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Title: Measurements of Actinides in Soil, Sediments, Water and Vegetation in Northern New Mexico

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Los Alamos
NATIONAL LABORATORY

Plutonium and Uranium in Sediments of the Northern Rio Grande Valley near Los Alamos, New Mexico

By

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ABSTRACT

This study was undertaken during 1991 – 1998 to identify the origin of plutonium and uranium in northern New Mexico Rio Grande and tributary stream sediments. Isotopic fingerprinting techniques help distinguish radioactivity from Los Alamos National Laboratory (LANL) and from global fallout or natural sources. The geographic area covered by the study extended from the headwaters of the Rio Grande in southern Colorado to Elephant Butte Reservoir in southern New Mexico. Over 100 samples of stream channel and reservoir bottom sediments were analyzed for the atom ratios of plutonium and uranium isotopes using thermal ionization mass spectrometry (TIMS). Comparison of these ratios against those for fallout or natural sources allowed for quantification of the Laboratory impact.

Of the seven major drainages crossing LANL, movement of LANL plutonium into the Rio Grande can only be traced via Los Alamos Canyon. The majority of sampled locations within and adjacent to LANL have little or no input of plutonium from the Laboratory. Samples collected upstream and distant to LANL show an average (± s.d.) fallout $^{240}Pu/^{239}Pu$ atom ratio of 0.169 ± 0.012, consistent with published worldwide global fallout values. These regional background ratios differ significantly from the $^{240}Pu/^{239}Pu$ atom ratio of 0.015 that is representative of LANL-derived plutonium entering the Rio Grande at Los Alamos Canyon. Mixing calculations of these sources indicate that the largest proportion (60% to 90%) of the plutonium in the Rio Grande sediments is from global atmospheric fallout, with an average of about 25% from the Laboratory. The LANL plutonium is identifiable intermittently along the 35-km reach of the Rio Grande to Cochiti Reservoir. The source of the LANL-derived plutonium in the Rio Grande was traced primarily to pre-1960 discharges of liquid effluents into a canyon bottom at a distance approximately 20 km upstream of the river. Plutonium levels decline exponentially with distance downstream after mixing with cleaner sediments, yet the LANL isotopic fingerprint remains distinct for at least 55 km from the effluent source.

Plutonium isotopes in Rio Grande and Pajarito Plateau sediments are not at levels known to adversely affect public health. Activities of $^{239+240}Pu$ within this sample set ranged from 0.001- 0.046 pCi/g in the Rio Grande to 3.7 pCi/g near the effluent discharge point. Levels in the Rio Grande are usually more than 1000 times lower than prescribed cleanup standards.

Uranium in stream and reservoir sediments is predominantly within natural concentration ranges and is of natural uranium isotopic composition. None of the sediments from the Rio Grande show identifiable Laboratory uranium, using the isotopic ratios. These results suggest that the mass of Laboratory-derived uranium entering the Rio Grande is small relative to the natural load carried with river sediments.

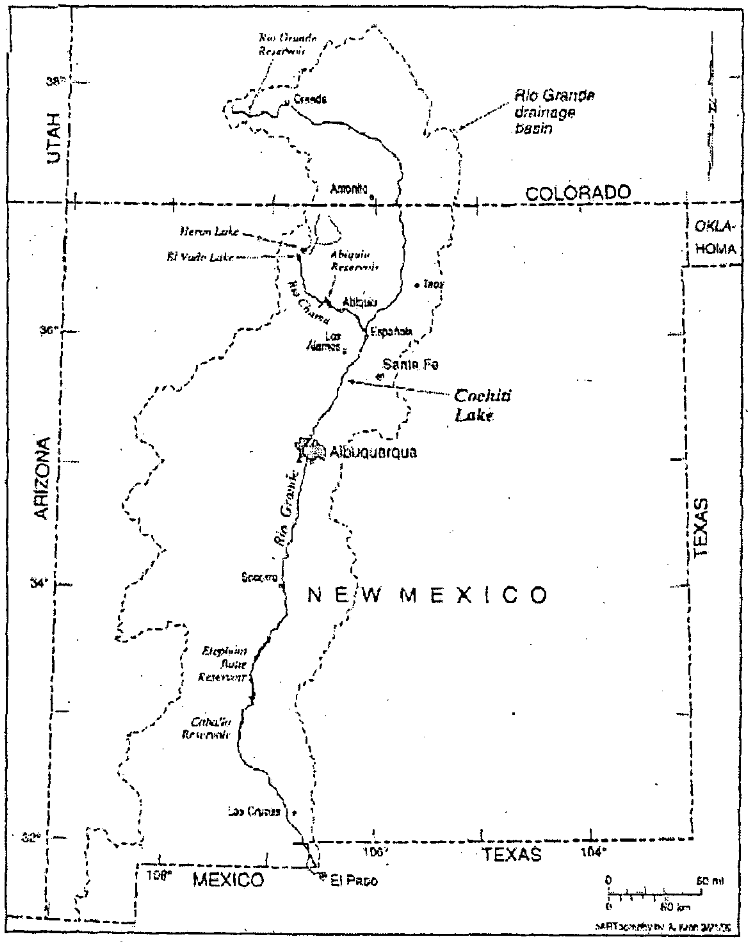

Figure 1. Rio Grande drainage map.

