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## Abstract

One of the deeper parts of the Tucumcari Basin of east-central New Mexico is what has been called the Cuervo sub-basin. The deepest well that has been drilled in the Cuervo sub-basin is the General Crude No. 1 Simpson, Sec. 21 T10N R23E, which reached Precambrian basement at a depth of 9,060 ft. The Cuervo sub-basin has been shown in published literature as a small feature centered in T10N R23E and terminated westward by an arcuate, southward thrust fault block or sheet. Gravity and magnetic data, however, as interpreted here suggest that the sub-basin emerges from beneath the west side of the thrust sheet and continues to the west-southwest. The original sub-basin length is interpreted as approximately 75 mi. This sub-basin appears to become shallower westward and culminates in a saddle between the Pedernal uplift to the south and the Sierra Grande uplift to the north. Because of its length, a more descriptive name for this Pennsylvanian- and Permian-age feature might be the Cuervo trough. The south margin of this trough apparently is the boundary between the clastic-dominated Cuervo trough to the north and the carbonate-dominated shelf to the south and may be a major locus for hydrocarbon accumulations in granite wash pinchouts, reefs, and anticlinal structures.

## Introduction

One of the deepest parts of the Tucumcari Basin is the so-called Cuervo sub-basin. This feature has been shown in published literature (Montgomery 1986) as a small down-warped or down-faulted area that is centered in T10N R23E, Guadalupe County (Fig. 1). Later writers have shown it as much larger (Broadhead and King 1988; Broadhead et al. 2002). The deepest well that has been drilled in the sub-basin is the General Crude No. 1 Simpson, Sec. 21 T10N R23E, which penetrated the top of Precambrian basement rocks at a depth of 9,060 ft or 4,396 ft below sea level. This well and others show that the sub-basin is a feature of Pennsylvanian and Permian age, filled largely with shales and sandstones. The earlier beds, of Pennsylvanian and Early Permian ages, are dominantly marine, whereas the later Permian strata are mostly non-marine (Broadhead and King 1988).

The main source of the clastic sediments in the sub-basin was the Sierra Grande uplift, a major Pennsylvanian and Permian positive feature lying immediately to the north of the sub-basin and trending northeastward. A second and probably less important source of sediment was the Pedernal uplift, which lay to the west of the Tucumcari Basin and trended roughly north-south.

South of the Cuervo sub-basin lies a broad carbonate shelf area of Pennsylvanian and Early Permian age, possibly extending more or less continuously to the northwest shelf of the Permian Basin. This area has been named the Sin Nombre arch by Broadhead and Jones (2002). The coarser clastics shed from the Sierra Grande uplift directly to the north of the Cuervo sub-basin during this time (Pennsylvanian and Early Permian) appear to have been largely trapped in and limited to the sub-basin and do not appear to be present in large volume on the carbonate shelf.

Many of the known hydrocarbon occurrences of the Tucumcari Basin are located around the Cuervo sub-basin (Fig. 1). These include the Santa Rosa tar sands to the west (Gorman and Robeck 1946), the Latigo Ranch oil and gas pool to the south, the Newkirk heavy oil field to the northeast, and the Yates No. 1 T–4 Ranch well to the east (Broadhead and King 1988). The presence of these oil and gas occurrences can probably be at least partly attributed to thick, mature Pennsylvanian source rocks in the sub-basin (Broadhead and King 1988; Broadhead et al. 2002).

## Extension of the sub-basin

The limits of the Cuervo sub-basin appear to be established fairly clearly to the north, east, and south by well control. The western limit, however, being hidden by a thrust sheet, is not clear. In an attempt to clarify this side of the sub-basin, a study of regional gravity and magnetic data was undertaken.

The regional gravity (Fig. 2) shows a strong gravity minimum some 12–15 mi wide extending west-southwest from the position of the Cuervo sub-basin. The gravity minimum is bounded by fault gravity anomalies separating it from the Sierra Grande uplift gravity maximum to the north and the broad gravity maximum area of the carbonate shelf to the south. The minimum continues westward for approximately 75 mi and suggests the possibility of a structural separation of the Pedernal uplift from the Sierra Grande uplift. The regional gravity does not clearly show the thrust sheet west of the Cuervo sub-basin; the thrust does, however, show on shallow-emphasis residual maps made from detailed gravity purchased from commercial data suppliers. These data indicate that the thrust front apparently arcs back northward from the west end of its position as shown by Figure 1.

