LAND USE TYPES, SOIL PROPERTIES, AND URANIUM PHYTOACCUMULATION AT TWO ABANDONED MINE SITES IN NORTHWEST NEW MEXICO

by

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INTRODUCTION

STUDY PURPOSE

Soils with uranium contamination exist due to mining in many different climatic regions. For large areas with diffuse surface uranium contamination, plant uranium uptake from the soil is a potentially cost-effective remediation technique. Phytoremediation of U-contaminated soils has been explored in temperate U.S. areas, but not in more arid areas. Semi-arid soils are significantly different from those in temperate areas as they typically have a higher pH, higher calcium carbonate content, and less organic carbon. Geobotanical studies in the Four Corners area have found evidence of accumulation of uranium in native plants, suggesting the possibility of phytoremediation in New Mexican semi-arid soils.

This study has three goals: 1) to describe semi-arid soil properties and geomorphology and relate these to uranium distribution at an old mine site. 2) to identify the plant species which uptake uranium in arid soils. 3) to relate the plant efficiency of uptaking uranium to arid soil properties such as carbonate content, alkaline pH, cation exchange capacity, and soil texture.

Naturally occurring uranium phytoaccumulating plants in New Mexico are identified through the evaluation of uranium uptake of plants at two old mine sites NW of Grants, NM. Relationships between site soil properties and geomorphology with uranium are also explored. The geomorphology of the site is broken into 4 "Land Uses," each with slightly different soil properties.

STUDY SITES

Two locations were selected from areas with diffuse uranium contamination, based on suggestions from Peter Luthiger of Rio Algom, and Michael Landon of the New Mexico State Land Office. The two main study sites are ~40 miles northwest of Grants, NM, adjacent to Rio Algom property. Both major mine sites were underground mines, but surface activity created a range of site conditions including waste piles, a tailings pond and a disturbed plain. In this study, these different areas of the abandoned mine are called *land use* areas. Each abandoned mine site is characterized by a flat disturbed plain, former drainage/ ponded water area, and mine waste piles. The waste piles are typically distinct, 3-4 meter tall hills which are very bare of vegetation. They are comprised of a homogenous sand at the surface, with some iron mine waste (crusher mill balls, general building material). The formerly ponded areas are depressions, with or without confining berms. These appear to have more organic matter and better water availability—the soil surface is darker, and supports more vegetation than the surrounding disturbed areas.

Minor additional plant sampling was done approximately ten miles southeast of the two major study sites in the Poison Canyon mine area in order to survey the area for additional plant species.

SECTION 27

The 'section 27' mine is privately owned but monitored by Rio Algom. The sampling site is 300 m x 400 m, and has an average elevation of 7030 feet. The site has a shallow arroyo that increases to ~ 1 m depth and drains west. The section 27 mine was closed more than 30 years ago, and left unremediated (Luthiger, 2001).

