Paleoseismologic Assessment of the Northern Tijeras- Cañoncito Fault System, Central New Mexico

Award Number 99-HQ-GR-0107

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Element II: Research on Earthquake Occurrence and Effects

Key words: Quaternary Fault Behavior, Geologic Mapping, Tectonic Structures, Fault Segmentation

Investigations Undertaken

The principal objective of this project is to (1) provide a detailed, 1:24,000-scale map of late Quaternary traces of the northern Tijeras-Cañoncito fault system, and (2) select a site for subsurface exploration that has the greatest potential for providing well-constrained paleoseismic data. The primary product of this effort will be a detailed map of fault strands, surficial deposits, and potentially fault-related features along the Tijeras-Cañoncito fault system between the towns of Golden and Cañoncito, New Mexico (Figures 1 and 2). This map is being prepared through compilation of existing geologic data, analysis of aerial photography, limited aerial reconnaissance, and field mapping of potentially active strands of the fault. The map area includes a 2-km-wide swath bordering the fault on the Golden, Captain Davis Mountain, Picture Rock, Galisteo, Bull Canyon, and Glorieta USGS 7.5-minute quadrangles.

Analysis of Aerial Photography
Our approach in mapping the northern Tijeras fault includes analysis of aerial photography and imagery, aerial reconnaissance, and field mapping along critical sections of the fault. We are using several types of aerial photography and imagery, because the fault traverses several large privately held land grants as well as land administered by the Bureau of Land Management and the U.S. Forest Service. In order to analyze the entire northern Tijeras fault, we have obtained and are analyzing the following imagery:

- Entire study area: 1:58,000-scale color-infrared images (USGS NHAP, 1981-82). These images provide a reconnaissance-level view of the fault, and help focus our activities on areas that will provide information on late Quaternary fault behavior.
- Golden quadrangle: 1:20,000-scale black-and-white photos (Soil Conservation Service, 1951). These photos pre-date much of the cultural modification of this area related to mineral extraction along the fault.
- Captain Davis Mountain and Galisteo quadrangles: 1:12,000-scale color photos (IntraSearch, Inc., 1970).
- Picture Rock and Galisteo quadrangles: 1:20,000-scale color photos (Bureau of Land Management, 1990)
- Galisteo, Bull Canyon, and Glorieta quadrangles : 1:15,840-scale color photos (U.S. Forest Service, 1973).

We acknowledge the assistance of Laura Gleasner of the Earth Data Analysis Center at the University of New Mexico, Albuquerque in obtaining these various sets of images. These photos are being interpreted to identify surficial deposits and fault-related features for compilation onto the 1:24,000-scale strip map and field reconnaissance. Approximately 40% of the available photography has been analyzed. We are delineating tonal contrasts, scarps, lineaments, springs, saddles, beheaded ridges, drainage pattern anomalies, and other potentially fault-related geomorphic features. We also are mapping late Quaternary surficial deposits that may provide stratigraphic information on the location and timing of recent fault movement.

Aerial Reconnaissance

Because the northern Tijeras-Cañoncito fault system crosses areas of rugged, heavily vegetated terrain that may be difficult to access, aerial reconnaissance is essential to closely examine these areas efficiently and adequately, and to assist in directing subsequent field activities. During September 1999, we conducted an aerial reconnaissance along parts of the northern Tijeras fault to help identify and map late Quaternary fault strands. The aerial reconnaissance was performed during low-sun-angle illumination (early morning), when shadows highlight potentially fault-related features. The flight extended from our previous trench site on the southern Tijeras fault south of Golden (Kelson et al., 1999) to the central part of the Ortiz Mountains in the Golden quadrangle. North of Carache Canyon, however, low clouds precluded safe air travel and we postponed our reconnaissance of the northern parts of the fault. In addition, our aerial reconnaissance included review of the La Bajada-Rosario fault, which strikes northward from the Tijeras fault at Golden.