The regional magnetic data (Fig. 3) do not appear to show the form of the gravity minimum. This suggests that the gravity minimum is not produced by a body of igneous or metamorphic rock within Precambrian basement. Only a small part of the length of the southern boundary fault gravity anomaly appears to be reflected by the magnetic data.

Magnetic source depth estimations made from U.S. Geological Survey aeromagnetic data (Aerial Surveys 1976 and Dempsey and Hill 1950), however, appear to reflect the low area suggested by the gravity minimum. A structure contour map was made from these depth estimates combined with the scattered well data points and the regional gravity data (Fig. 4). This map reflects not only the Cuervo sub-basin where it is shown by Figure 1, but also the lobate form of the thrust and a westward extension of the sub-basin in the position of the gravity minimum. Because this interpreted westward extension of the sub-basin is much longer than the previously named Cuervo sub-basin, it appears that a more descriptive name for the sub-basin might be the Cuervo trough.

The western end of the gravity minimum area, rather than being structurally low, appears to be, from the magnetic depth estimations, structurally high. This is interpreted from the tabular nature of the source suggested by the aeromagnetic data in this area (Aerial Surveys 1976), to be most likely caused by one or more Tertiary diorite or diabase sills of the type described by Smith (1957, p. 37).

The extended Cuervo trough apparently becomes more shallow westward, as shown in Figure 4. An isopach map of the interval between the top of the Permian Glorieta Sandstone and the top of the Precambrian (Fig. 5) suggests that the trough was fairly constant in sedimentary accumulation depth during Pennsylvanian and Permian time. It may, consequently, have provided a marine connection between the Tucumcari Basin to the southeast and the Rowe–Mora Basin to the northwest.