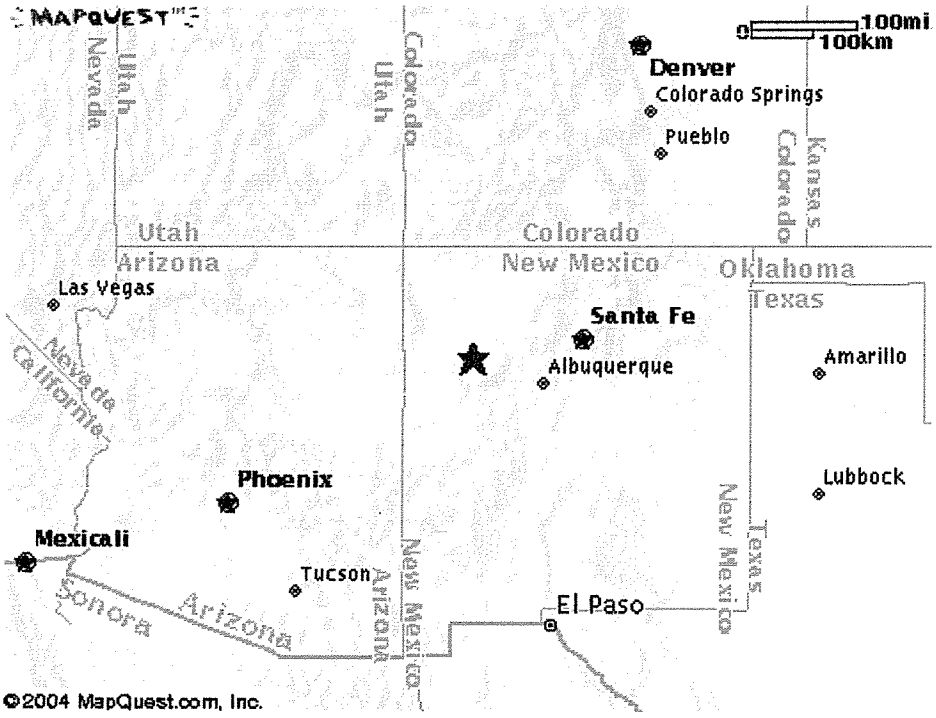
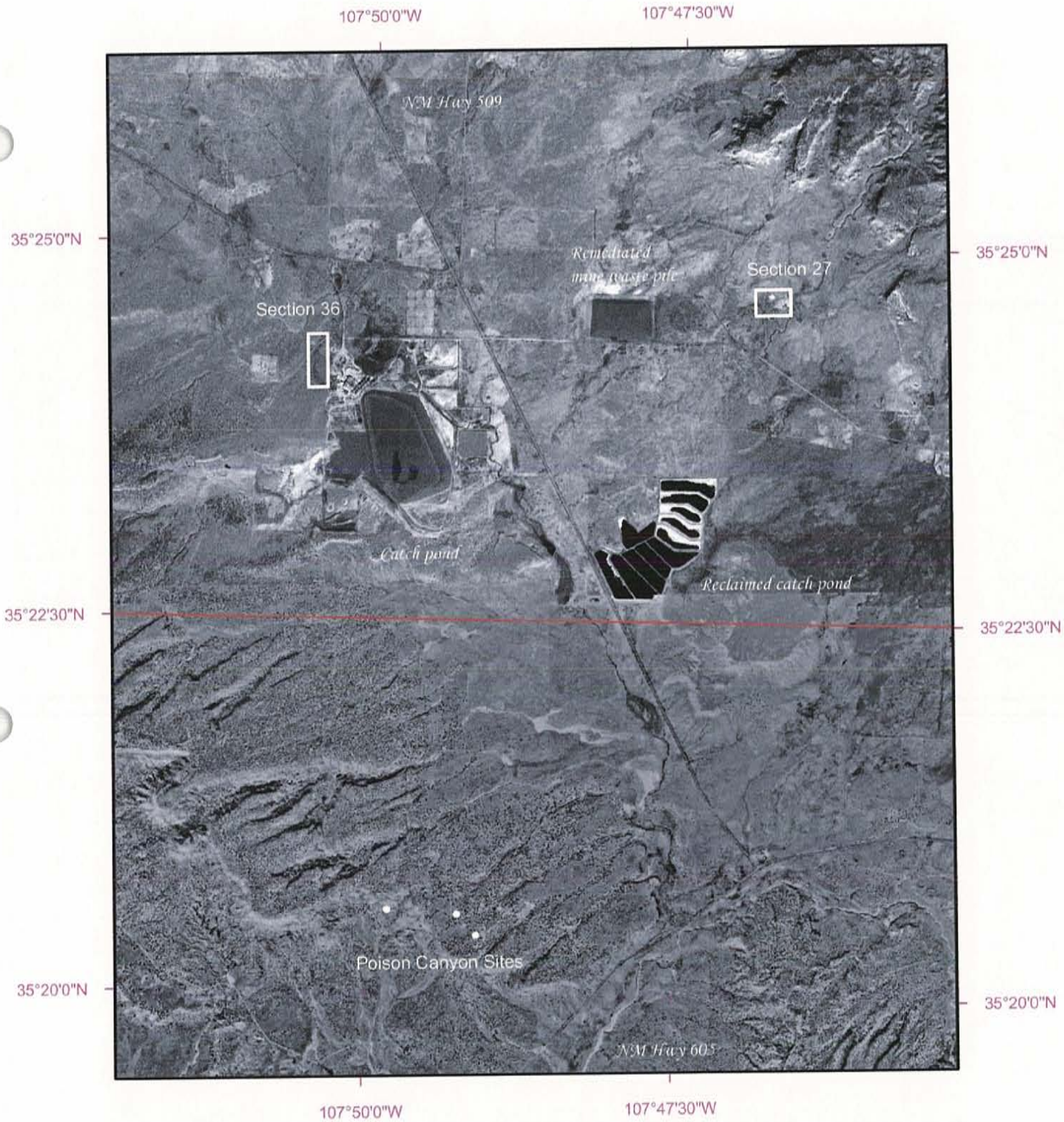


Figure 1. General Study Site Location, northwest New Mexico.

