Cross section across the Jornada del Muerto, Engle, and northern Palomas Basins, south-central New Mexico

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Introduction

Recent geologic mapping and information from six oil exploration wells provide sufficient data to construct a geologic cross section across the Jornada del Muerto, Engle, and northern Palomas Basins of south-central New Mexico. The Engle and Palomas Basins are part of the Rio Grande rift (Chapin, 1971; Seager and Morgan, 1979), whereas the Jornada del Muerto Basin is a broad syncline that has been interpreted as a remnant Laramide structure by Kelley (1955) and a late Tertiary feature by Seager (1986). Data from two recently drilled wells are also reported herein.

The cross section begins on the eastern edge of the Jornada del Muerto and extends westward through the Cutter sag, crosses the Engle and northern Palomas Basins, and terminates in the Sierra Cuchillo Range, a distance of about 60 km (42 mi; Fig. 1). Data from the six oil exploration wells are listed in Table 1. The West Elephant Butte Federal Nos. 1 and 2, Gartland 1 Brister, Summit 1A Mims, and Sierra "K" State No. 1 wells have been projected onto the cross section line. True fault plane geometries are not known and are shown schematically on the cross section (Fig. 2). Possible fold structures and unconformities occurring within rock units in the cross section are not shown. A generalized stratigraphic chart (Fig. 3) lists the units shown on Fig. 2. For more detailed descriptions of these units, see Kottlowski et al. (1956), Lozinsky (1986), Maxwell and Oakman (1986), Heyl et al. (1983), Jahns et al. (1978), and pertinent articles and roadlogs in New Mexico Geological Society's 37th Field Conference Guidebook (Clemons et al., 1986).

Jornada Del Muerto Basin

The Jornada del Muerto Basin contains the most complete and least-deformed section in Figure 2. Little or no faulting is seen in this area, but the broad synclinal structure of the basin is apparent. This basin is unique because it has not undergone appreciable extension despite occurring in an extension-dominated terrane. Basin-fill sediments along the cross section in this part of the Jornada del Muerto (which are mostly Santa Fe Group equivalents) are generally less than 100 m thick.

Data from the Sierra "K" State No. 1 well indicate that eastward from the Cutter sag all Paleozoic units, except the San Andres Formation, thicken, and Upper Cretaceous units thin. Erosional truncation is probably the cause of the Cretaceous thinning as opposed to a sedimentary pinch out because these Cretaceous rocks extend eastward into the Carrizozo–Capitan area (Kelley, 1971). No McRae strata were penetrated in this well.

The absence of the McRae Formation in this part of the Jornada del Muerto brings up two important questions: 1) does this absence suggest a pinch out of the McRae west of the well and, therefore, the eastern limit of McRae deposition? or 2) does the absence indicate an erosional truncation with the McRae originally extending farther east? These are difficult questions to answer because the regional extent of the McRae is poorly understood. To date, McRae outcrops have only been recognized in the Cutter sag/Jornada del Muerto area. Kelley and Thompson (1964) speculated that the McRae depositional area extended into the Carrizozo–Capitan area based on correlation of the McRae Formation with the Cub Mountain Formation. Similar lithologies and general stratigraphic position were the basis for correlation. However, it is very difficult to document if the McRae and Cub Mountain Formations were co-extensive because of limited outcrops and no subsurface data. More detailed sedimentologic studies of these units are necessary to answer these questions.

The Sierra "K" State No. 1 well also penetrated Permian Glorieta and Mississippian Lake Valley strata that are absent in the Cutter sag–Caballo and Mud Springs uplifts. Unit thicknesses shown on the western side of the Jornada del Muerto and in the Cutter sag are based on measured sections in the Caballo–Cutter sag uplift by Kelley and Silver (1952), Bushnell (1953), and Mason (1976).

Cutter sag

The Cutter sag, a structually low part of the Caballo–Fra Cristobal uplift, divides the Jornada del Muerto from the Engle Basin. Units in this area generally dip between 10–15° eastward. McRae Formation thickness in the Cutter sag is problematic. Bushnell (1953) estimated the McRae to be about 1,000 m thick, but this estimate is based on extrapolation across Elephant Butte Reservoir where faults and other structures may be present. Based on mapping by Lozinsky (1986), McRae thickness is probably closer to 500 m. This is the thickness used in the cross section.