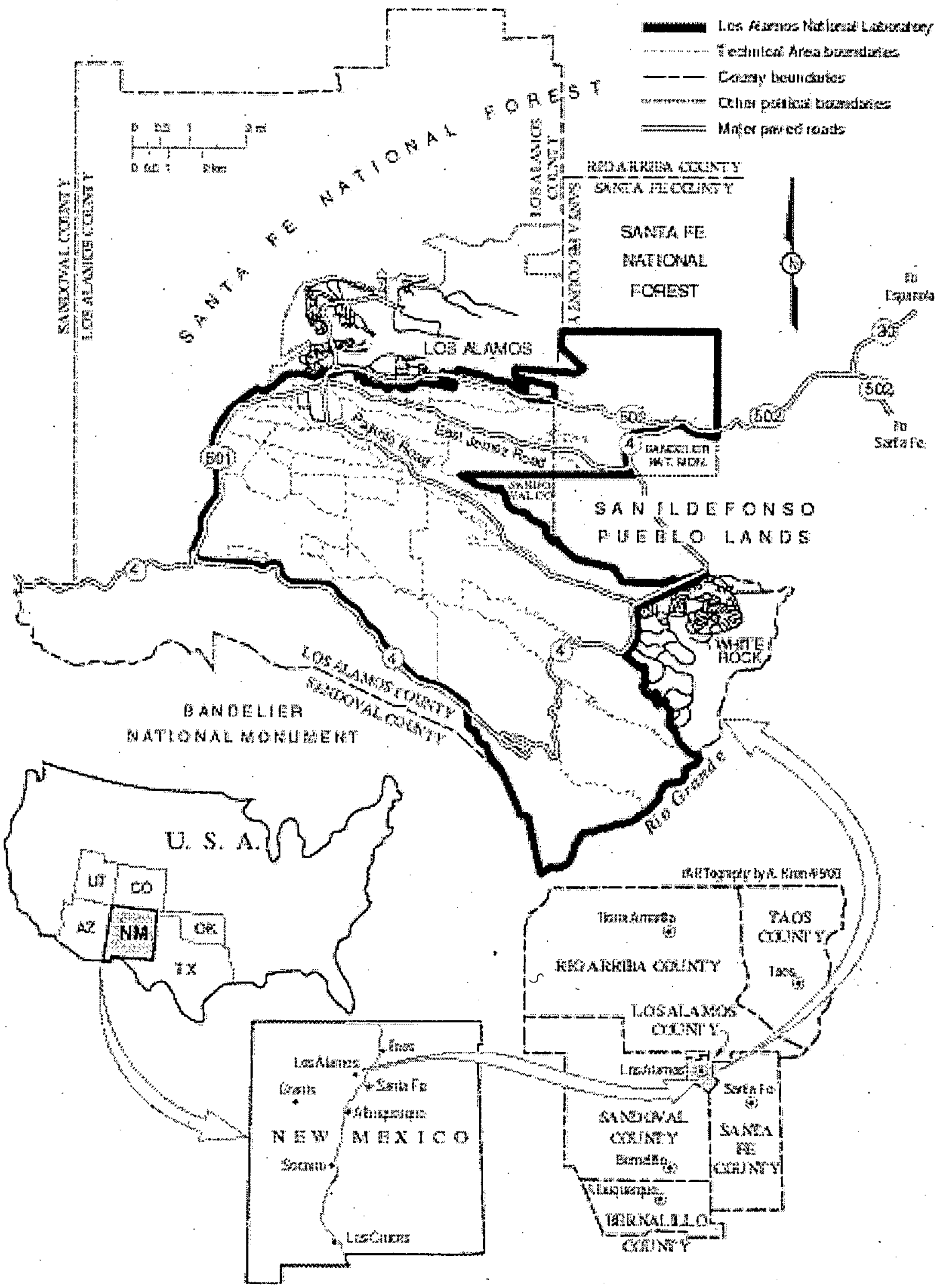

Figure 2. Map of Los Alamos area.

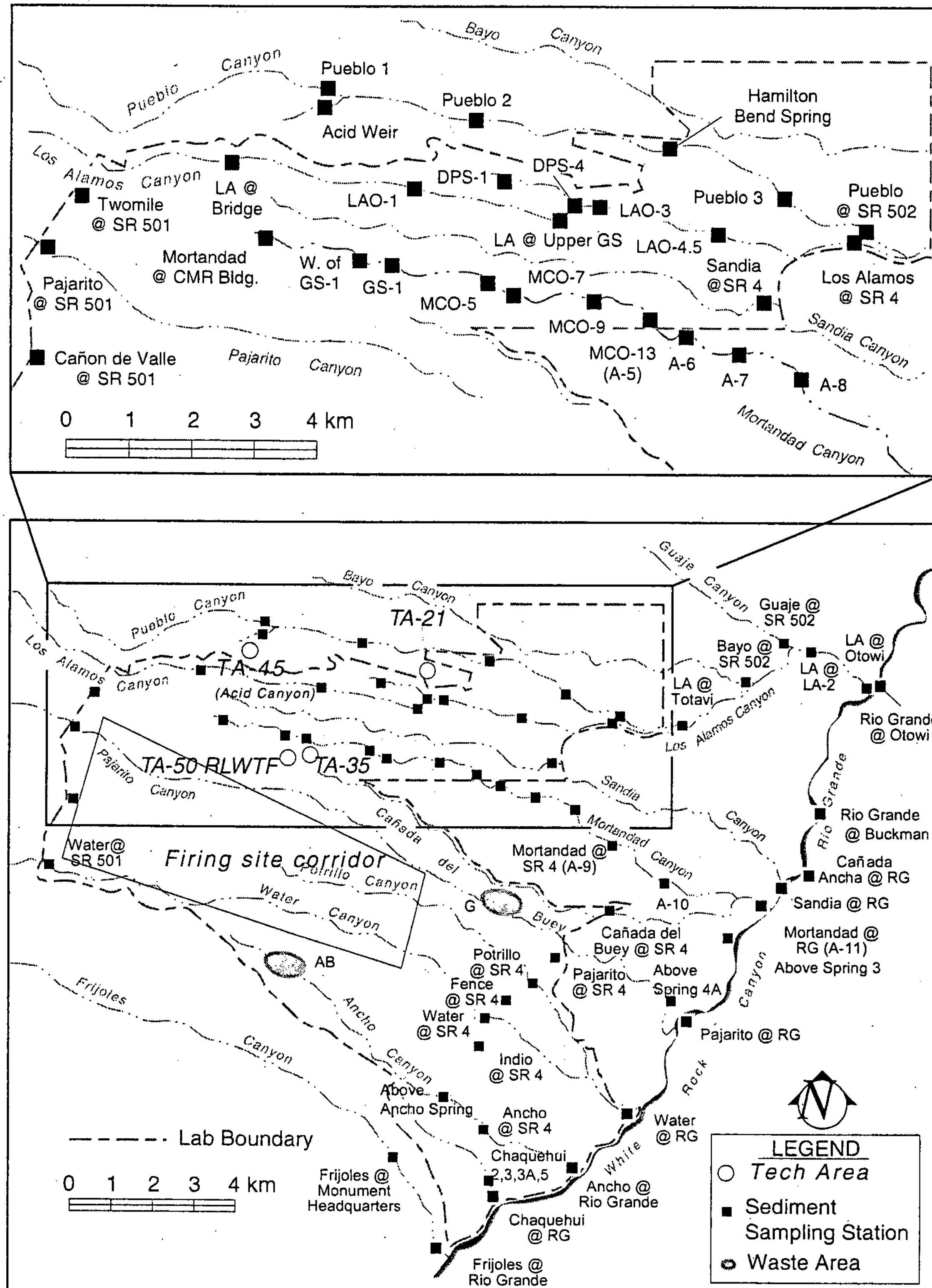

Figure 3. Sediment sampling stations on the Pajarito Plateau near Los Alamos National Laboratory. Solid waste management areas with multiple sampling locations are shaded. (Map denotes general locations only).