SECTION 36

The section 36 mine was one of the original mines in the area, and has been undisturbed for 50 years (Landon, 2001). It is state land with permitted access. It is directly west of the current Rio Algom operation, which is 2 miles south of the Ambrosia Lake ghost town. The site is approximately four miles southwest of the Section 27 site. The sampling site is 600 m x 200m and is at an elevation of 6970 feet. The site has a central depression which drains northward, but is a small closed basin within the site.



Study site locations, Ambrosia Lake district, NM

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OVERVIEW

In 1959, New Mexico produced 3.3 tons of uranium, predominantly in the Bluewater-Ambrosia Lake area. Sixty mines were in operation at various times through 1952-1962 (Gay, 1963). The uranium boom ended in the early 1980's, due to international price competition and cutbacks in building nuclear power plants. (Chenoweth, 1990). Rio Algom, the last operating New Mexican uranium mill, closed in 2002.

The uranium ore dewatering and milling process produced significant amounts of mine waste and mill tailings containing variable amounts of uranium ore, both often left at the mine site. Some large mine sites in the Ambrosia Lake mining district have been intensely remediated, but sites with more diffuse contamination remain unremediated. Diffuse contamination remains at abandoned uranium mines throughout the semi-arid American West, including mine sites in NM, Ut, Wy, and Co. These sites typically have uranium contamination at the surface from waste rock, the ore dewatering process, and mine tailings. Rio Algom continues to work contractually to clean up a number of the abandoned mine sites in the Ambrosia Lake area.

The diffuse nature of the contamination, as well as the semi-arid climate and the radioactivity and metal toxicity of uranium make remediation a challenge. Soil uranium concentrations are below 1000 ppm. A technique that can remove a relatively small amount of uranium from a large soil volume is needed. Two current approaches for removing uranium from contaminated soil are soil washing and phytoremediation.

Soil washing can be a physical or chemical process. Physical methods involve wet screening or attrition scrubbing (Francis and Dodge, 1998). Chemical methods involve liquid additions to the soil (acidic or basic) in order to dissolve and remove uranium (Francis and Dodge, 1998). Fifty-three to ninety-three percent of uranium was extracted in different applications of soil washing (Elless and Lee, 1998; Duff et al., 2000).

Leach-based remediation is often less efficient at extracting uranium than uranium mining, due to the heterogeneous nature of soils. Soil washing generates large volumes of liquid waste, and involves a drastic alteration of soil physical and chemical properties. The leachate becomes a difficult-to-dispose-of "mixed waste," in addition to the uranium possibly left at the site (Duff et al., 2000). The soil washing process may purge the soil of iron, magnesium, calcium and silica, which are common soil elements (Duff et al., 2000). Soil washing agents can persist in the environment and may cause post-remediation radionuclide migration (Francis and Dodge, 1998). After soil washing, site vegetation restoration is often difficult because of the major soil chemical changes (Huang et al., 1998). High standards of remediation, requiring complete removal of uranium, can also make soil washing financially challenging (Duff et al., 2000).

Uranium phytoremediation is based on sequestering the contaminant to be removed within the plants grown on the contaminated site. This is a low cost and low impact alternative to soil leach remediation. Phytoremediation uses specific plants to target the contaminant of concern: plants can extract and concentrate metals from the soil, or degrade organic contaminants. This process generates a minimum amount of secondary waste and allows in-situ treatment (Huang et al., 1998). Plants that have taken

up uranium can then be gathered and ashed to reduce the amount of total remediation waste.

Phytoremediation combined with citric acid soil treatments can have up to a 99% uranium recovery rate (Francis and Dodge, 1998). Citric acid is a preferred 'soil washing' agent because it is a consistent biodegradeable multidentate complexing agent. In the case of less efficient extraction rates, the phytoextraction procedure can easily be repeated without harm to the soil.

Most uranium phytoremediation studies to date have been made in the eastern United States or in Europe (Baumgartner et al, 2000; Hossner et al, 1992; Huang et al, 1998; Meyer et al, 1998; Pfeifer et al, 1994; Saric et al, 1995; Yoshida et al., 2000). Soils of the western United States are more arid, with higher pHs and lower organic carbon content than temperate soils of the eastern United States or Europe. Both soil pH and carbon content affect uranium solubility in soil water. Conclusions drawn from studies of uranium phytoremediation in temperate soils cannot automatically be extended to more arid regions.

Oftentimes, different soils and climate dictate the natural plant community's species composition, or the type of crop plants grown in a certain area. Plants used for phytoremediation in the eastern United States will probably not grow in semi-arid areas, or accumulate uranium at the same rates. The applicability of uranium phytoremediation to soils of the western United States remains unexplored.