Faulting is more common in the Cutter sag than in the Jornada del Muerto. Faults in the Cutter sag usually have stratigraphic separations of 100 m or less. The Hot Springs fault marks the boundary between the Cutter sag and the Engle Basin. At the surface, the Hot

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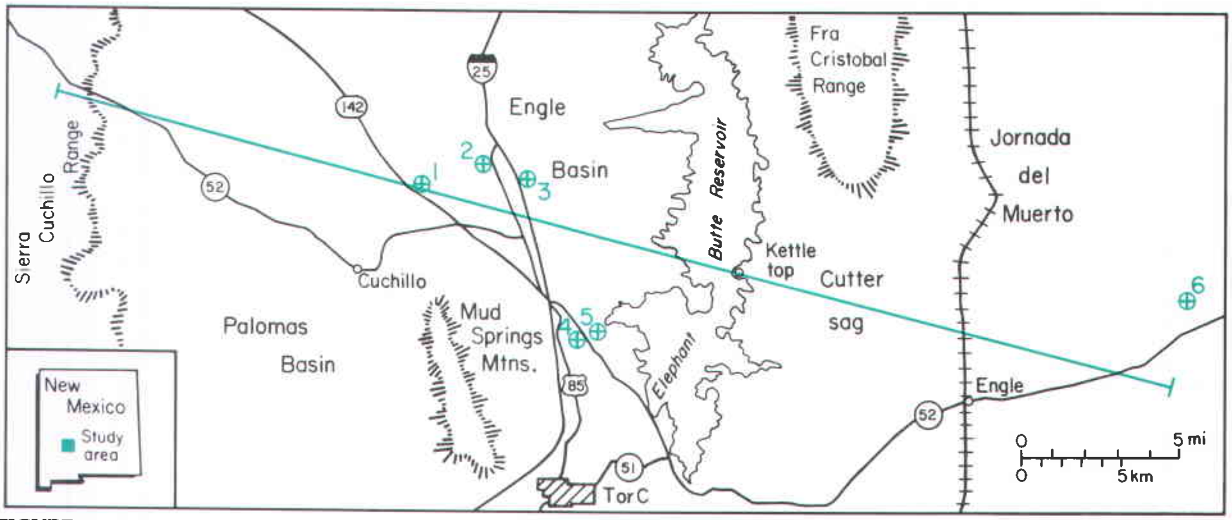


FIGURE 1—Location of map of cross section and study area. Numbers in blue refer to wells listed in Table 1. Hatchured line indicates railroad.