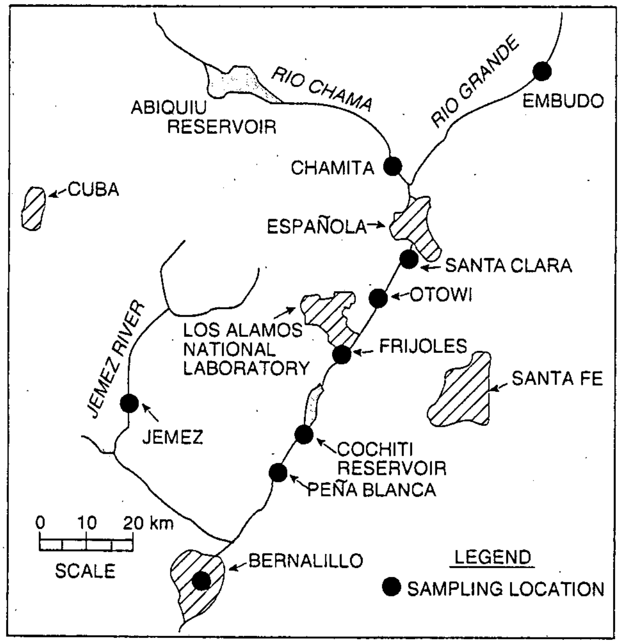

Figure 4. Regional sediment sampling locations.

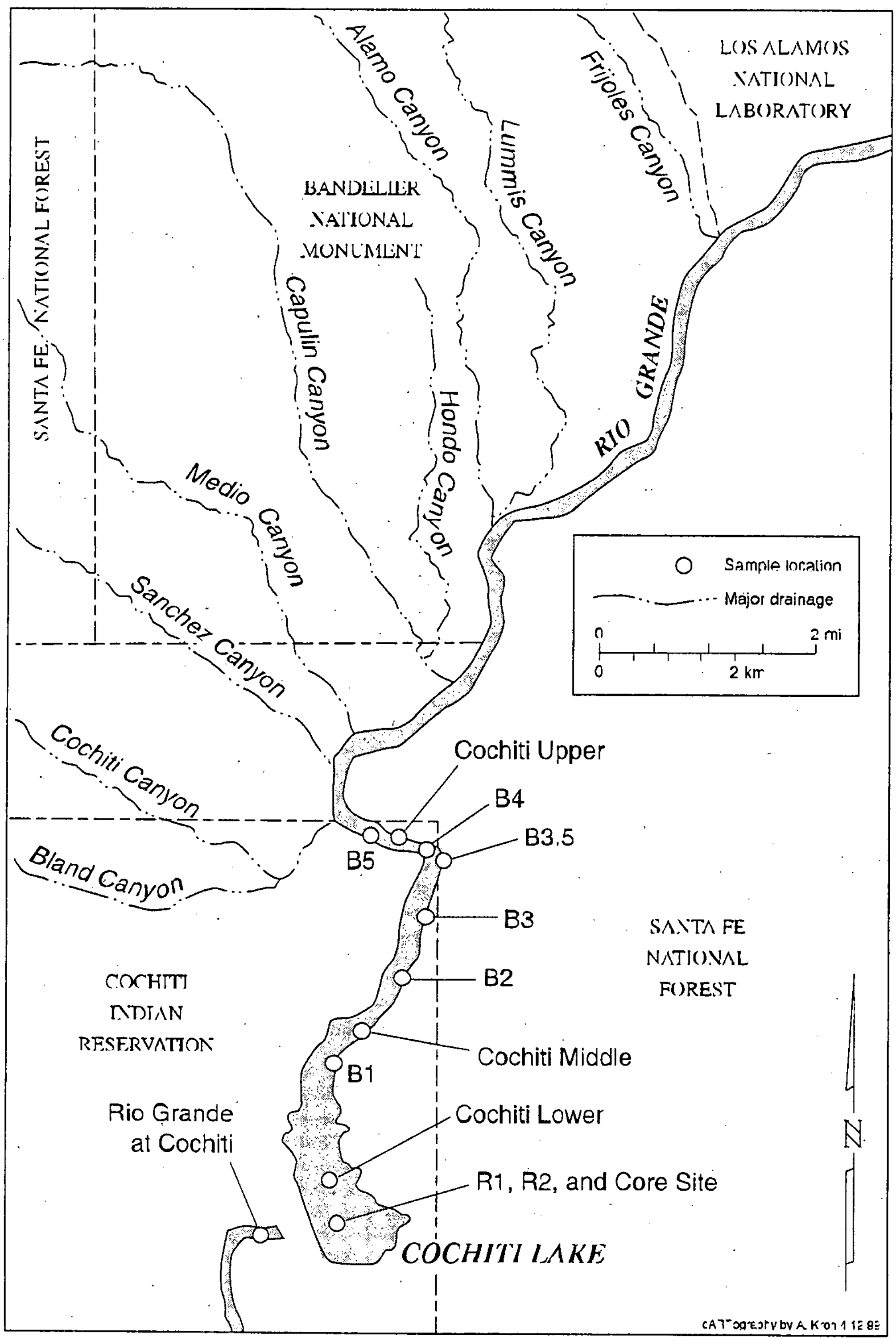

Figure 5. Sediment sampling locations in vicinity of Cochiti Reservoir.

Figure 6. Core samples of Cochiti Reservoir bottom sediments were collectd by U.S. Geological Survey scientists and analyzed by LANL for plutonium and uranium isotopes. Photograph courtesy of Peter VanMetre, USGS.

