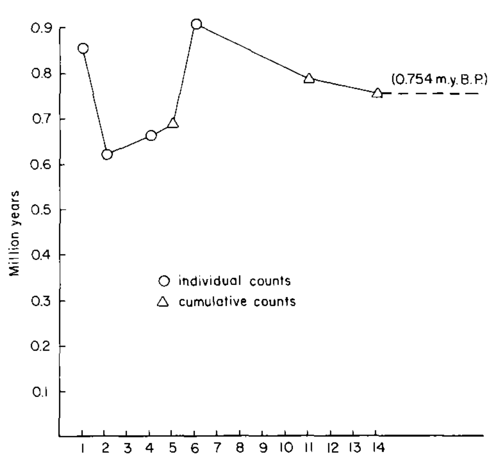

FIGURE 4—ZIRCON FISSION-TRACK AGE DETERMINATION for ash from Grama Gully.

Morphology and petrology

To gain further evidence as to the identity of the ash deposit preserved near Grama, other physical properties were examined. Glass shards from the sample were examined with an optical petrographic microscope. The average index of refraction was 1.500 ± 0.005. The only phenocrysts identified were biotite, magnetite, and zircon, for which the indices of refraction were not determined.

Detailed three-dimensional-shard morphology was examined using a scanning electron microscope. The sample from Grama Gully is typified by complex shard forms: 65% pumiceous shards, 10% complex bubble-junction shards, and 20–25% bubble-wall shards.

Table 4 contrasts the physical properties of the Bishop Ash with the Pearlette type-O ash. When the physical properties of the ash from Grama Gully are compared to the properties shown in table 4, one can see that the ash from Grama Gully has properties consistent with those of the Bishop Ash.

TABLE 4—SUMMARY OF CHARACTERISTICS OF BISHOP ASH AND PEARLETTE TYPE-O ASH (modified from Izett and others, 1970b).

	Bishop Ash	Pearlette type-O
Color	chalky white	silver gray
Diagnostic shard shape	minutely pumiceous	bubble walls, junctions
Glass refractive index	average 1.494–1.496	average 1.499
Diagnostic phenocryst	biotite	ferroaugite
Total iron (as % FeO)	0.6–0.7 percent	1.2–1.5 percent
TiO_2	.06–.08 percent	.10–.12 percent
Zn	30–40 ppm	70–90 ppm

Conclusions

On the basis of fission-track age, chemical similarity, petrography, and ash-shard morphology, the ash from Grama Gully correlates with the Bishop Ash of Long Valley, California. The ash was ejected during a caldera-forming event approximately 0.75 m.y. b.p. The ash was carried westward by prevailing winds and was deposited and preserved in an overbank depression genetically and spatially related to the ancestral Rio Grande. The sediments that preserve the ash represent an overbank subfacies deposited during an aggradational cycle that culminated in the construction of the Rincon surface sometime in post-Bishop time, probably about 0.6–0.5 m.y. ago.

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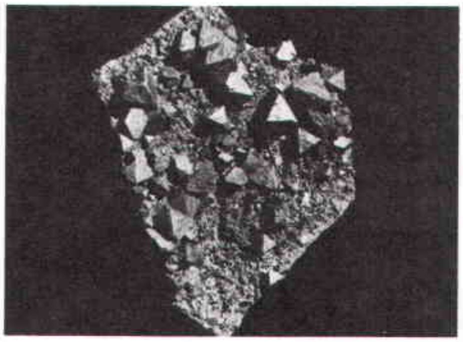
New Mexico's minerals



MAGNETITE, Fe_3O_4. BESSEMER IRON PITS, FIERRO, GRANT COUNTY, NEW MEXICO

Crystal system: isometric — Hardness: 6
Specific gravity: 5.18 — Magnetic
Color: black
Specimen pictured: 3½″ × 3½″ across widest point

Magnetite, the most abundant member of the spinel group, is a common constituent of igneous rocks. The specimen pictured is from a contact-metamorphic deposit where a hot igneous intrusive body came into contact with limestone. Copper, zinc, lead, gold, and silver mineralization also occur in the immediate area of this specimen. Magnetite is an important iron ore.