Field Reconnaissance

On the basis of the air-photo analysis and aerial reconnaissance, we focused our initial field efforts on areas along the northern Tijeras fault that appeared to have evidence of late Quaternary activity. So far, we have conducted field reconnaissance along the 7-km-long portion of the fault from south of Golden to Carache Canyon. All of this reach of the fault is on private land and was completed with local consulting geologist Stephen Maynard. Maynard currently is completing bedrock geologic mapping of the Golden quadrangle for the USGS STATEMAP program.

Results

Our analysis of aerial photography and aerial reconnaissance shows that fault strands within the Tijeras-Cañoncito fault system have surface expression in bedrock terrane and, in many cases, are coincident with lineaments and other features in surficial deposits that potentially are related to surface rupture. For example, there are numerous lineaments and topographic scarps developed across a high alluvial fan at the mouth of Carache Canyon, about 7 km northeast of Golden (Figure 3). Our field reconnaissance of this area suggests that a topographic scarp is present on the high alluvial fan at the mouth of Carache Canyon, although there is no scarp across a lower, inset fan surface. Our preliminary interpretation of these relations is that there may have been surface rupture along the fault during the middle Quaternary or possibly the late Quaternary. Our reconnaissance along the fault between Golden and Carache Canyon identified several bedrock fault strands that coincide with topographic or vegetation lineaments. These lineaments occur within a broad, 1-km-wide zone that is contains very limited surficial deposits. None of the lineaments is clearly associated with displacement of late Quaternary surficial deposits, although at this time we cannot preclude late Quaternary activity on this reach of the fault.

Another prominent, potentially fault-related lineament exists approximately 10 km west of the village of Galisteo. The lineament is approximately 2.5 km long and is roughly parallel to Cunningham Creek near the confluence with Arroyo Chorro. At its eastern extent the lineament projects into Quaternary fluvial terrace deposits. Further to the east the lineament becomes less prominent, but is expressed as a bedrock lineament with aligned saddles and beheaded ridges. Based solely on air photo analysis, Quaternary activity on this lineament is inconclusive. On the basis of these observations, we conclude that our future activities should focus on selected areas that contain abundant surficial deposits, as identified by analysis of aerial photography and aerial reconnaissance.

In addition, our reconnaissance of the La Bajada-Rosario fault showed little or no expression of late Quaternary movement, although a few isolated localities contain lineaments that may suggest Quaternary activity. At present, we believe that the La Bajada-Rosario fault probably has not had late Quaternary activity.

Non-technical Summary of Proposal

This study is obtaining information that will help evaluate the earthquake potential of the northern Tijeras-Cañoncito fault system, which lies slightly east of Albuquerque and Santa Fe, New Mexico. The study will assess whether the fault is a possible source of strong ground motion to the cities of Albuquerque and Santa Fe. The study will identify the location of potentially active fault traces, through analysis of aerial photography, aerial reconnaissance, and field mapping at a scale of 1:24,000. Data from the study will help estimate the probability of future large earthquakes in the Albuquerque-Santa Fe corridor.

Reports Published

Because this study is in progress, there have been no reports published. However, we recently published two articles and one map database, and submitted one NEHRP Final Technical Report, on the southern Tijeras fault and other faults in the Albuquerque region:

Kelson, K.I., Hitchcock, C.S., and Harrison, J.B.J., 1998, Paleoseismologic assessment of the southern Tijeras fault, central New Mexico: Final Technical Report submitted to the USGS National Earthquake Hazards Program, Award Number 1434-HQ-97-GR-03012, 33 p.

Kelson, K.I., Hitchcock, C.S., and Harrison, J.B.J., 1999, Paleoseismology of the Tijeras fault near Golden, New Mexico: New Mexico Geological Society Guidebook, 50th Field Conference, Albuquerque Geology, p. 200-209.

Machette, M.N., Personius, S.F., Kelson, K.I., Haller, K.M., and Dart, R.L., 1998, Map and data for Quaternary faults and folds in New Mexico: U.S. Geological Survey Open-file Report 98-521, 443 p.

Personius, S.F., Machette, M.N., and Kelson, K.I., 1999, Quaternary faults in the Albuquerque area—An update: New Mexico Geological Society Guidebook, 50th Field Conference, Albuquerque Geology, p. 189-200.

