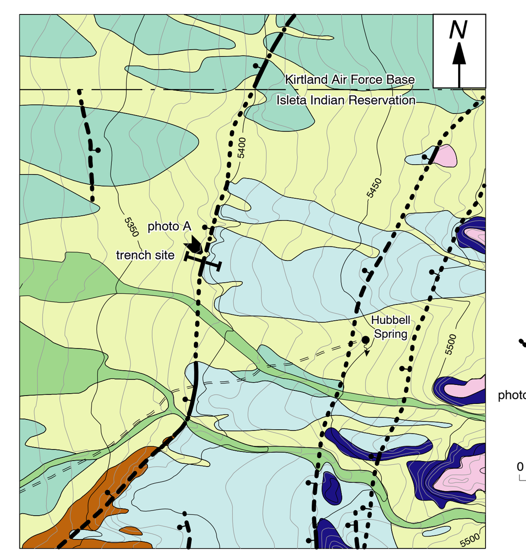
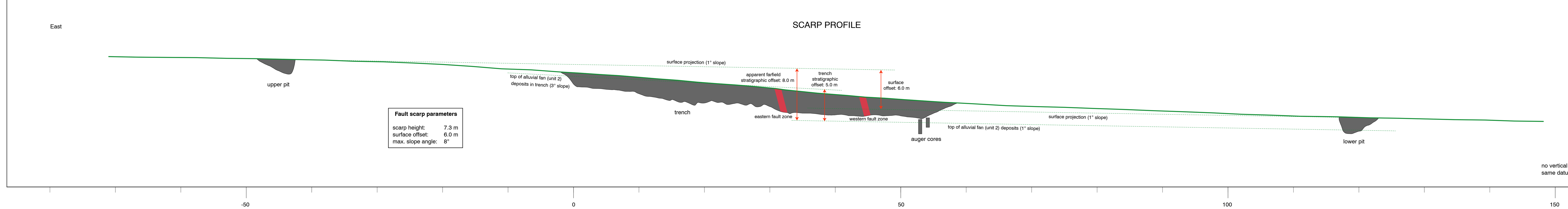
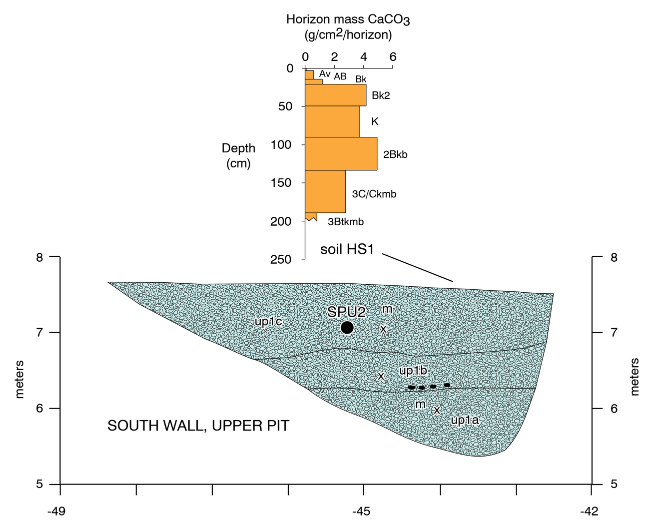
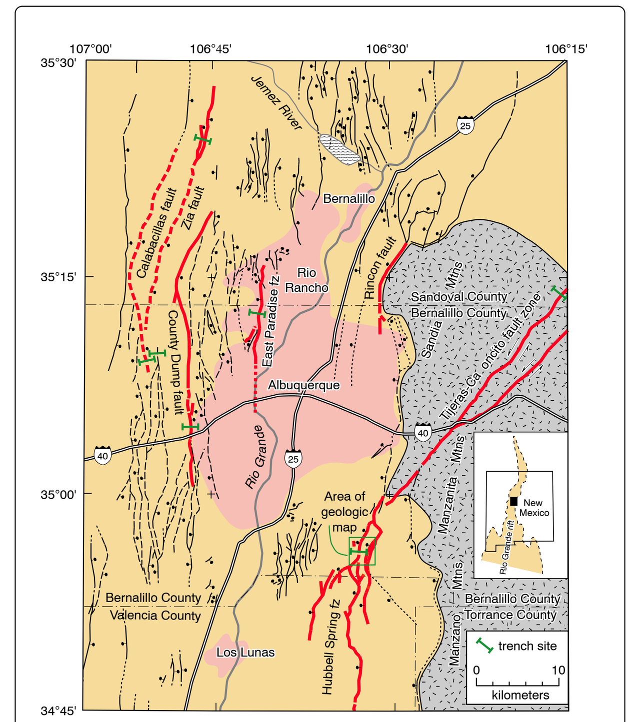


Surficial geologic map of Hubbell Spring trench site and vicinity; modified from Love and others (1996). See Quaternary fault map for location.