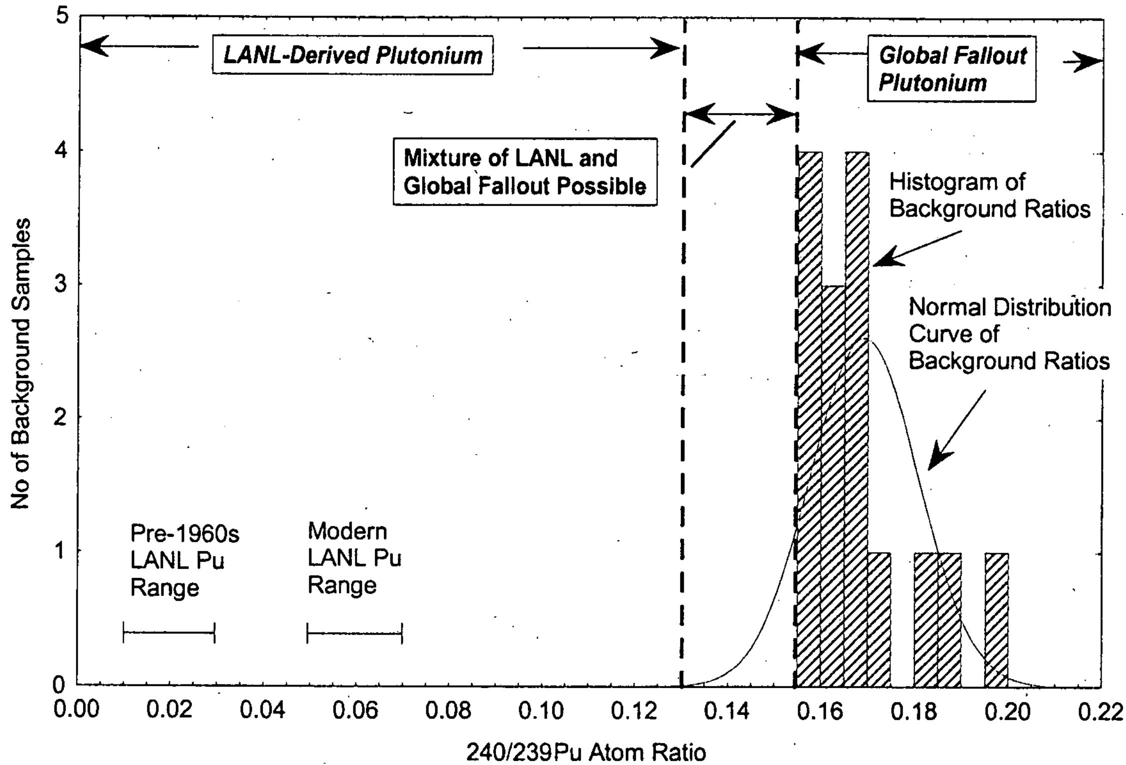

Figure 7. Histogram of background (fallout) $^{240}Pu/^{239}Pu$ atom ratios compared to LANL sources.

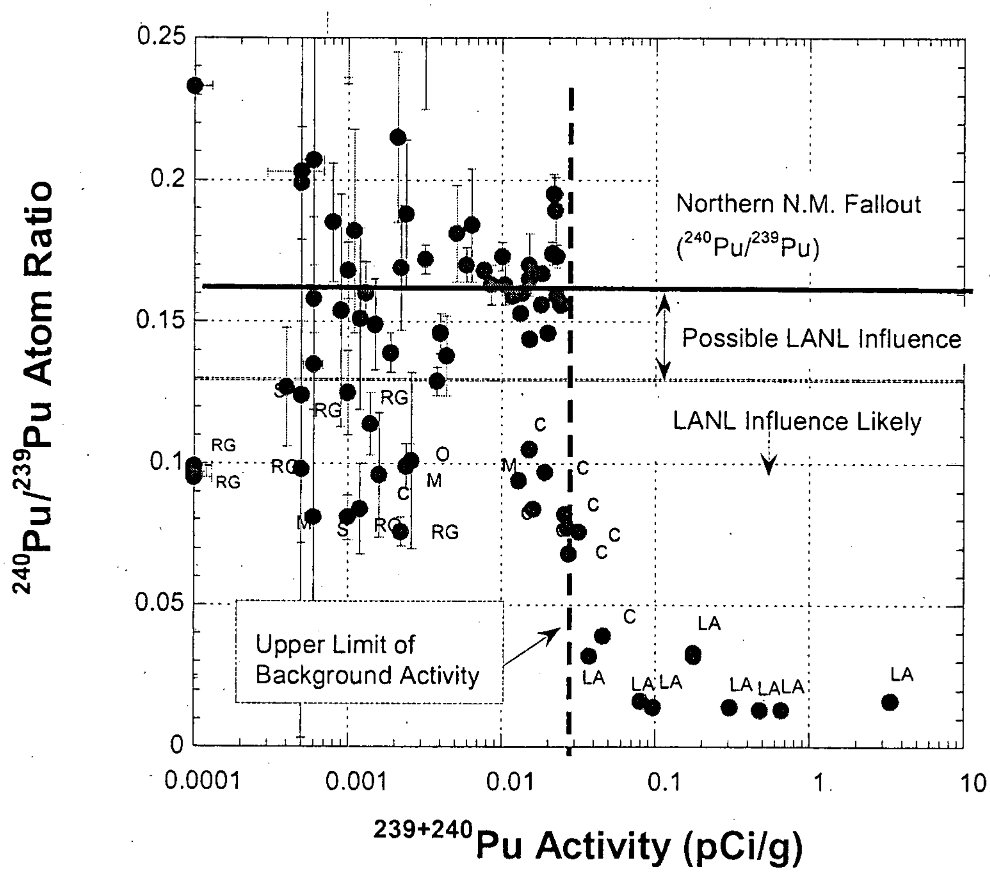

Figure 8. Relationship between plutonium atom ratios and activities at sediment sampling stations below LANL. Error bars represent uncertainty (1 standard deviation).

RG = Rio Grande samples, C = Cochiti Reservoir samples, S = Sandia Canyon, M = Mortandad Canyon, LA = Pueblo/Los Alamos Canyon.