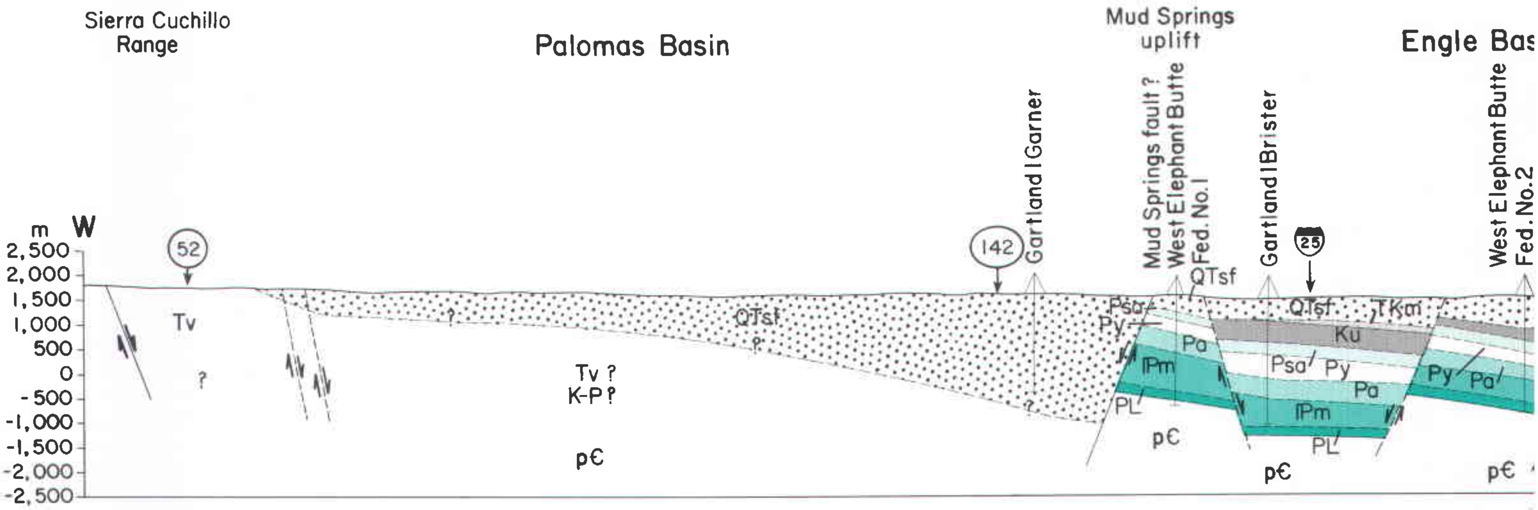


FIGURE 2—Cross section across the Jornada del Muerto, Engle, and northern Palomas Basins. Refer to Fig. 3 for explanation of unit symbols. Plio-Pleistocene basalt flows that partly cap the Cutter sag are not shown. Surface geology compiled from Lozinsky (1986), Heyl et al. (1983), Maxwell and Oakman (1986), and Machette (written comm. 1982).

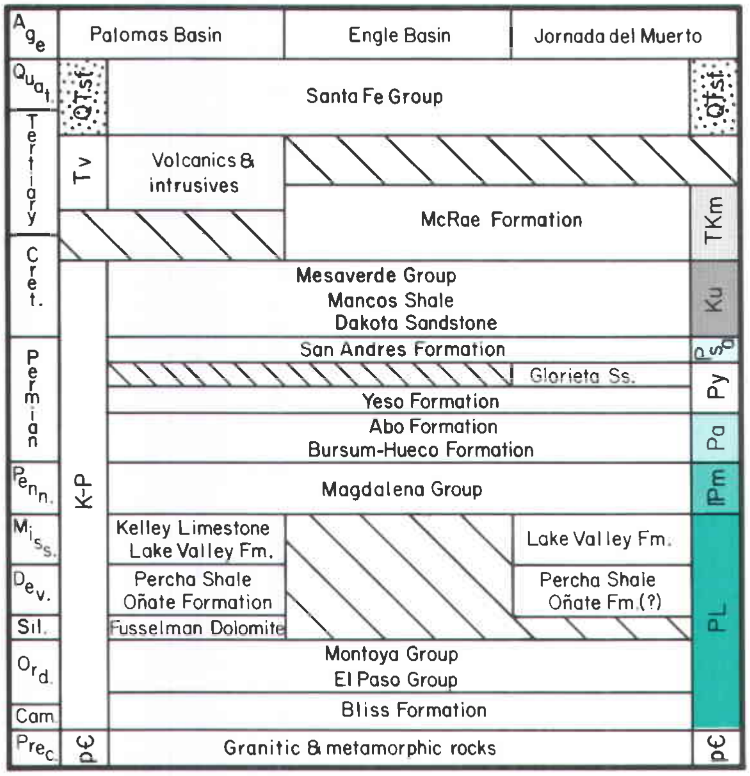


FIGURE 3—Stratigraphic chart for cross section. Unit symbols refer to those shown in Fig. 2.

Springs fault dips about 70–80° to the west and has at least 1,220 m of down-to-the-west separation (Lozinsky, 1986). The Hot Springs fault is shown as a single fault because, in this area, the trace is submerged beneath the waters of Elephant Butte Reservoir. This fault may actually be a complex zone containing many splays and small fault blocks as seen in exposures north and south of the reservoir. Chapin (1983) has interpreted faults like the Hot Springs as major right-lateral strike-slip faults of late Laramide age that have been reactivated as normal faults during late Cenozoic rifting.

