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Strontium Concentrations in Chamisa (Chrysothamnus nauseosus) Shrub Plants Growing in a Former Liquid Waste Disposal Area in Bayo Canyon

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P. R. Fresquez
T. S. Foxx
L. Naranjo, Jr.

Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

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STRONTIUM CONCENTRATIONS IN CHAMISA (*Chrysothamnus nauseosus*) SHRUB PLANTS GROWING IN A FORMER LIQUID WASTE DISPOSAL AREA IN BAYO CANYON

by

P.R. Fresquez, T.S. Foxx, and L. Naranjo Jr.

ABSTRACT

Chamisa (*Chrysothamnus nauseosus*) shrub plants growing in a former liquid waste disposal site (Solid Waste Management Unit [SWMU] 10-003[c]) in Bayo Canyon at Los Alamos National Laboratory (LANL) were collected and analyzed for strontium (^{90}Sr) and total uranium. Surface soil samples were also collected from below (understory) and between (interspace) shrub canopies. Both chamisa plants growing over SWMU 10-003(c) contained significantly higher concentrations of ^{90}Sr than a control plant—one plant, in particular, contained 90,500 pCi ^{90}Sr g^{-1} ash in top-growth material. Similarly, soil surface samples collected underneath and between plants contained ^{90}Sr concentrations above background and LANL screening action levels; this probably occurred as a result of chamisa plant leaf fall contaminating the soil understory area followed by water and/or winds moving ^{90}Sr to the soil interspace area. Although some soil surface migration of ^{90}Sr from SWMU 10-003(c) has occurred, the level of ^{90}Sr in sediments collected downstream of SWMU 10-003(c) at the Bayo Canyon/State Road 4 intersection was still within regional (background) concentrations.

I. INTRODUCTION

Several studies have shown that vegetation growing over buried low-level radioactive waste sites at Los Alamos National Laboratory (LANL) may translocate radionuclides from the roots to aboveground plant compartments (Dreesen and Marple 1980, Wenzel et al. 1987, Fresquez et al. 1995a). Deep-rooted perennial plant species like trees and shrubs were cited to be the major offenders (Foxx et al. 1984a, Foxx et al. 1984b), and may act as conduits to other biotic (Hakonson and Bostick 1976, Gilbert et al. 1988, Pinder et al. 1991) and abiotic (Healy 1977, Lee et al. 1985, Becker 1992, Bunzl et al. 1994) components that may eventually result in a radiation dose to humans (Fresquez et al. 1994, Fresquez et al. 1995b, Fresquez et al. 1995c, Fresquez et al. 1995d).

During a recent Environmental Restoration predrilling radiological surface survey in Bayo Canyon at LANL, some Chamisa (*Chrysothamnus nauseosus*) shrub plants exhibited elevated beta

radioactivity (Derek Faulk, ERM/Golder, personal communication, July 1994) (Figure 1). These late-successional plants, which may root as deep as 4.5 m (13.5 ft) (Tierney and Foxx 1987), were growing over a former liquid waste disposal structure (#TA-10-43) (Solid Waste Management Unit [SWMU] 10-003[c]) (LANL 1992). Liquid waste disposal structure TA-10-43 held lanthanum (^{140}La) and strontium (^{90}Sr) contaminated wastes generated by the radiochemistry laboratory (TA-10-1) and was decommissioned and decontaminated in 1963—the structure was removed, excavated to a depth of 6 m (18 ft), and backfilled with soil and building debris from other parts of the TA-10 operation (Blackwell and Babich 1963). In 1974, a soil subsurface investigation detected elevated levels of gross beta radioactivity near SWMU 10-003(c) (Mayfield et al. 1979).

Strontium-90, a beta emitting isotope with a relatively long half-life (28 years) and high degree of food chain mobility, constitutes a potential long-term hazard (Wicker and Schultz 1982). The objective of this study was to determine the amount of ^{90}Sr uptake in deep-rooting chamisa plants from a former liquid waste disposal area and determine the extent of soil-surface contamination.