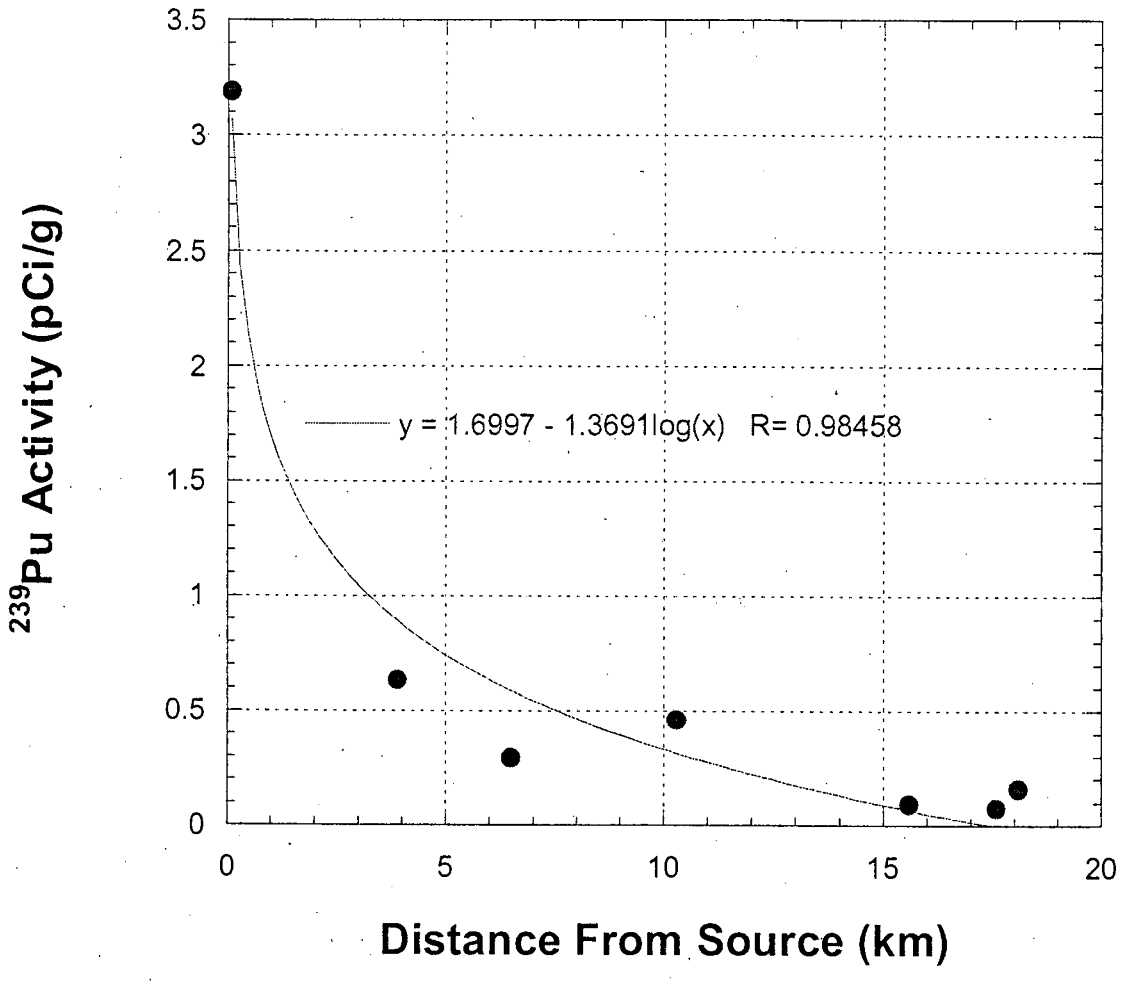

Figure 9. Downstream changes in 239Pu activities in Pueblo/Los Alamos Canyon from source (Acid Canyon).

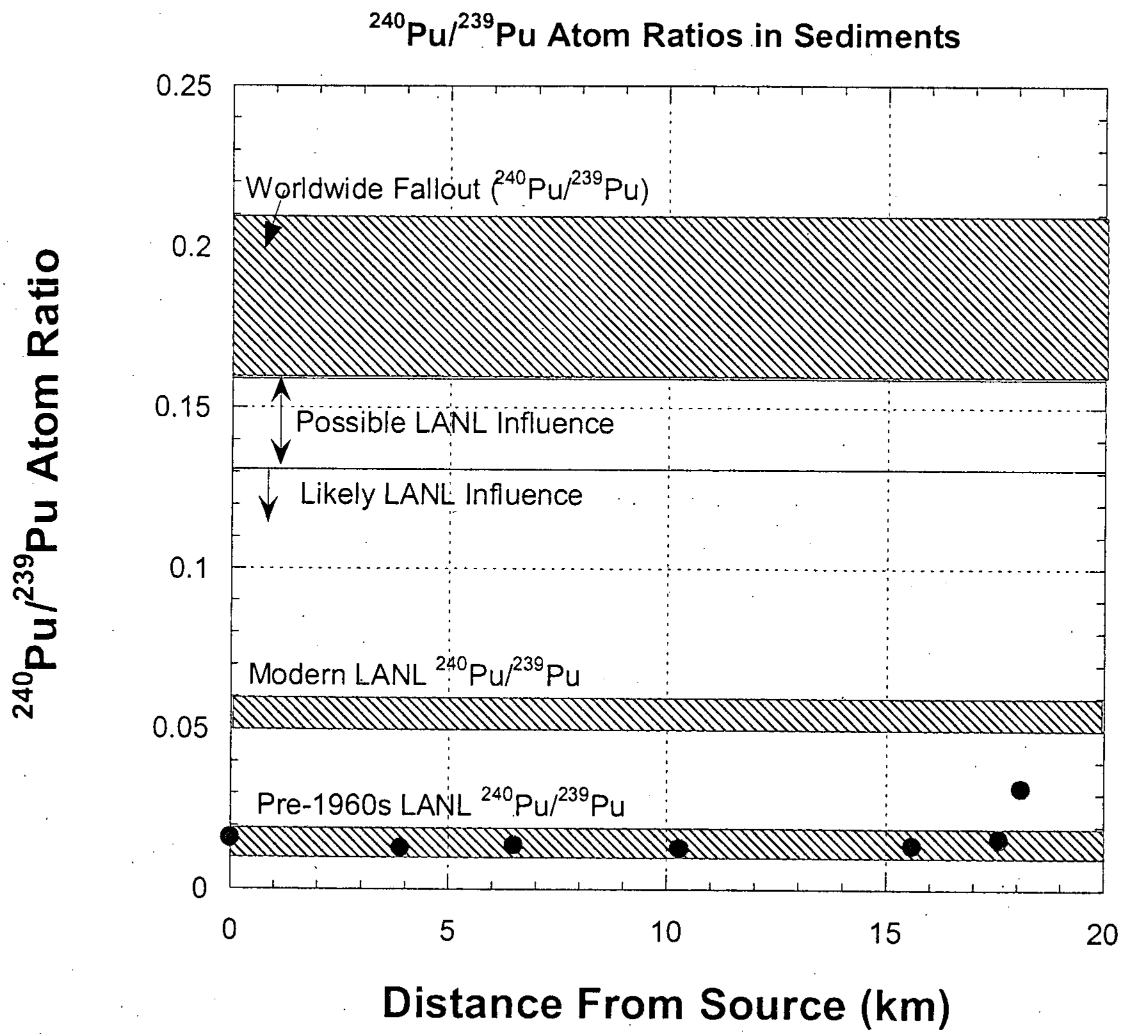

Figure 10. Downstream changes in plutonium atom ratios in Pueblo/Los Alamos Canyon sediment from source (Acid Canyon). The Pueblo/Los Alamos Canyon results are compared against typical atom ratio ranges for fallout and LANL sources (shaded).