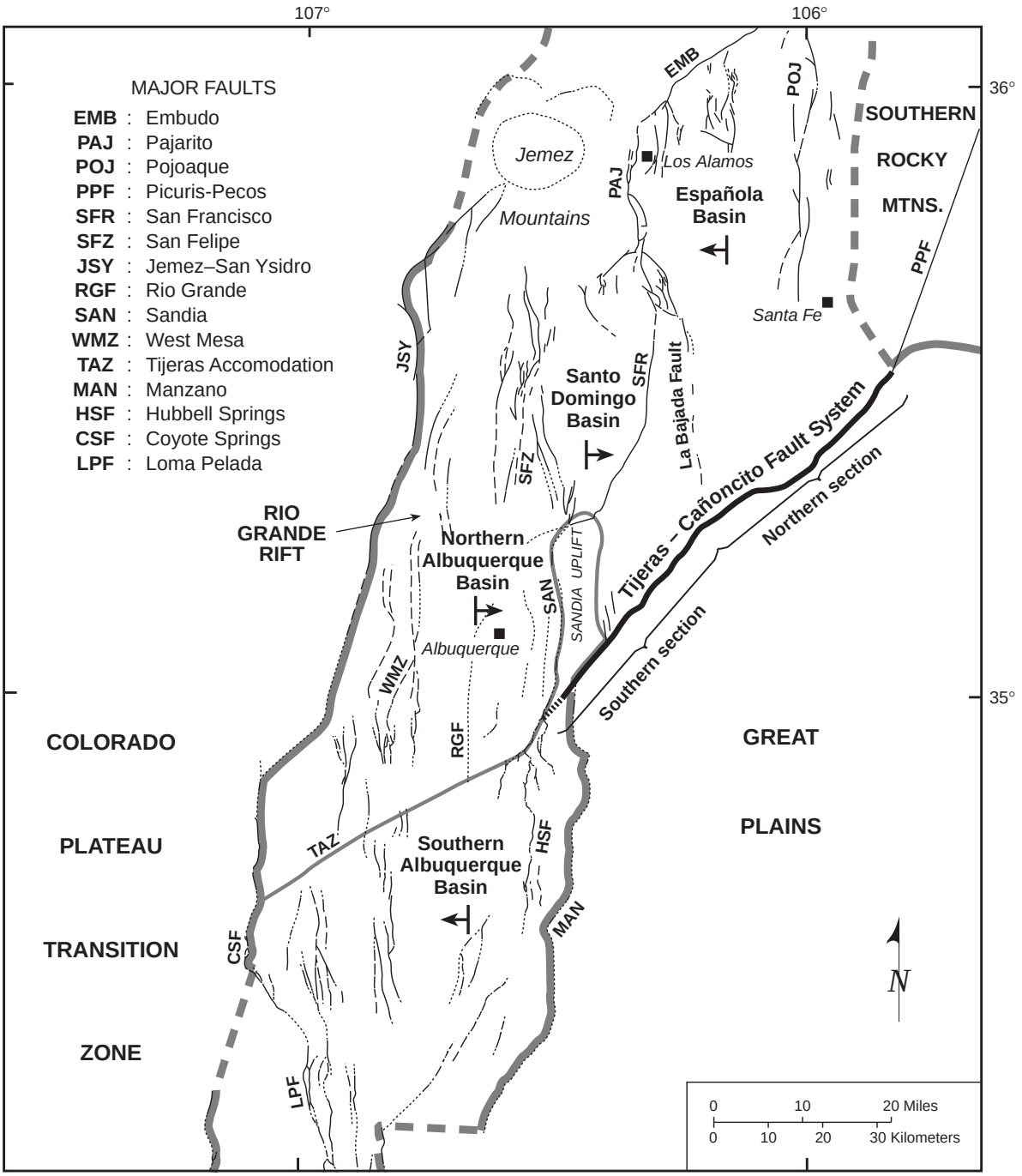

Figure 1. Generalized regional tectonic map of the Rio Grande rift near Santa Fe and Albuquerque. Arrows show tilt of major rift basins. Bold lines define seismotectonic provinces.