II. METHODS

Soil samples were collected underneath (understory) and between (interspace) two chamisa plant shrub canopies—those that measured the highest in beta radioactivity with field survey instrumentation—growing in Bayo Canyon with a stainless steel scoop at the 0- to 2-inch depth in August of 1994. At least three subsamples were collected from each zone, mixed thoroughly in a stainless steel bowl, poured into 500-mL poly bottles, and double bagged in Ziploc containers. Similarly, plant top growth and root growth from each of the two chamisa plants were sampled by cutting the desired plant parts into 1- to 2-inch pieces, placing into 1-L glass beakers, covering with tin foil, and double bagging into Ziploc containers. All samples were transported to the Laboratory under full chain-of-custody protocols in a locked ice chest. At the Laboratory, plant samples were ashed to 500|C, transferred to labeled 500-mL poly bottles, sealed with chain-of-custody tape, and submitted along with the soil samples to the Environmental Chemistry Group for the analysis of ^{90}Sr using a gas-proportional counter technique (Purtyman et al. 1987) and total uranium by the kinetic phosphorescence method (Fresquez et al. 1995).

III. RESULTS

The analysis of ^{90}Sr and total uranium in chamisa plants and soils collected over SWMU 10-003 (c) in Bayo Canyon can be found in Table 1 and Table 2, respectively.

Both chamisa plants, and especially in top-growth material, contained significantly higher concentrations of ^{90}Sr than top-growth material collected from a background chamisa plant. One chamisa plant, in fact, contained 90,500 pCi g^{-1} ash of ^{90}Sr—over 300,000 times higher than the

control plant. Although the amount of ^{90}Sr contamination at depth (source) is not completely known, a recent Environmental Restoration borehole investigation conducted approximately 2 to 3 feet away from where the plants where collected showed 4,201 pCi g^{-1} of ^{90}Sr at the 5- (15-ft) to 5.3-m (16-ft) depth (Newlin 1995). Strontium-90, a high biological mobile isotope because of its chemical similarity to calcium, is readily taken up by plants (Menzel 1965) and chamisa plant roots have been shown to grow as deep as 4.5 m (13.5 ft) or more (Tierney and Foxx 1987). All uranium levels in top-growth and root-growth materials from chamisa plants growing over SWMU 10-003(c) were equal to uranium levels in top-growth and root-growth samples from chamisa plants collected from a background location. The higher concentrations of uranium in the roots of the chamisa plants as compared to the top-growth materials were probably due to the fact that the root samples contain more soil on the surface than does the top-growth material which biased the analytical results.

Both understory and interspace soil samples contained ^{90}Sr at above-background concentrations; this probably occurred as a result of chamisa plant leaf fall contaminating the soil understory area followed by water and/or wind dispersal contaminating the soil interspace areas. Soil collected from underneath chamisa plant #1, in fact, contained 1,914 times more ^{90}Sr than background soil samples which correlates very well with the chamisa plant uptake data. Interspace soil areas also contained ^{90}Sr at elevated levels ranging in concentration from 13 to 16 pCi g^{-1}; the highest level was over 11 times higher than background. Moreover, both understory and interspace soil areas contained ^{90}Sr levels above the LANL screening action level (SAL) of 5.9 pCi g^{-1} (Dorries 1994). Radionuclide concentrations in soils above SAL's, which are based on radiation dose levels using a risk assessment pathway computer code called RESRAD, initiate and require the Laboratory to further evaluate the area (i.e., site-specific baseline risk assessment, additional sampling, etc.) (ERAC 1995). Although the soils data show that some migration of ^{90}Sr from the contaminated source has occurred, the levels of ^{90}Sr in sediments (0.10 pCi g^{-1}) collected downstream of SWMU 10-003(c) at the Bayo Canyon/State Road 4 intersection in 1994 (EPG 1995) were still within regional (background) concentrations (0.87 pCi g^{-1}) (Purtymun et al. 1987), however. Also, all uranium concentrations in soils collected from underneath and between chamisa plants growing over SWMU 10-003(c) were within background soil concentrations. These data correlated very well with other soil uranium background studies conducted within LANL (Longmire et al. 1995) and regional off-site areas (Fresquez et al. 1995).