*Text continued on p. 89*

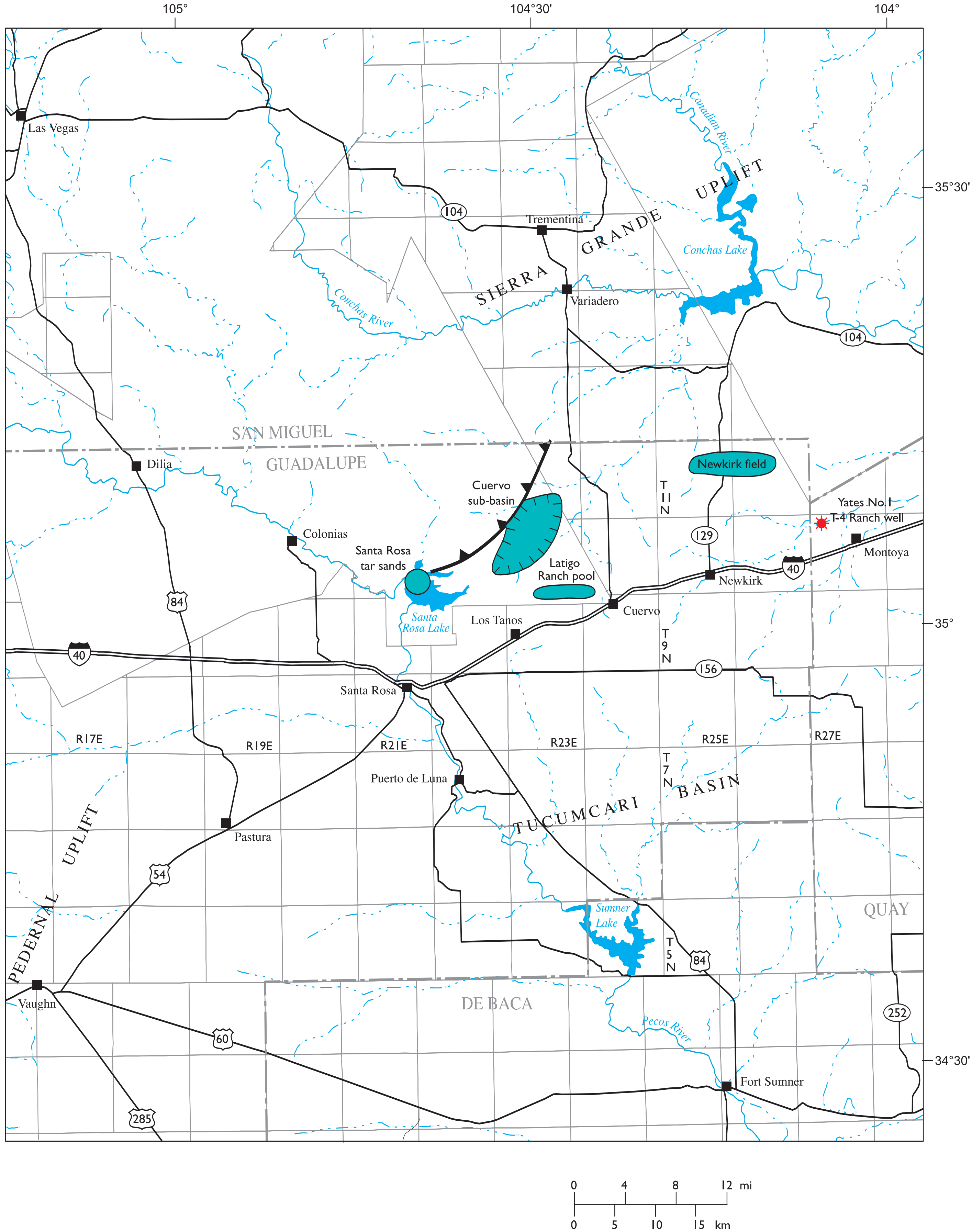


FIGURE 1—Location of Cuervo sub-basin and surrounding known occurrences of hydrocarbons. Thrust fault and sub-basin form from Montgomery (1986).