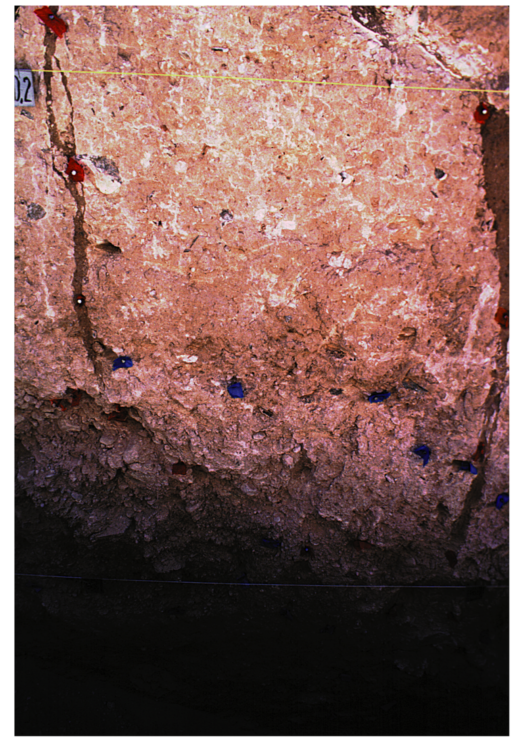




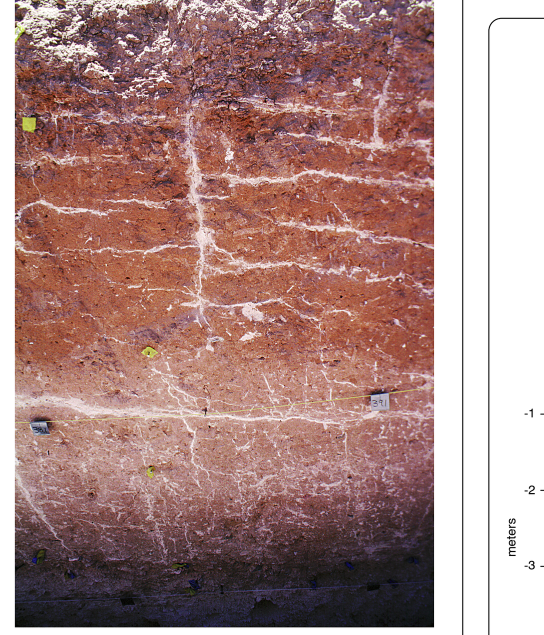
Photograph A. View of the upper part of the south wall of the Hubbell Spring trench. Note presence of both slope-parallel and subvertical calcium carbonate filled fractures. See surficial geologic map for location.



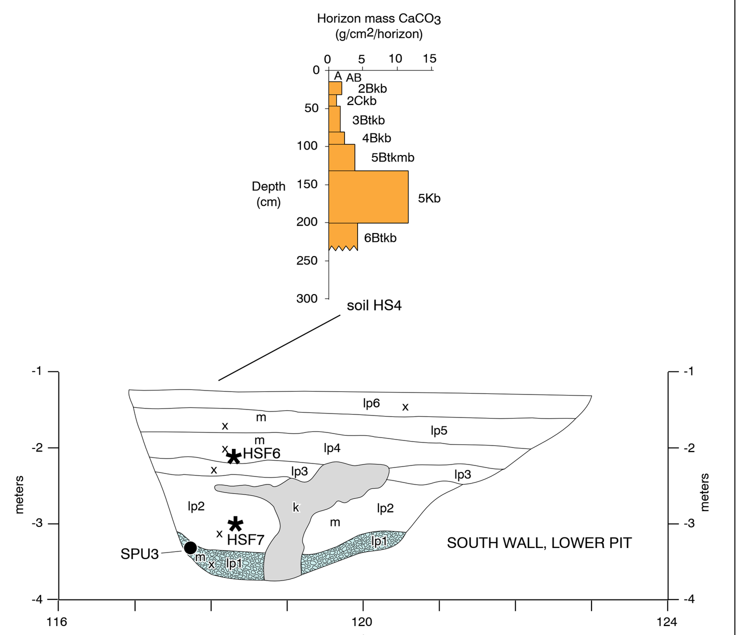
Map of Quaternary faults in the vicinity of Albuquerque, New Mexico (modified from Machette and others, 1998; Personius and others, 1999). Traces of the Hubbell Spring fault zone and other faults with known late Quaternary (<130 ka) displacement are shown in red. Shading and stipple pattern depict pre-Tertiary rocks in the Manzano, Manzanita, and Sandia Mountains; pink shading depicts urbanized areas.