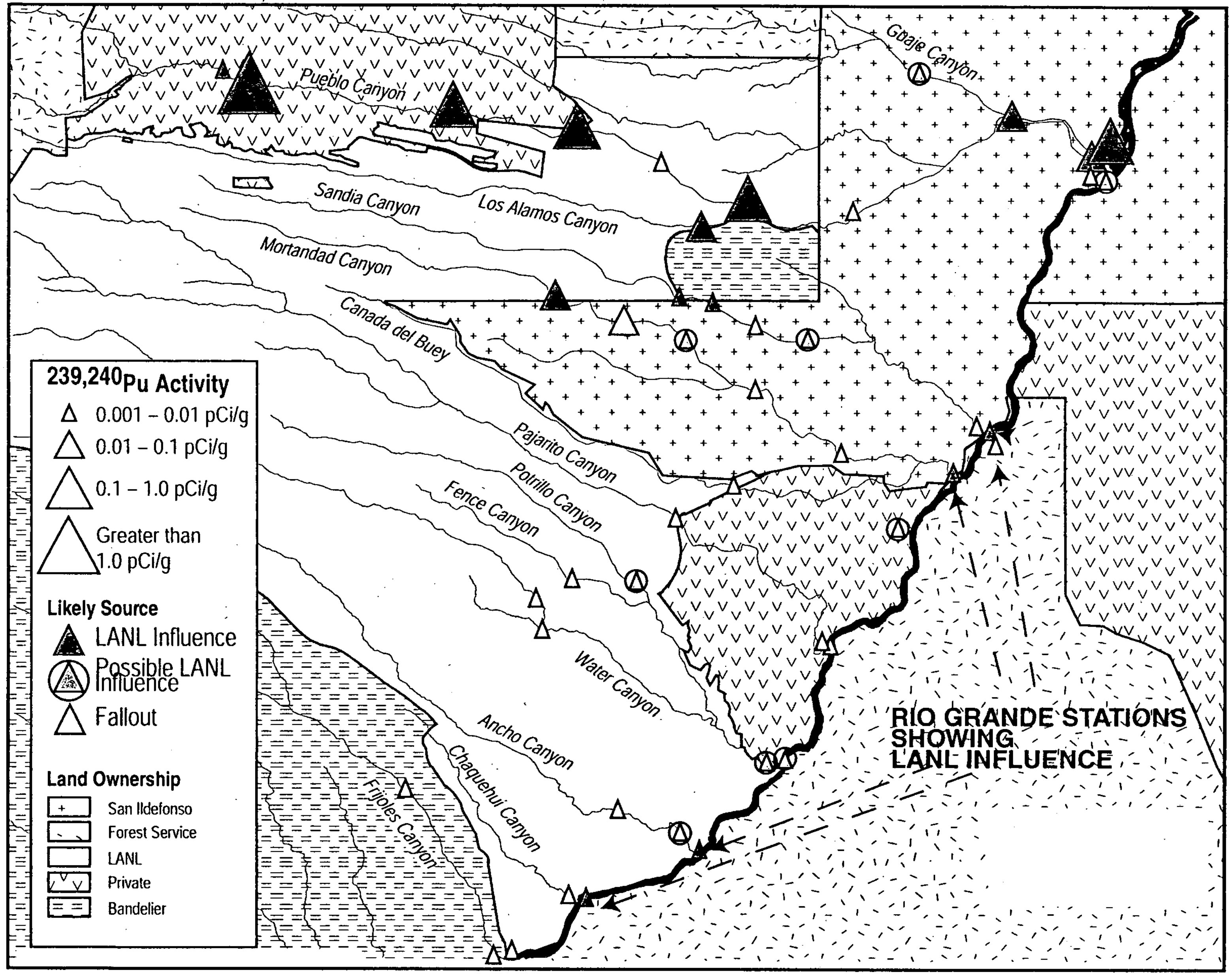

Figure 11. Plutonium-239,240 activities in sediments from TIMS and likely sources determined by atom ratios.

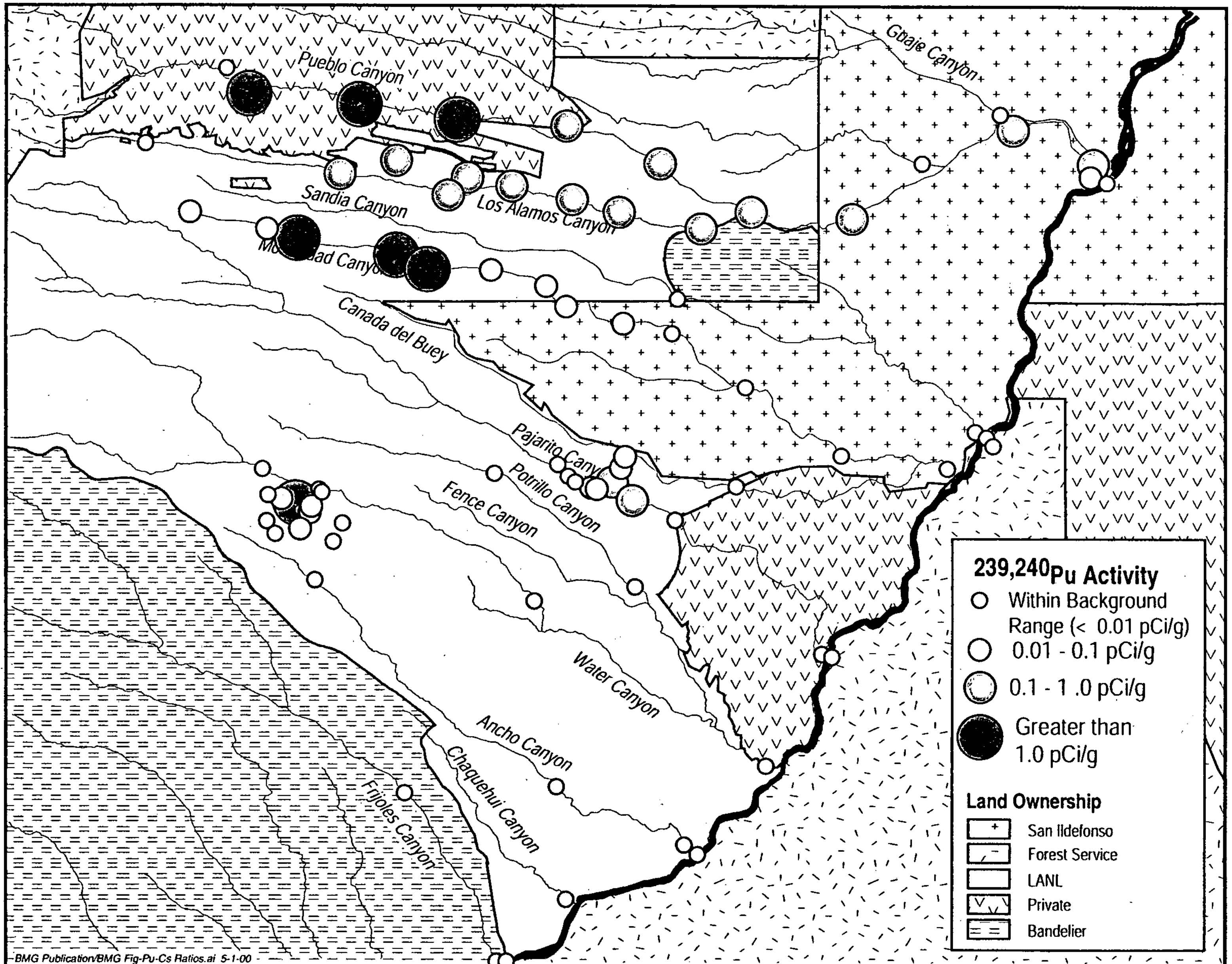

Figure 12. Long-term median Plutonium-239,240 activities in sediments (1970s through 1998).