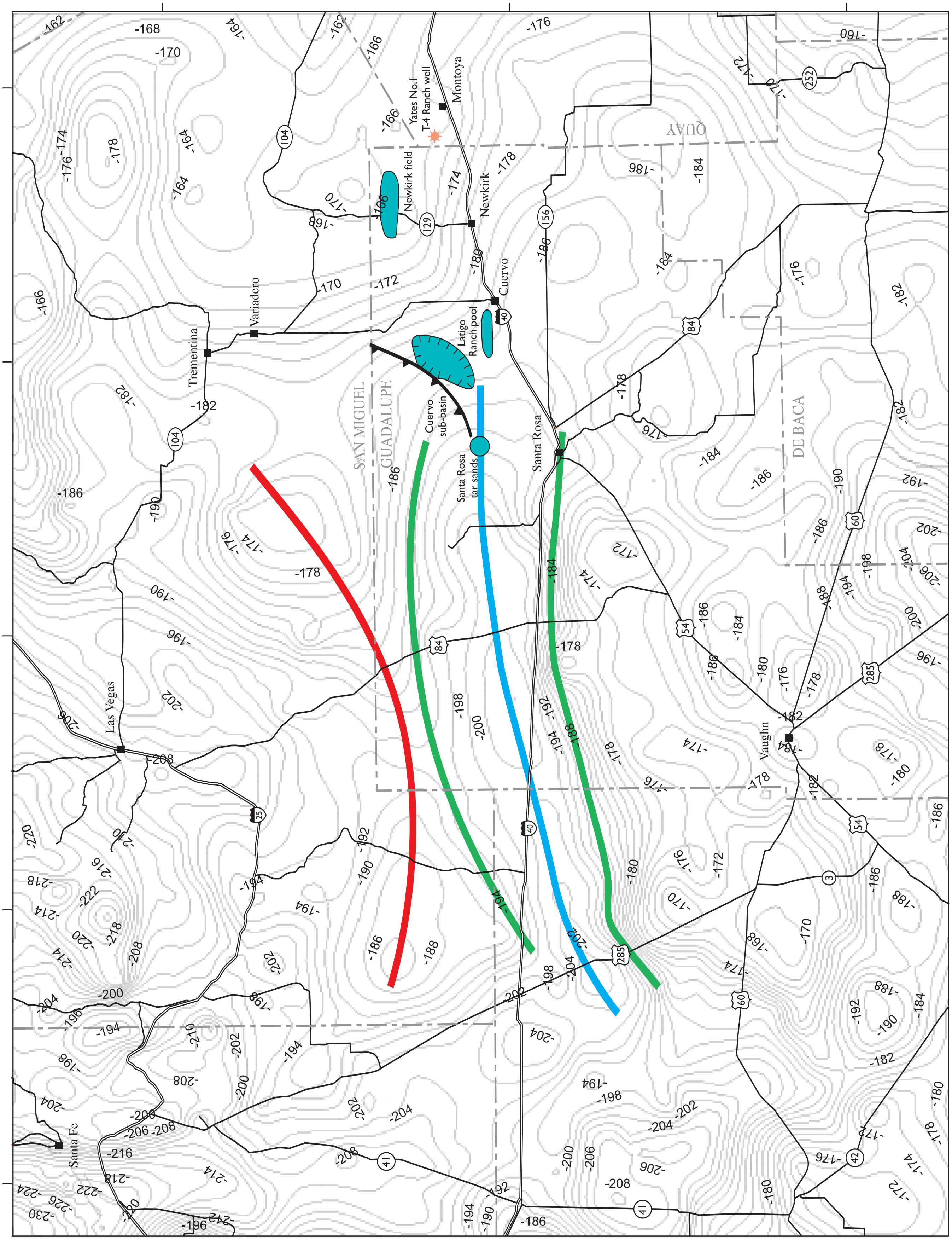


FIGURE 2—Regional Bouguer gravity map from Kucks et al. (2001) showing Cuervo trough gravity minimum (blue), gravity anomalies suggesting major faults (green), bounding gravity minimum, and Sierra Grande uplift gravity maximum (red).