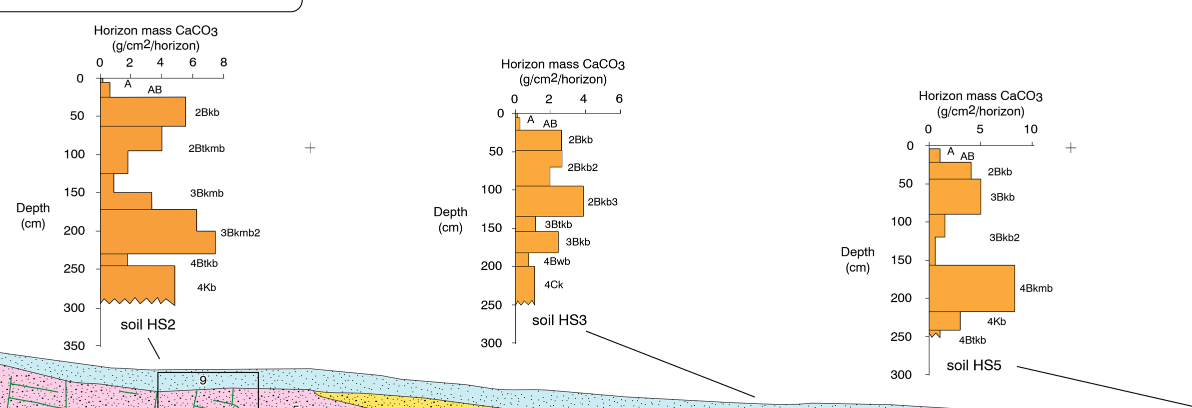


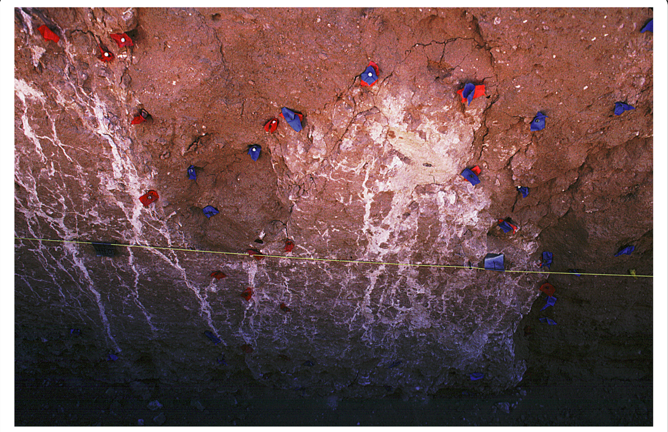
Photograph B. View of central part of eastern fault zone; red pins mark fault traces, blue pins mark stratigraphic contacts. Note fault traces filled with dark, organic-rich burrow fill on left and right margins of the image.



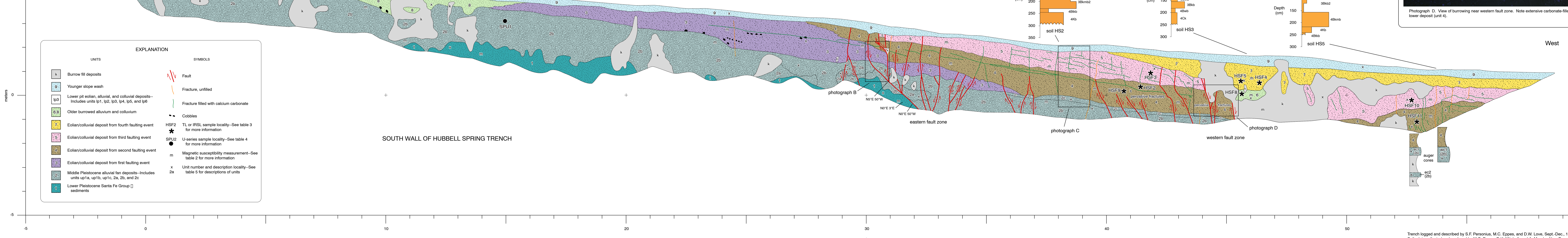
Photograph C. View of extensive "boxwork" of calcium carbonate filled fractures in two eolian/colluvial deposits; upper reddish-brown deposit is unit 5, and lower light-tan deposit is unit 4. Note the increased abundance of fractures in the lower unit, which suggests this unit has been subjected to at least one additional surface-faulting event.