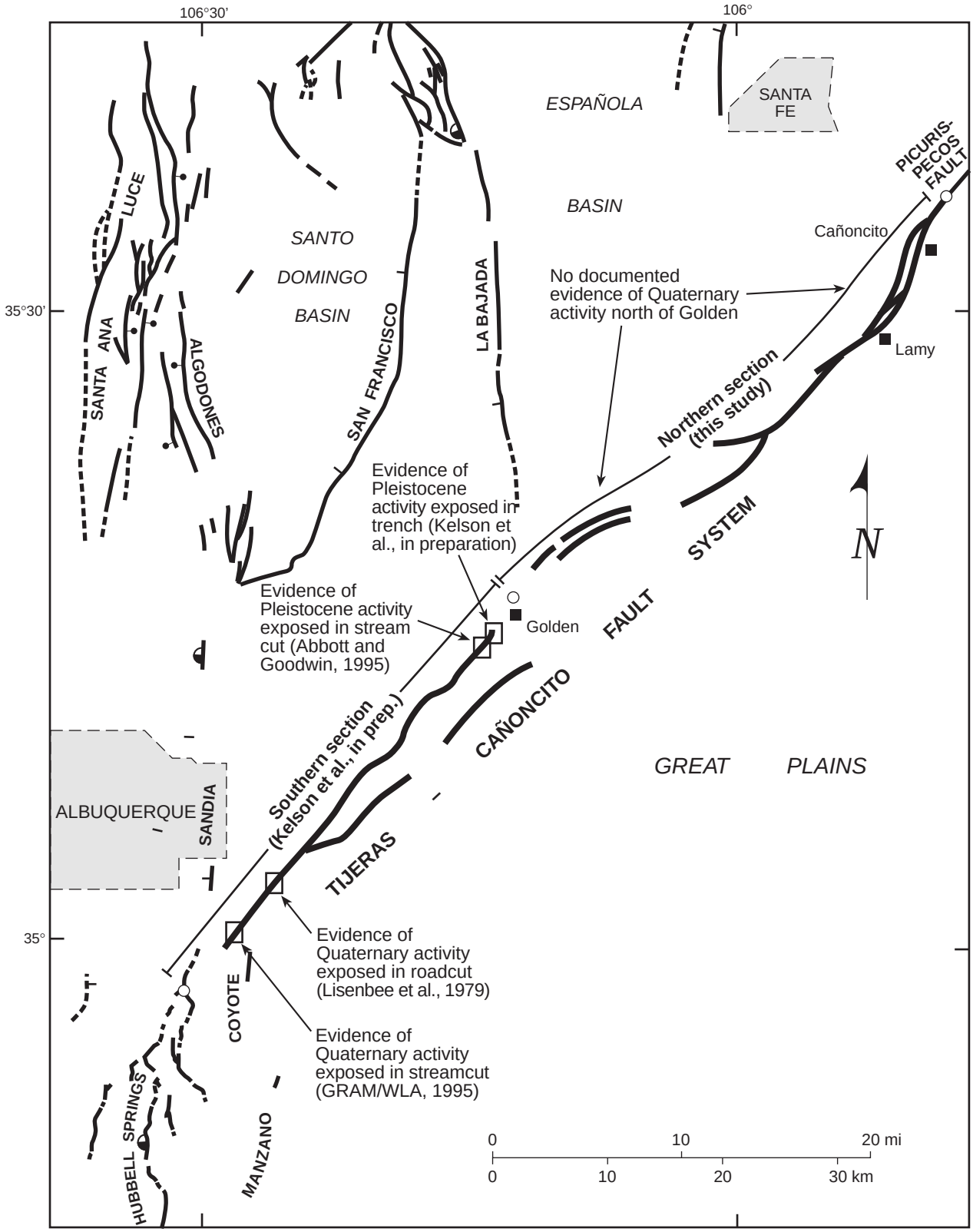

Figure 2. Regional fault map showing sections of the Tijeras–Cañoncito fault system. Open circles show ends of fault sections identified by Machette et al. (1998).