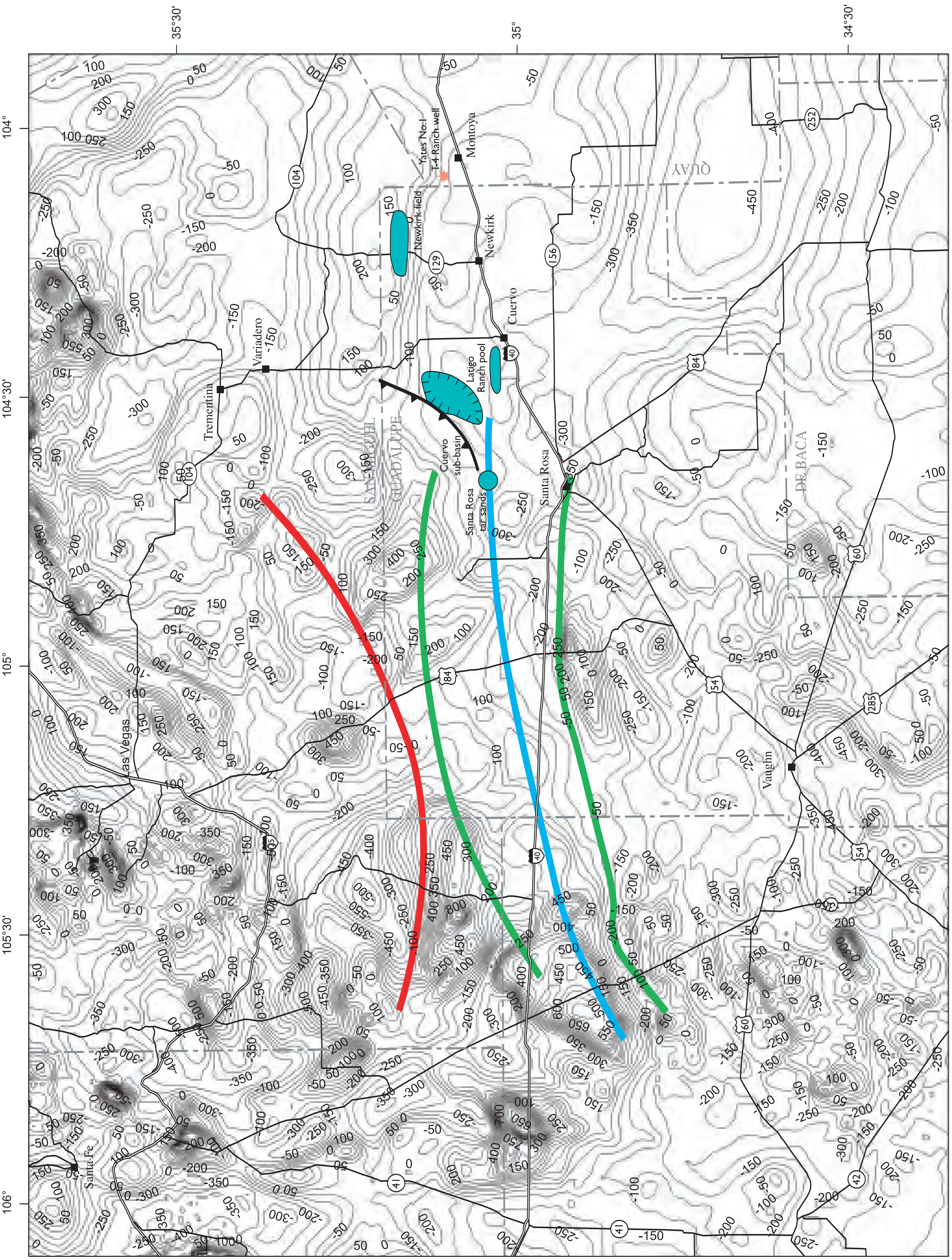


FIGURE 3—Regional aeromagnetic map (from Kucks et al. 2001) showing no clear expression of Cuervo trough.