HYPOTHESES

Land Use Types:

- Land use types will show differences in their soil uranium content. The more disturbed areas will contain more uranium.

Null hypothesis:

Soil properties and land use type do not affect the distribution of uranium.

Uranium in soils:

- Uranium concentration increases in proportion to changes in soil properties—for example, increased pH, or decreased $CaCO_3$ content.

Null hypothesis:

Soil uranium content is not affected by soil properties.

Uranium in plants:

- Certain species accumulate more U than others (U per gram plant: U per gram soil).

Null hypothesis: All plant species will accumulate uranium equally well.

BACKGROUND

URANIUM CHEMISTRY

Different uranyl species form in different pH environments (figure 2). At higher, alkaline pH, $UO_2CO_3^0$ and carbonate complexes predominate. Increasing pH also increases sorption by favoring precipitation of uranium minerals and complexes (Willett, 1995). Sorption of uranyl onto natural materials is maximal in the pH range 5.0 - 8.5 (figure 2). Turney (1995) found post-experiment pH of soil effluent to be "...an indicator of overall U removal from the soils" (p. 102). This suggests that soil pH could be a controlling factor on uranium phytoextraction.

Uranyl sorption onto soil is readily reversible with changing pH (Willett, 1995). This means that uranium sorption is a reversible process when based on changing soil conditions, such as the wetting and drying cycles of semi-arid soils.

Uranium primarily takes two cation forms -- U (IV) or U (VI). Each is soluble under different conditions. It is useful to briefly examine these conditions as it provides more specific insight into uranium's behavior in semi-arid soils. Due to the oxidizing conditions prevalent in semi-arid soils, U(VI) is the dominant species. In these soils U(VI) is very soluble as it forms stable complexes with chlorides, sulfates, and carbonates (Turney, 1995). The CO_3 ligand is primarily associated with the U (VI) and OH with U(IV) (Jurinak, 1993). Adsorption of U (VI) onto soil particles strongly increases from pH 4.5 - 5.5, and decreases from pH 7.5 to 8.5. This is the likely pH range of semi-arid soils, which means that U (VI) is more available for plant uptake in semi-arid soils.

Uranium (IV) is typically extremely insoluble; it occurs in very low concentrations in soil water (< .01 ug/L). It is more likely to dissolve below pH 2 or above pH 7 (Elless and Lee, 1998; Watt, 1996). Uranium (VI) appears in figure 2, below, as (UO_2^{2-}). In figure 3, U(IV) appears as the species $U(OH)_5^-$.

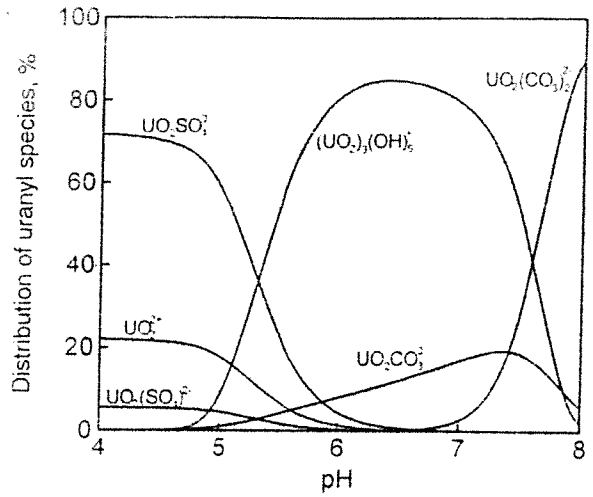


Figure 3. Uranyl species as a function of pH. Calculated at 25 C for .0025 M $MgSO_4$, 10 mg U L^{-1}, and in equilibrium with atmospheric CO_2. (Willett et al, 1998).