Engle Basin

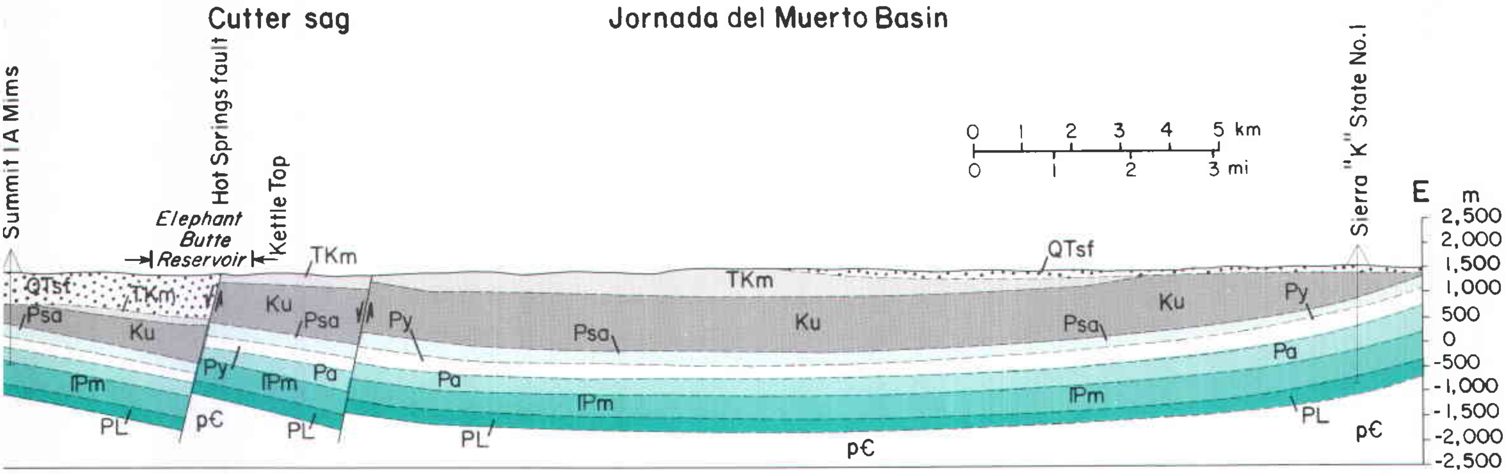
The Engle Basin is a half graben with its deeper portion to the east along the Hot Springs fault. Here, the basin fill is probably as much as 700 m or more thick. Note how the Upper Cretaceous units thin westward in the Engle Basin. This thinning is probably due to pre-Santa Fe erosion. The McRae Formation has also thinned to about 27 m in the Gartland 1 Brister well. No McRae strata were recognized in either the West Elephant Butte Federal No. 2 or the Summit 1A Mims wells. Mesaverde Group strata underlie the basin fill in the two wells. However, the two wells probably do not indicate accurately the thickness of the McRae Formation east of the Gartland 1 Brister well because they are located about 4 km south of the cross section line. Thus, McRae strata probably disappear just west of the Gartland 1 Brister well and south towards the Summit 1A Mims well. The McRae disappearance may be the result of pre-Santa Fe erosion or it could represent the McRae's western limit of deposition because McRae units are not found farther west (Jahns et al., 1978; Heyl et al., 1983).

All wells in the Engle Basin penetrate dioritic(?) intrusives of various thicknesses in the Yeso Formation. These intrusives have increased the thickness of the Yeso, especially in the Gartland 1 Brister well. A fault is hypothesized between the Gartland 1 Brister and West Elephant Butte No. 2 wells to account for the elevation difference to the top of the Precambrian.

Mud Springs uplift

The western portion of the Engle Basin probably represents a buried part of the Mud Springs uplift because the basin depth decreases and the northeastern extension of the Mud Springs uplift projects into this area of the cross section (M. Machette, pers. comm. 1982). For the most part, the Mud Springs uplift is a northeast-tilted block. However, where exposed near T or C, the Mud Springs uplift is complex structurally and contains an overturned syncline (Kelley and Silver, 1952). These same complexities may also occur in the buried part of the cross section. The West Elephant Butte Federal No. 1 well shows that the Upper Cretaceous units are absent on this buried block and that the basin fill rests directly on limestone of the San Andres Formation. Pre-Santa Fe Group erosion probably removed the Cretaceous units and part of the San Andres Formation from the Mud Springs block.

The tops of units between the Gartland 1 Brister and West Elephant Butte Federal No. 1 wells differ greatly, especially the depth of the Precambrian. Thus, there may be another major fault between these two wells. The thicker Pennsylvanian Magdalena Group in the West Elephant Butte Federal No. 1 well may be due to one of the following reasons: 1) late Paleozoic syn-depositional faulting; 2) juxtaposition across a strike-slip fault; 3) repetition of beds due to faulting; or 4) steeper dips. Between the West Elephant Butte Federal No. 1 and Gartland 1 Garner wells, the Santa Fe Group greatly thickens over a distance of 3 km. This thickness increase over such a short distance



probably delineates the Mud Springs fault, which marks the boundary between the Palomas Basin and the buried uplift.