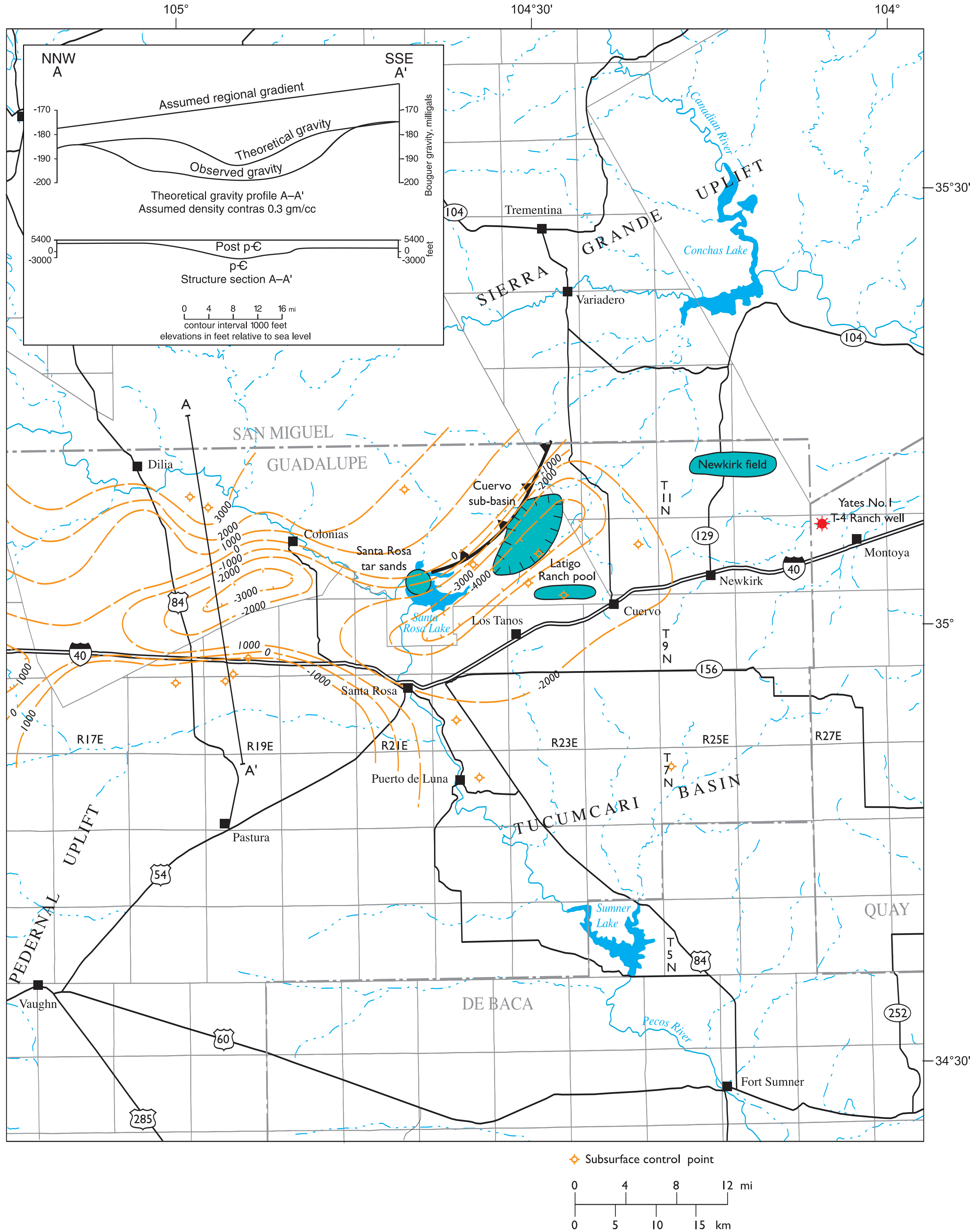


FIGURE 4—Map showing structure contours on top of Precambrian basement rocks, based on subsurface data, magnetic source depth estimates, and gravity data. **Inset**—Theoretical gravity profile A–A′ is interpreted as showing that the Paleozoic Cuervo trough is too shallow and too narrow to supply the gravity minimum of Figure 2.

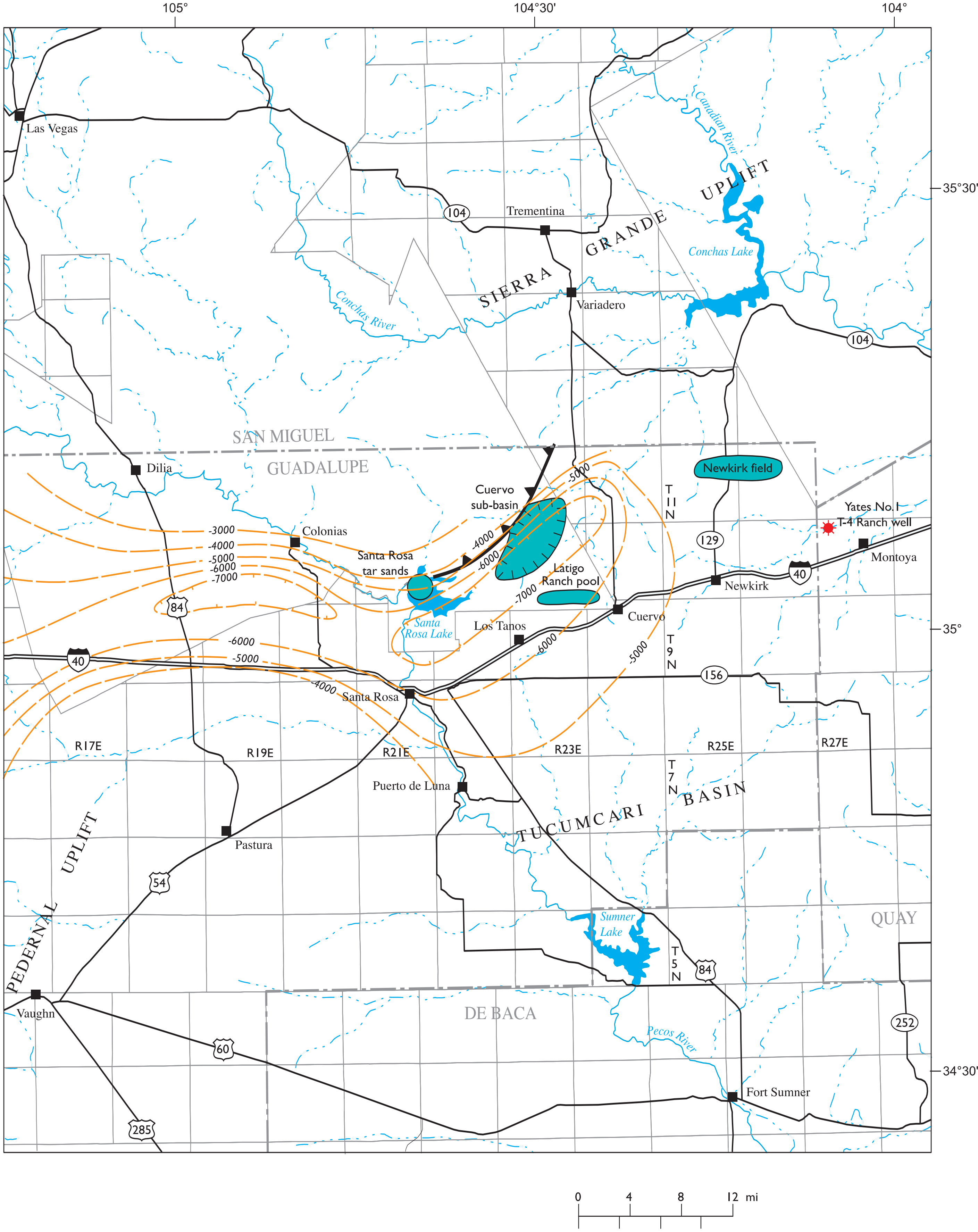


FIGURE 5—Map showing isopach contours of the stratigraphic interval between the top of Permian Glorieta Sandstone and the top of Precambrian basement rocks.