Photo by K. S. Rider

Geographic names

U.S. Board on Geographic Names

Pinatosa Canyon—canyon, 34 km (21 mi) long, heads 5.6 km (3.5 mi) south-southeast of Gallinas Peak at 34°12′14″ N., 105°45′46″ W., trends southwest to Largo Canyon 34 km (21 mi) north of Carrizozo; Spanish word "pinatosa" means "stand of measured pine"; in Lincoln County, New Mexico; sec. 20, T. 4 S., R. 10 E.; 33°56′35″ N., 105°54′40″ W.; *not:* Pinatasa Canyon, Pinatoso Canyon, Pintosa Canyon

Pinatosa Tank—tank, in a tributary of Pinatosa Canyon 8 km (5 mi) south of Gallinas Peak and 20.9 km (13 mi) southwest of Corona; Spanish word "pinatosa" means "stand of measured pine"; in Lincoln County, New Mexico; sec. 33, T. 1 S., R. 11 E.; 34°10′40″ N., 105°47′48″ W.; *not:* Pintosa Tank.

Tecolote Peak—peak, elevation, 2,230 m (7,315 ft), 7.2 km (4.5 mi) north-northwest of Tecolote and 20.9 km (13 mi) southwest of Corona; Spanish word "tecolote" means "owl"; in Lincoln County, New Mexico; sec. 4, T. 3 S., R. 12 E.; 34°04′40″ N., 105°41′18″ W.; *not:* Cerro Tecolote, Cerro Tecolote Peak.

Golondrina Draw—watercourse, 13.7 km (8.5 mi) long, heads at 33°21′25″ N., 105°50′40″ W., trends west-northwest to Three Rivers 27 km (17 mi) west of Ruidoso; Spanish word "golondrina" means "swallow"; in Otero County, New Mexico; sec. 13, T. 11 S., R. 9 E.; 33°21′27″ N., 105° 58′04″ W.; *not:* Golondrina Creek.

Hasperos Canyon—canyon, 80 km (50 mi) long, heads in Jicarilla Mountains at 33°53′36″ N., 105°38′23″ W., trends east-southeast to Arroyo del Macho 31 km (19 mi) north-northeast of Arabela and 69 km (43 mi) northwest of Roswell; "hasperos" is a local Spanish word applied to a white rock found in the canyon; in Lincoln County, New Mexico; sec. 26, T. 5 S., R. 18 E.; 33°50′21″ N., 105°01′42″ W.; *not:* Big Asparos Canyon, Hasparos Canyon.

—Dave Love,
NMBMMR Correspondent

Update on NURE quadrangle reports

New Mexico Geology, v. 3, no. 4 (November 1981) featured an article "Uranium resources in New Mexico—discussion of the NURE program," by Virginia T. McLemore. Appendix 1 of that article was a list of available NURE quadrangle reports (DOE open-file reports) available at NMBMMR in Socorro, NM, and U.S. Doe in Grand Junction, CO. Following is an update of that list.

Quadrangle	HSSR	ARMS	Folio
Aztec	GJBX-129(78), 321(81)	GJBX-65(80)	PGJ-012(80)*
Brownfield	GJBX-103(78), 60(76), 319(81)	GJBX-33(76)	—
Carlsbad	GJBX-415(81)	GJBX-412(81)	—
Clifton	GJBX-69(78), 359(81)	GJBX-23(79)	PGJ-116(81)
Clovis	—	GJBX-33(76)	—
Douglas	GJBX-69(78), 244(81)	GJBX-23(79)	PGJ-118(81)
El Paso		GJBX-412(81)	—
Ft. Sumner	GJBX-21(77), 345(81)	GJBX-412(81)	
Hobbs	GJBX-103(78), 288(81)	GJBX-228(80)	—
Las Cruces	GJBX-215(81), 416(81)	GJBX-412(81)	—
Raton	GJBX-138(78), 358(81)	GJBX-9(80)	GJQ-005(80)
Roswell	—	GJBX-412(81)	—
Silver City	GJBX-69(78), 320(81)	GJBX-23(79)	PGJ-131(81)
Tucumcari	—	GJBX-33(76)	—
Tularosa	GJBX-104(78), 215(81), 326(81)	GJBX-67(79)	PGJ-004(80)*

*Preliminary reports for public inspection.