Palomas Basin

The Palomas Basin is an eastward-tilted, half graben similar to the Engle Basin as evidenced by gravity data (Gilmer et al., 1986) and by eastward dips of Santa Fe Group beds along the western edge of the basin (Heyl et al., 1983). Basin-fill thickness is probably greater than 2,000 m along the eastern side of the Palomas Basin. Here, the Gartland 1 Garner well bottomed in the Santa Fe Group at a depth of 1,988 m. This well penetrated mostly poorly sorted, coarse- to fine-grained sand with minor silt and clay interbeds. These sediments may be proximal alluvial-fan deposits derived from the Mud Springs uplift.

Heyl et al. (1983) mapped the surface geology along the western margin of the Palomas Basin, including a basin-bounding fault. They showed that the eastern flank of the Sierra Cuchillo Range consists of Tertiary volcanic units. Due to a lack of well control in the Palomas Basin, it is not known how far east these volcanics extend into the Palomas Basin. However, they do not extend as far as the West Elephant Butte Federal No. 1 well because no volcanic units are seen in the well cuttings. Thus, the volcanics must either pinch out somewhere in the Palomas Basin or have been eroded from the Mud Springs block before deposition of the Santa Fe Group.

It is not known what units are present below the volcanics. In the Sierra Cuchillo Range, Jahns et al. (1978) reported a similar stratigraphic section as that for the Engle Basin with the addition of Silurian, Devonian, and Mississippian strata (Fig. 3). This same section may also be present in the subsurface of the Palomas Basin.

Conclusions

Figure 2 shows that the Jornada del Muerto is a broad synclinal basin and that the Engle and Palomas Basins are east-tilted, half grabens. A buried extension of the Mud Springs uplift separates the Engle Basin from the Palomas Basin. The buried Mud Springs uplift has Upper Cretaceous units missing from its section. Basin-fill thickness is greatest along the eastern margins of the Engle and Palomas Basins. McRae Formation strata partly extend into the Engle and Jornada del Muerto Basins. Tertiary volcanic units exposed in the Sierra Cuchillo Range probably extend an unknown distance eastward into the Palomas Basin. Little is known about the subsurface geology of the Palomas Basin because of limited well control. When this work is combined with area geophysical studies (such as Gilmer et al., 1986), a more refined interpretation of the subsurface geology may be possible.

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TABLE 1—Well data. Well numbers refer to those shown in blue in Fig. 1. Data was derived from analyses of geophysical logs, lithologic logs, and in some places, well cuttings. **NP**, not penetrated; *, estimated tops or thicknesses; †, total thickness of dioritic(?) intrusives in Yeso Formation.

Well no.	Name; location; completion date	Surface Elevation (m)	Total depth (m)	Tops (m)								Thickness (m)							
				TKm	Ku	Psa	Py	Pa	IPm	PL	p€	QTsf	TKm	Ku	Psa	Py	Pa	IPm	PL
1	Gartland 1 Garner; 11–12S–5W; 12/21/50	1,500	1,988	—	—	—	—	—	—	—	—	>1,988	—	—	—	—	—	—	—
2	West Elephant Butte Federal No. 1; 7–12S–4W; 12/12/82	1,509	2,204	—	—	1,186	1,066	712	415	−401	−645	323	—	—	120	354 123†	297	816	244
3	Gartland 1 Brister; 8–12S–4W; 1/21/51 redrilled 9/20/55	1,480	2,617	1,038	1,011	581	355	−178	−563	NP −1,034*	NP −1,259*	442	27	430	226	533 226†	385	471*	225*
4	West Elephant Butte Federal No. 2; 3–13S–4W; 1/5/83	1,394	2,303	—	798	577	346	112	−183	−653	−880	596	—	221	231	234 29†	295	471	226
5	Summit 1A Mims; 2–12S–4W; 10/3/51	1,393	1,888	—	789	354	125	−110	−367	NP −838*	NP −1,064*	604	—	435	229	235 26†	257	471*	226*
6	Sierra "K" State No. 1; 35–12S–1W; 8/10/70	1,558	2,396	—	—	996	793	333	−64	−771	NP −1,026*	<20?	—	542	203	460	397	707*	225*

