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 clastic deposits. The Bishop Tuff of Long Valley, California. Table I shows the results of this analysis and compares the analyses of the Bishop Ash from Grama Gully with analyses of the Bishop Tuff and the Pearlette type-O ash. Visual inspection is not conclusive.

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. Physically, the composition of the ash from Grama Gully apparently is closer chemically to both the Bishop volcanic 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 Sarma-Wojciki, 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 $= 1.00 \pm 0.20$, 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 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).

<table>
<thead>
<tr>
<th>Grama Ash</th>
<th>Bishop Ash</th>
<th>Bishop Ash</th>
<th>Bishop Tuff</th>
<th>Pearlette type-O</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>77.9%</td>
<td>72.3%</td>
<td>77.4%</td>
<td>72.63%</td>
</tr>
<tr>
<td>TiO₂</td>
<td>0.11%</td>
<td>0.08%</td>
<td>0.07%</td>
<td>0.12%</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td>13.4%</td>
<td>12.5%</td>
<td>12.3%</td>
<td>11.71%</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>1.0%</td>
<td>0.7%</td>
<td>—</td>
<td>0.57%</td>
</tr>
<tr>
<td>FeO</td>
<td>—</td>
<td>—</td>
<td>0.7%</td>
<td>1.40%</td>
</tr>
<tr>
<td>MgO</td>
<td>0.4%</td>
<td>—</td>
<td>0.05%</td>
<td>0.17%</td>
</tr>
<tr>
<td>CaO</td>
<td>0.6%</td>
<td>—</td>
<td>0.45%</td>
<td>—</td>
</tr>
<tr>
<td>Na₂O</td>
<td>3.4%</td>
<td>—</td>
<td>4.5%</td>
<td>2.0 %</td>
</tr>
<tr>
<td>K₂O</td>
<td>5.1%</td>
<td>—</td>
<td>4.8%</td>
<td>5.44%</td>
</tr>
<tr>
<td>Na</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>K</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

parts per million

Rb 183 ppm 160 ppm 150 ppm 190 ppm 230 ppm
Ba 199 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 —

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

<table>
<thead>
<tr>
<th></th>
<th>Rb ppm</th>
<th>Rb ppm</th>
<th>Rb ppm</th>
<th>Rb ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOUTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.4</td>
<td>183</td>
<td>160</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>Basill-floor facies</td>
<td>erosional unconformity</td>
<td>Camp Rice</td>
<td>calcareous silt</td>
<td>volcanic ash</td>
</tr>
<tr>
<td>No.3</td>
<td>180</td>
<td>160</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>No.1</td>
<td>180</td>
<td>160</td>
<td>150</td>
<td>190</td>
</tr>
<tr>
<td>NORTH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.2</td>
<td>180</td>
<td>160</td>
<td>150</td>
<td>190</td>
</tr>
</tbody>
</table>

Age of Bishop Ash: Sample ST-05 — 0.754 ± 0.2 m.y.
Standard deviation: 0 = 26.9%.

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

<table>
<thead>
<tr>
<th>Fossil</th>
<th>Induced</th>
<th>s/i</th>
<th>Absolute</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>tracks</td>
<td>tracks</td>
<td></td>
<td>age (m.y.)</td>
<td>age (m.y.)</td>
</tr>
<tr>
<td>1</td>
<td>66</td>
<td>0.015152</td>
<td>.855</td>
<td>.855</td>
</tr>
<tr>
<td>4</td>
<td>346</td>
<td>0.011561</td>
<td>.664</td>
<td>.695</td>
</tr>
<tr>
<td>6</td>
<td>373</td>
<td>0.011561</td>
<td>.915</td>
<td>.799</td>
</tr>
<tr>
<td>3</td>
<td>272</td>
<td>0.010299</td>
<td>.622</td>
<td>.754</td>
</tr>
</tbody>
</table>

Age of Bishop Ash: Sample ST-05 — 0.754 ± 0.2 m.y.
Standard deviation: 0 = 26.9%.
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, magnesite, and ilmenite, 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**

<table>
<thead>
<tr>
<th>Bishop Ash</th>
<th>Pearlette type-O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Chalky white</td>
</tr>
<tr>
<td>Diagnostic shard shape</td>
<td>Finely pumiceous</td>
</tr>
<tr>
<td>Glass refractive index</td>
<td>Average 1.460-1.466</td>
</tr>
<tr>
<td>Diagnostic phenocrysts</td>
<td>Biotite</td>
</tr>
<tr>
<td>Total iron (as % FeO)</td>
<td>0.6-0.1 percent</td>
</tr>
<tr>
<td>Zn</td>
<td>0.06-0.08 percent</td>
</tr>
<tr>
<td></td>
<td>0.0-40 ppm</td>
</tr>
</tbody>
</table>

**Conclusions**

On the basis of fission-track ages, 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.

**References**


**New Mexico’s minerals**

**Magnetite, Fe₃O₄, Biisserem iron pats, Fierro, Grant County, New Mexico**

Crystal system: isometric

Specific gravity: 5.18

Color: black

Specimen pictured: ¾" x ¾" 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

---

**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 I 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**

- Aztec
- Brownfield
- Carlsbad
- Clifton
- Clovis
- Douglas
- El Paso
- Ft. Sumner
- Hobbs
- Las Cruces
- Raton
- Roswell
- Silver City
- Tucumcari
- Tularosa

**HSSR**

- GBX-129(78), 321(81)
- GBX-103(78), 607(76), 319(81)
- GBX-415(81)
- GBX-69(78), 359(81)
- GBX-69(78), 244(81)
- GBX-21(77), 345(81)
- GBX-103(78), 288(81)
- GBX-215(81), 416(81)
- GBX-138(78), 358(81)
- GBX-69(78), 320(81)
- GBX-104(78), 215(81), 326(81)

**ARMs**

- GBX-65(80)
- GBX-33(76)
- GBX-412(81)
- GBX-23(79)
- GBX-33(76)
- GBX-412(81)
- GBX-412(81)
- GBX-228(80)
- GBX-412(81)
- GBX-908(80)
- GBX-412(81)
- GBX-23(79)
- GBX-33(76)

**Folio**

- PGJ-012(80)*
- —
- —
- —
- —
- —
- —
- —
- —
- —
- —
- —
- PGJ-003(80)*
- —
- —
- —
- —

---

**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 Carrizo; 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: Pinatosa Canyon, Pinatosa 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: Pinatosa 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°40'4" 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 Jocassee 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

---

**New Mexico’s minerals**

---

May 1982

New Mexico Geology