## Origin of the Cuervo trough

The Cuervo trough appears to be one of the "elevator basins" of Broadhead and Chapin (1999), active from Middle Pennsylvanian through Early Permian time. Comparison of the structure contour map (Fig. 4) with the regional gravity minimum (Fig. 2), however, shows that the gravity minimum is much wider than the Cuervo trough of Pennsylvanian and Permian age. A theoretical gravity profile (Fig. 4, inset) appears to show that the trough is not only narrower but also shallower than indicated by the gravity minimum. This is interpreted as suggesting that the Cuervo trough had ancestral form in the Precambrian, and hence may be a Paleozoic rejuvenation of an earlier, larger, presumably Proterozoic trough.

## Petroleum possibilities

The Pennsylvanian petroleum source rocks of the Cuervo trough have probably generated much of their oil and gas (Broadhead and King 1988). Though many of these hydrocarbons may have remained within the trough, large quantities may have migrated north or south out of the deep trough.

Oil and gas migrating northward would be likely to escape upward along basin-bounding faults, as may be the case with the Santa Rosa tar sands and the Newkirk field, or through the open updip ends of sandstones and granite washes. Furthermore, the north side of the trough is likely to have a long history of invasion of potential reservoirs by fresh water from the Sierra Grande uplift; formation waters from the Pennsylvanian and Permian of the north side of the trough commonly are brackish or fresh. In contrast, formation waters from Pennsylvanian and Permian rocks from the trough and the adjacent carbonate shelf tend to be of the salinity of normal sea water or more saline (R. Johnson, unpublished data 1997). For these reasons, the south side of the Cuervo trough and north edge of the carbonate shelf are considered to be more attractive for possible petroleum accumulations.

Three principal types of hydrocarbon accumulations along the south margin of the trough seem likely. First are possible stratigraphic traps in sandstones and granite washes that pinch out updip against the steep edge of the carbonate shelf to the south; the Latigo Ranch pool found during the 1980s by Trans-Pecos Resources is evidently of this type, and appears to contain a number of potential reservoirs. A second type of possible accumulation is in anticlines located along the carbonate shelf edge. Several such anticlines are known, and none have been properly tested. The third possible trap type, and perhaps the most attractive, is potential reef development along the northern edge of the carbonate shelf, and possibly under some or all of the anticlines. Altogether, these three types of possible oil and gas traps, spread along a clastic trough and carbonate shelf boundary more than 50 mi long, could constitute a very large or even giant petroleum province.

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*Cover caption continued from p. 82.*

Piedmont arroyos head at the base of the mountain in the foreground and become shallower and die out on the lower piedmont. Climate change may affect the density of the junipers in the foreground. Wood cutting could also reduce juniper density and may have occurred on the mesa sides in the past. Vegetation on the bench where the camera was located includes grass, abundant beargrass (*Nolina* sp.), some cholla cactus, some juniper, sparse mesquite trees, abundant small yucca, and four-wing saltbush.

Wayne Lambert is a Colorado-based photographer who maintains a gallery in Colorado Springs. His large-format black and white photographs reflect his interest in two of photography's oldest traditions: landscape photography and documentary photography. Subjects of special interest are the landscapes of the public lands and national parks of the American West and the culture of rural Mexico. His photographs are included in the collections of Texas Tech University and the Center for Southwest Research at the University of New Mexico.

In the Southwest Wayne is equally well known as a geologist. After receiving his M.S. and Ph.D. degrees from the University of New Mexico, he worked for the U.S. Geological Survey and taught at West Texas State University. Through the 1980s Wayne made photographs for the New Mexico Geological Society fall field conference guidebooks and in 1978 for the bureau's Circular 163, *Guidebook to Rio Grande rift in New Mexico and Colorado*. Last year he donated to the bureau several maps and information related to his studies of the geology of New Mexico.

To see more of Wayne Lambert's photographs, visit his Web site at www.waynelambert.net or the Web gallery Photo Bistro at www.photobistro.com.