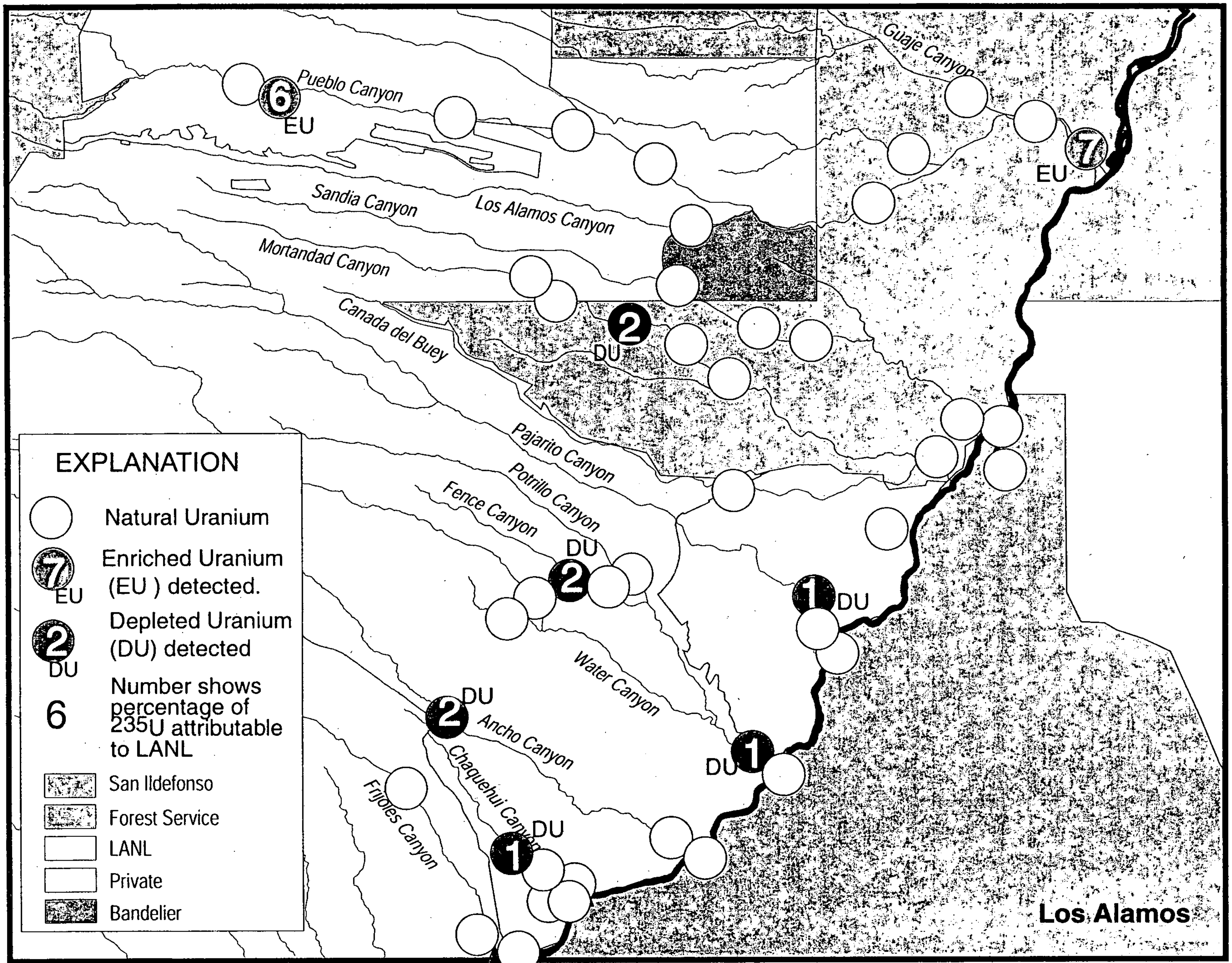

Figure 13. Uranium isotopic composition and source(s) of uranium based on the $^{238}U/^{235}U$ atom ratio.

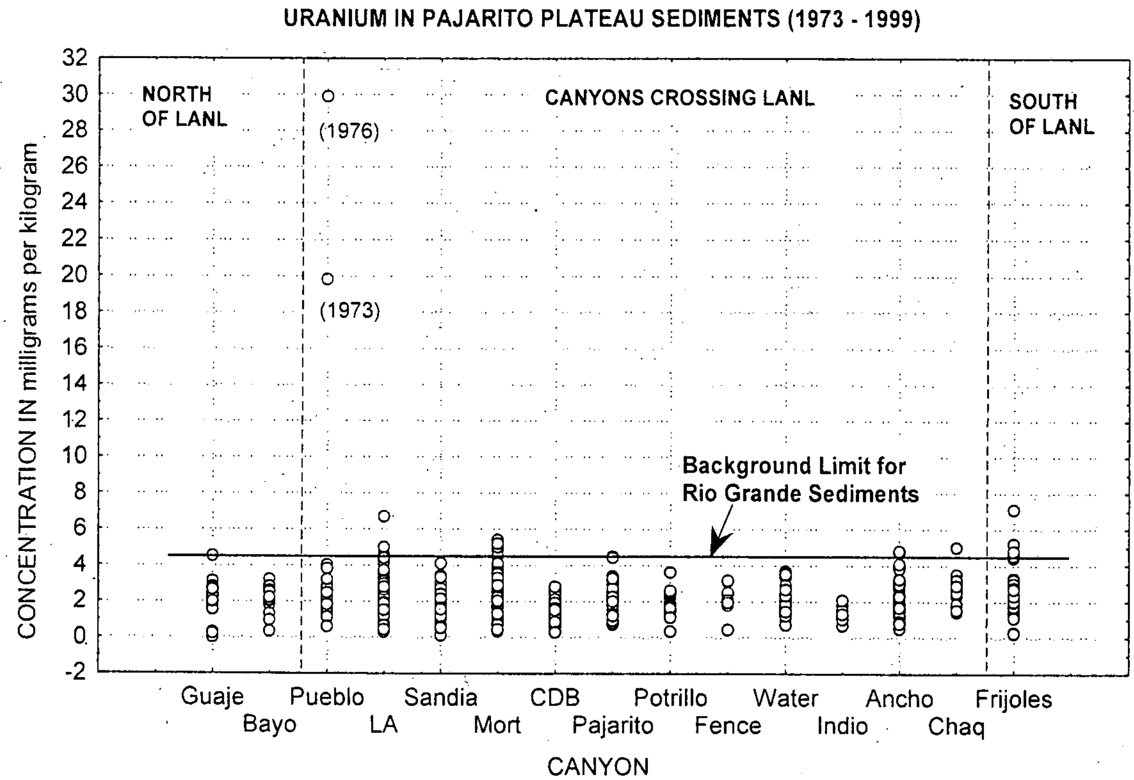

Figure 14. Long-term total uranium concentrations in Pajarito Plateau sediments (1970s through 1998).