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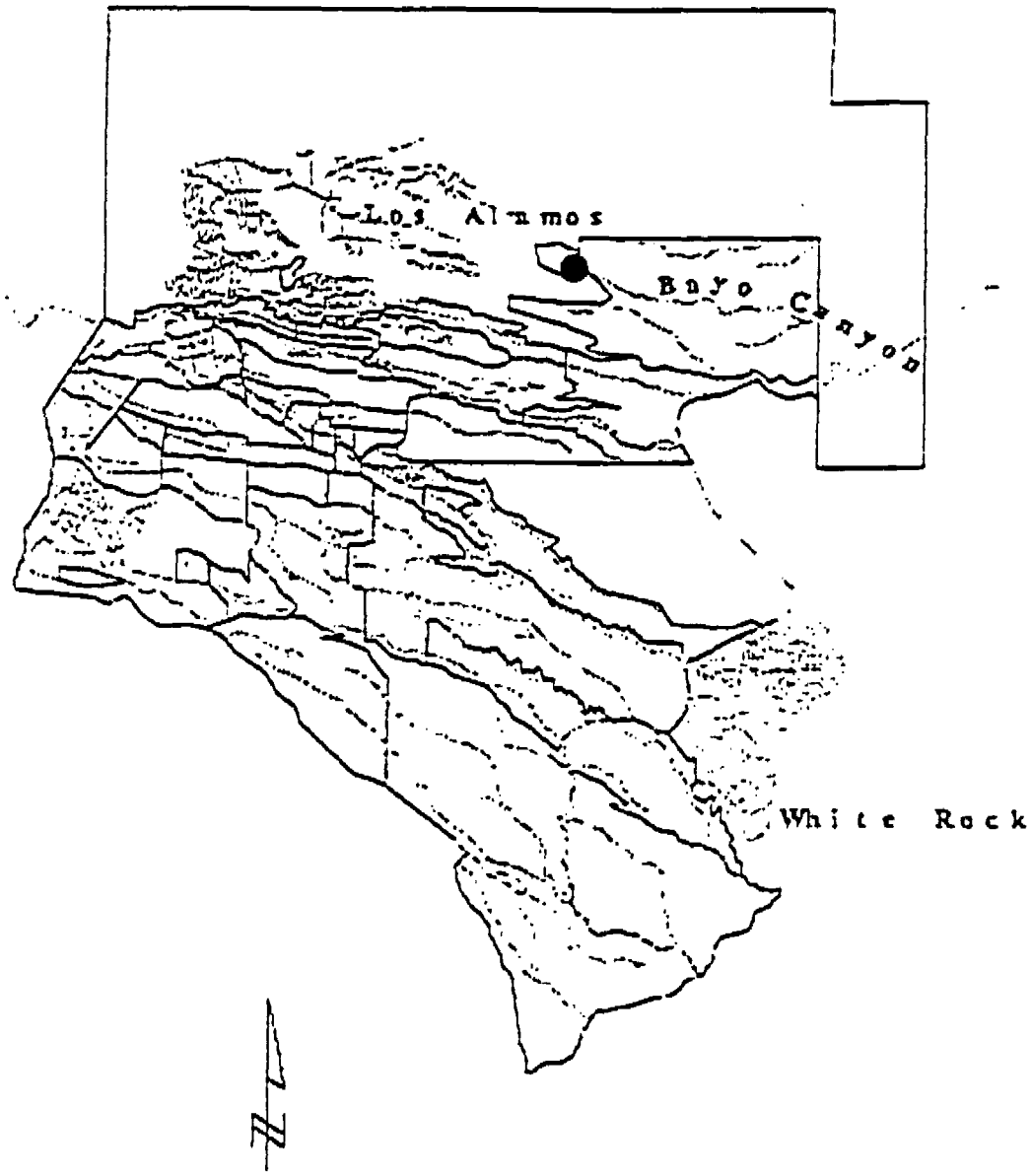

Figure 1. Sample Location within
Bayo Canyon at
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