Exploration roundup in New Mexico during 1986

Exploration activity in New Mexico remained at a relatively low level, reflecting the depressed condition of many of our extractive industries. Virtually no activity was posted by the base metal (i.e., copper, lead, zinc), uranium, and potash sectors, traditionally the "big three" among the state's nonfuel mineral industries. Only gold and coal markets had any significant activity. Little of the activity in the gold industry is likely to result in a producing mine in the near future, primarily because of an ever-tightening web of environmental red tape.

A possible gold find is being evaluated by Molycorp, Inc. (division of Unocal, Corp.) in the Red River area in northern New Mexico. The nearby Questa area has been mined for molybdenum for more than 60 years, but several gold prospects in the surrounding mountains predate the moly mine by 30 or more years. Molycorp has applied twice to the U.S. Forest Service for permission to drill 20 exploratory holes south of Red River near Junebug campground. But the area is within a wilderness study area, and both permit applications have been denied.

Similarly, La Paz Mining Co. attempted to develop a small gold placer on Bear Creek near Piños Altos, Grant County, but became embroiled with the Army Corp of Engineers over a section 404 permit (which regulates the placing of fill material back into a river or stream). The permit was denied on the basis that the mining activity by La Paz would critically damage downstream water and habitats.

Long Lac Minerals Exploration continued to drill on its gold prospect in the southern portion of the Ortiz mine grant, Santa Fe County, concentrating efforts in the Lukas and Carache Canyon areas. Long Lac planned to complete 12 holes during the year.

St. Cloud Mining Company pursued an on-going sampling and evaluation program in the Chloride mining district of the Black Range, Sierra County. Essentially, efforts are geared toward the production of precious-metal-bearing siliceous smelter flux. Shipments have been made from the U.S. Treasury mine, Great Republic mine, and other properties. Sunshine Mining Company relinquished its option on the St. Cloud–U.S. Treasury mine in mid-year after a small, and apparently unsuccessful, drilling and sampling program.

Also in the Chloride mining district, First Mississippi Corp. completed assessment drilling on the Hoosier and Silver monument properties, while the area around the Weber shaft (extreme north end of the district) was evaluated for smelter flux potential. Elsewhere in Sierra County, exploration drilling near Hillsboro resulted in a small-scale operation at the Rattlesnake mine. During the year, a sorted product grading approximately 1 oz gold, 3.5 oz silver, and 3.5% copper was sold to ASARCO, Inc., for flux.

A small amount of exploratory drilling was done at Sierra Rica just north of the Mexican border in Luna County, and a small amount of exploration activity, geared toward small-scale gold placer mining, was done on upper Rio Grande placers near Pilar.

An unexpected molybdenum find was revealed in an exploration hole drilled by Los Alamos National Labs in the Valles caldera structure 38 mi northwest of Santa Fe. This hole, second of three planned, was designed to gather scientific data on geothermal systems as well as to learn more about formation of ore deposits. Molybdenite (MoS_2), along with small amounts of copper, lead, and zinc, was encountered between 80 and 400 ft, some possibly of ore grade.

The New Mexico Bureau of Mines and Mineral Resources (NMBMMR), along with funding from the New Mexico Energy Research and Development Institute and private industry completed the second year of a projected 4-year program to evaluate strippable coal resources in the San Juan Basin. A total of 56 holes was completed during 1986: 35 in the Menefee Formation around San Mateo, La Ventana, and Chacra Mesa; 10 in the Menefee/Crevasse Canyon Formations in the Gallup coal field; eight in the Crevasse Canyon Formation near Crownpoint and Borrego Pass; and three in the Fruitland Formation near Star Lake.

NMBMMR staff also provided geologic expertise and chemical analyses as part of an exploration drilling program on the yttrium rare-earth deposits at Laughlin Peak in Colfax County.

A few properties other than those mentioned above are currently being promoted vigorously on the basis of very high gold and/or platinum values. Some of these (particularly the platinum "deposits") will eventually be exposed as fraud. The would-be investor is advised to exercise extreme caution.

—Robert W. Eveleth
NMBMMR Mining Engineer

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