Photograph D. View of burrowing near western fault zone. Note extensive carbonate-filled fractures in lower deposit (unit 4).



Trench logged and described by S.F. Personius, M.C. Eppes, and D.W. Love, Sept.-Dec., 1997

INTRODUCTION

[illegible]

SOILS DATA

[illegible] was determined with the paraffin-clod method (Machette, 1986; Singer, 1986). Total carbonate contents for each horizon were calculated using the methods of Machette (1978, 1985), and are the product of the weight-percent $CaCO_3$, bulk density, thickness, and percent fine-earth fraction of each horizon. Soil carbonate data are summarized in table 1 and shown graphically adjacent to their locations on the trench and pit logs.

Soil carbonate data are potentially useful as a chronologic tool, if secondary (pedogenic) carbonate contents and regional rates of carbonate accumulation can be accurately determined (Machette, 1978, 1985). Several aspects of our soil carbonate data, however, prevent us from performing extensive age analyses: (1) our total carbonate values do not include secondary carbonate accumulated as rinds on gravel clasts; (2) our total carbonate values include both secondary (pedogenic) as well as an unknown amount of primary carbonate present in the parent materials prior to soil formation--we could not determine the primary carbonate content because no unaltered parent materials were exposed in the trench; and (3) degradation of soils in the upper pit and upper part of the trench, and the presence of relatively large amounts of carbonate in some of the younger trench deposits (see profiles HS2, HS3, HS5) probably indicate significant erosion and redeposition of carbonate on the face of the fault scarp. Detailed soils studies elsewhere in the Albuquerque basin enable us to estimate the contribution of carbonate rinds and primary carbonate to total soil carbonate values. For example, carbonate rinds in most gravelly soils in New Mexico probably do not contribute more than a few percent of the total carbonate in most well-developed calcic soil horizons (M.N. Machette, oral commun., 1999), and primary carbonate contents are low (2-10%) in most alluvial and eolian deposits in the Albuquerque basin (Machette, 1978; Machette and others, 1997; J.P. McCalpin, written commun., 1999). Reasonable estimates of these parameters may allow calculation of apparent ages for the soils in the fan alluvium (unit 2) exposed in the upper pit, where input of reworked carbonate is probably minimal. Unfortunately, probable recycling of carbonate into sediments deposited across the fault scarp prevents the use of this technique for estimating the ages of soils in the younger eolian/colluvial deposits (units 3-7). Thus, future determinations of the ages of surface-faulting events on the Hubbell Spring fault zone will rely primarily on our numerical age determinations (luminescence and uranium-series ages), and to a lesser extent on qualitative and quantitative soils data.

MAGNETIC SUSCEPTIBILITY DATA

Recently acquired high-resolution aeromagnetic data show prominent magnetic anomalies that coincide with most strands of the Hubbell Spring fault zone and many other faults in the Albuquerque basin (U.S. Geological Survey and Sander Geophysics, Ltd., 1998; Grauch, 1999; Maldonado and others, 1999). We took magnetic susceptibility measurements from most units exposed in the Hubbell Spring trench (table 2) to help determine the source of these linear anomalies. The minor differences in magnetic properties measured across the trench indicate that the abrupt gradients seen in the aeromagnetic data probably are related to juxtaposition of bedrock units with differing magnetic properties (Grauch, 1999) located at much greater depths than the sediments exposed in the trench.

Although the magnetic susceptibility data were not useful in explaining the aeromagnetic anomalies, they were useful as a correlation tool in the trench. For instance, burrowing has isolated sediments exposed in the westernmost part of the trench, but comparisons of the magnetic data support our correlation of these deposits with units 4 and 5 in the central part of the trench. The magnetic susceptibility data also indicate that several deposits exposed in the lower pit (units lp2-lp5) have no obvious correlatives in the trench.