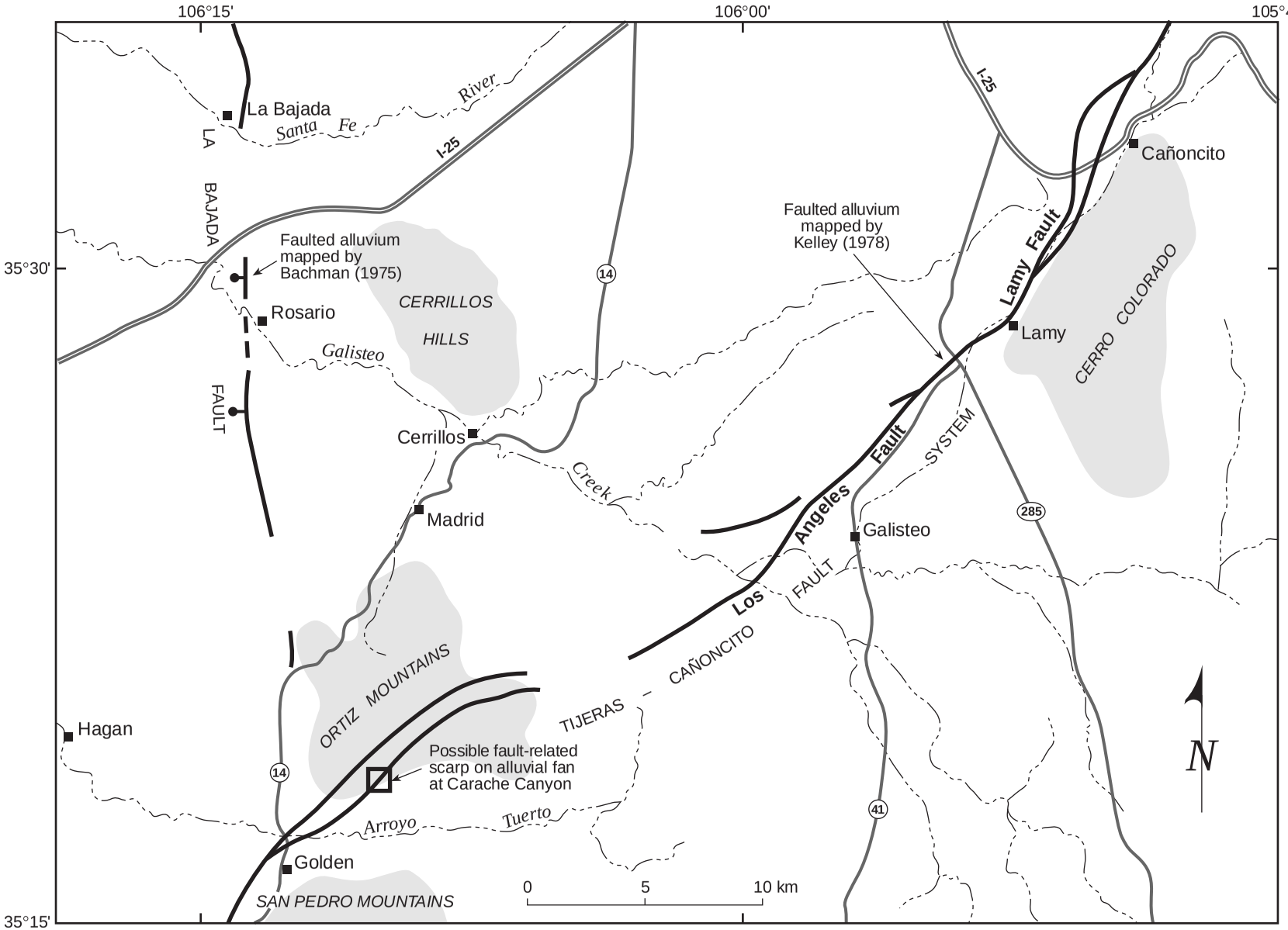

Figure 3. Map of the northern section of the Tijeras–Cañoncito and La Bajada fault systems, after Bachman (1975), Kelley (1978), Lisenbee et al. (1979), and Machette et al. (1998).