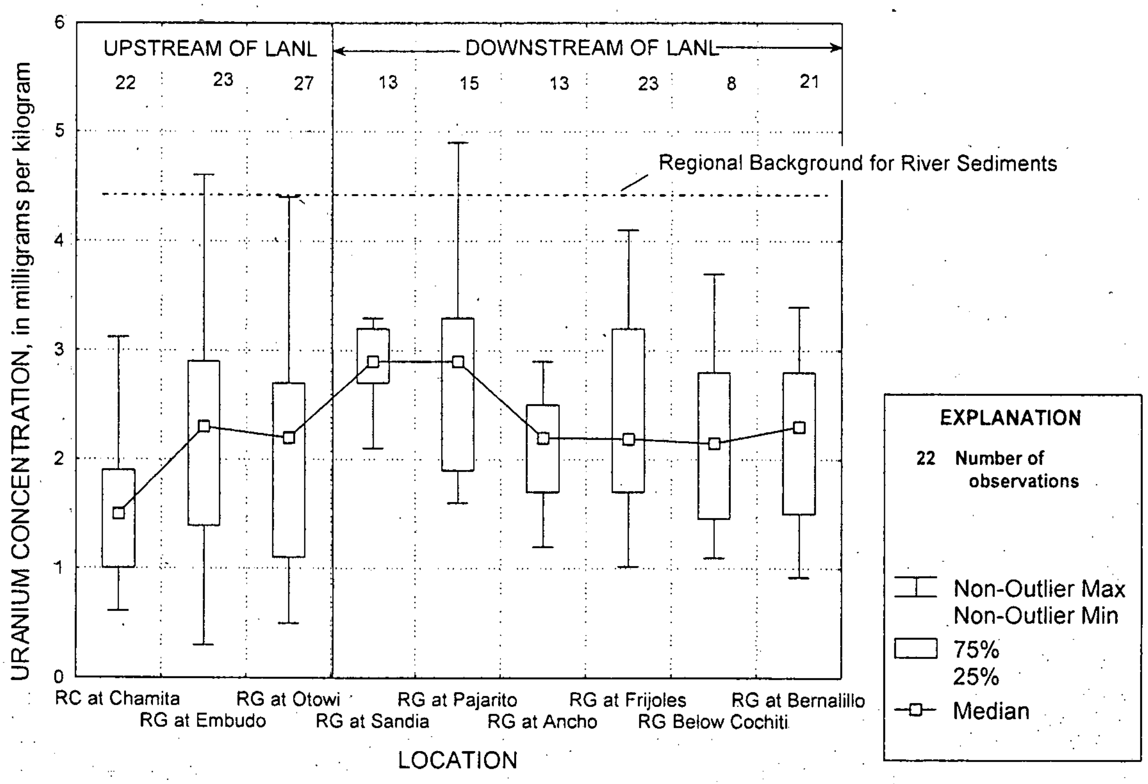

Figure 15. Boxplot of long-term uranium concentrations in Rio Grande (RG) and Rio Chama (RC) river sediments (1973 through 1999).

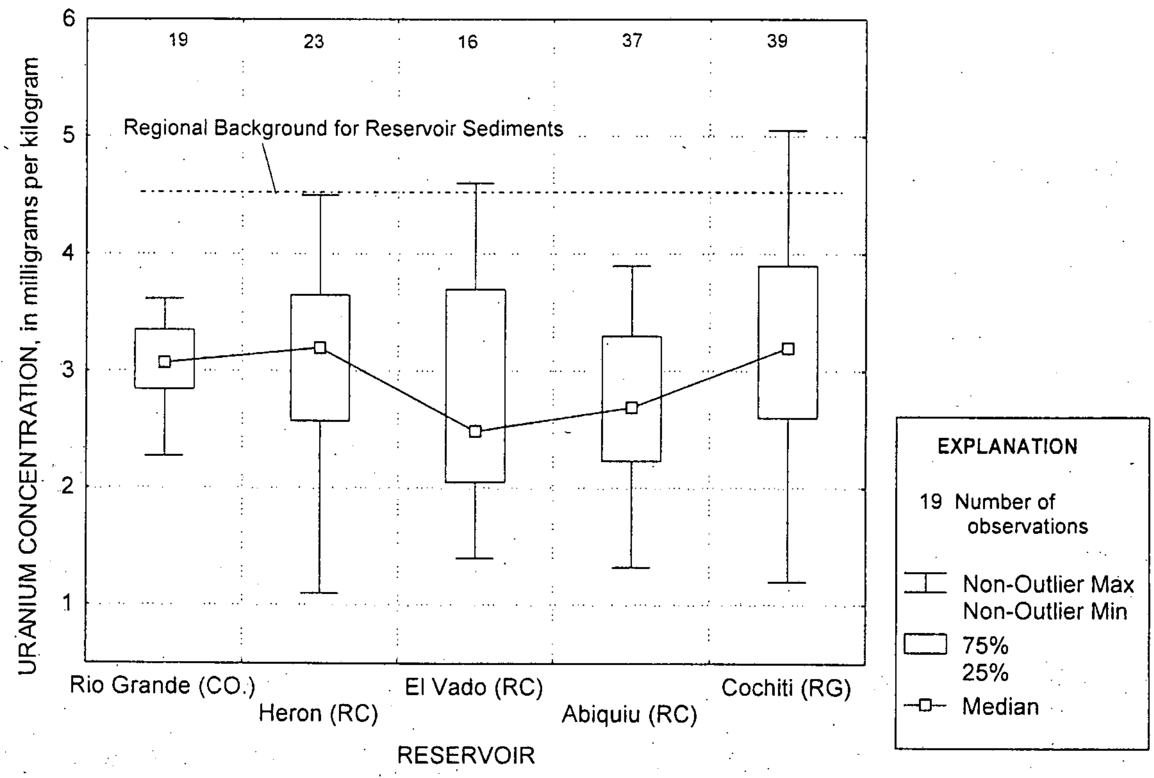

Figure 16. Box plot of long-term total uranium concentrations in reservoir sediments from Rio Grande (RG) and Rio Chama (RC).