RADIOMETRIC AGE DATA

We used luminescence dating techniques to determine the ages of post-alluvial fan sediments (units 4-7) exposed in the trench (table 3). TL (thermoluminescence) and IRSL (infrared stimulated luminescence a type of optically stimulated luminescence or OSL unique to feldspars) techniques date the last time sediment is exposed to sunlight, presumably during deposition (Berger, 1988). Trench units 4-7 consist primarily of eolian sand, and thus should be reliable luminescence recorders (Wintle, 1993). Kilogram-size blocks or cores were collected from the freshly cleaned trench walls and stored in lightproof and airtight plastic bags. A polymineralic, fine-silt-size (4-11μm) fraction was isolated for each sample. Dose rates were determined by laboratory analyses (high-resolution gamma spectrometry) of extra sediment collected with each set of samples, and field moisture contents of 0.5-10 percent by weight were determined for each sample. Samples were subjected to combinations of sunlight sensitivity tests, anomalous fading tests (Wintle, 1973), total bleach and partial bleach experiments (Wintle and Huntley, 1980; Singhvi and others, 1982) for TL, and additive dose experiments for IRSL (Aitken, 1998).

Our TL and IRSL ages (table 3) are generally consistent and in stratigraphic order. The youngest eolian/colluvial deposit (unit 7) yielded TL and IRSL ages of 11-14 ka, and the underlying eolian/colluvial deposit (unit 5) yielded ages of 27-34 ka. Dating results are less certain for an older eolian/colluvial deposit (unit 4), but our most consistent ages are 52-60 ka. These results clearly indicate that most of the post-alluvial fan sediment exposed in the trench is late Pleistocene in age.

We used uranium-series (uranium/thorium disequilibrium) dating in an attempt to determine the age of the alluvial fan sediment (unit 2) exposed in the trench (table 4). Uranium and thorium isotopic data were obtained by mass spectrometry on four samples of pedogenic calcium carbonate rinds formed on cobble gravel clasts from unit 2. These clasts were sampled at three sites, from the best-developed parts of carbonate soils formed in the fan sediment. The application of this technique relies on the assumption that uranium-bearing carbonate rinds begin to form on gravel clasts in soils that develop soon after stabilization of the alluvial fan surface. U-series analyses of the innermost rinds thus should yield ages that are similar to or slightly younger than the age of fan-surface abandonment.

Significant corrections for detrital thorium components in all four samples, and evidence of uranium loss in two samples, complicate our limited U-series analyses. Our four samples yielded three divergent ages ranging from 70 to 244 ka; only one of these (92 ± 7 ka) may be a reasonable estimate of the age of carbonate rind formation. However, an age of ~90 ka is younger than the middle Pleistocene age assigned to the fan deposits during recent mapping in the area (Love and others, 1996). This age is also younger than similarly developed calcic soils in other parts of the Albuquerque basin (Machette, 1985; Machette and others, 1997).

Solution and reprecipitation of pedogenic carbonate are commonly cited problems in previous U-series dating studies of carbonate soils (Slate and others, 1991; Geyh and Eitel, 1998), and evidence of soil erosion, in the form of brecciated carbonate soil horizons, partially dissolved carbonate rinds, and numerous rodent burrows, is present throughout the trench. Erosion and redeposition of pedogenic carbonate in the fan sediment may help explain the wide range of U-series ages we obtained, but much more detailed U-series studies will be required before any definitive conclusions can be made about the age of carbonate soils at the Hubbell Spring trench site.

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Birkeland, P.W., 1999, Soils and Geomorphology, third edition: New York, Oxford University Press, 430 p.
[illegible]

Table 1. Soils data from Hubbell Spring trench

[illegible]

Table 2. Magnetic susceptibility data from Hubbell Spring trench

[illegible]

Table 3. Thermoluminescence (TL) and infrared stimulated luminescence (IRSL) ages from Hubbell Spring trench

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Table 4. Uranium-series ages from Hubbell Spring trench

[illegible]

Table 5. Unit descriptions from Hubbell Spring trench

[illegible]

Log and data from a trench across the Hubbell Spring fault zone, Bernalillo County, New Mexico

By

Stephen F. Personius,[1] Martha C. Eppes,[2] Shannon A. Mahan,[1] David W. Love,[3] David K. Mitchell,[2] and Anne Murphy[2]

2000

Author affiliations:
[1]U.S. Geological Survey, Denver, CO 80225
[2]Dept. of Earth & Planetary Sciences, University of New Mexico, Albuquerque, NM 87131
[3]New Mexico Bureau of Mines and Mineral Resources, Socorro, NM 87801