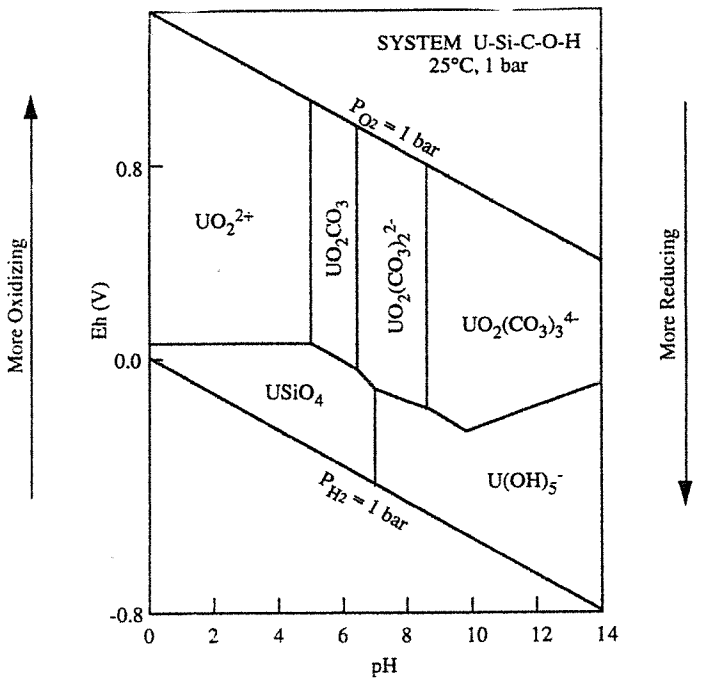


Figure 4. U-Si-C-O-H Pe-pH diagram. Assumed activities for dissolved species are: U= 10^{-8} M, C= 10^{-3} M, and Si=10^{-3} M (Brookins, 1998) (Turney, 1995).

Uranium movement varies between soil horizons because of different chemical and physical properties in each horizon. Soil properties and soil development relevant to uranium presence in arid soils are described later in this section.

GEOLOGY OF AMBROSIA LAKE DISTRICT

The Grants mineral belt extends from the Laguna area in a northwestern direction for approximately 100 miles, ending north of Gallup, NM. The late Jurassic Morrison formation, part of the Colorado Plateau sedimentary sequence (figure 9), is the host for more than 90% of these uranium deposits (Santos, 1963). It is primarily an arkosic sandstone with minor amounts of layered mudstone.

Ambrosia Lake uranium deposits typically occur in paleo-fan systems; here, they are fluvial sandstones with mudstone interbeds (Galloway, 1979). The Poison Canyon

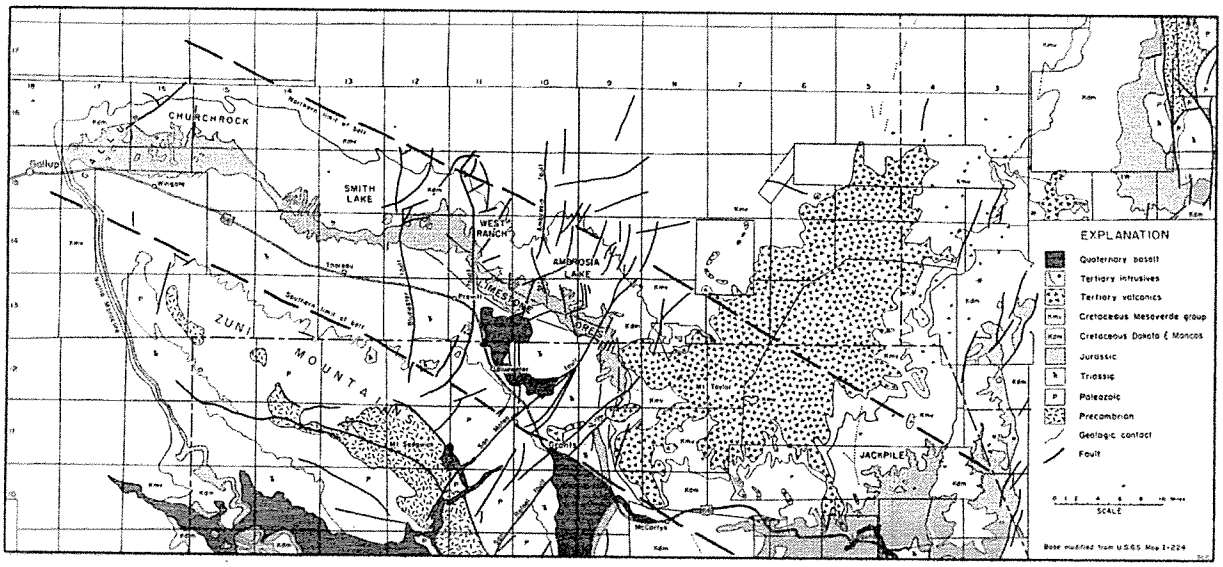


Figure 5. Geologic Map of Grants Uranium District, showing the Grants mineral belt and mining areas (Laverty et al., 1963).

ore body is in the Brushy Basin member of the Morrison formation, which is stratigraphically higher than the Westwater Canyon member (Fitch, 1979).

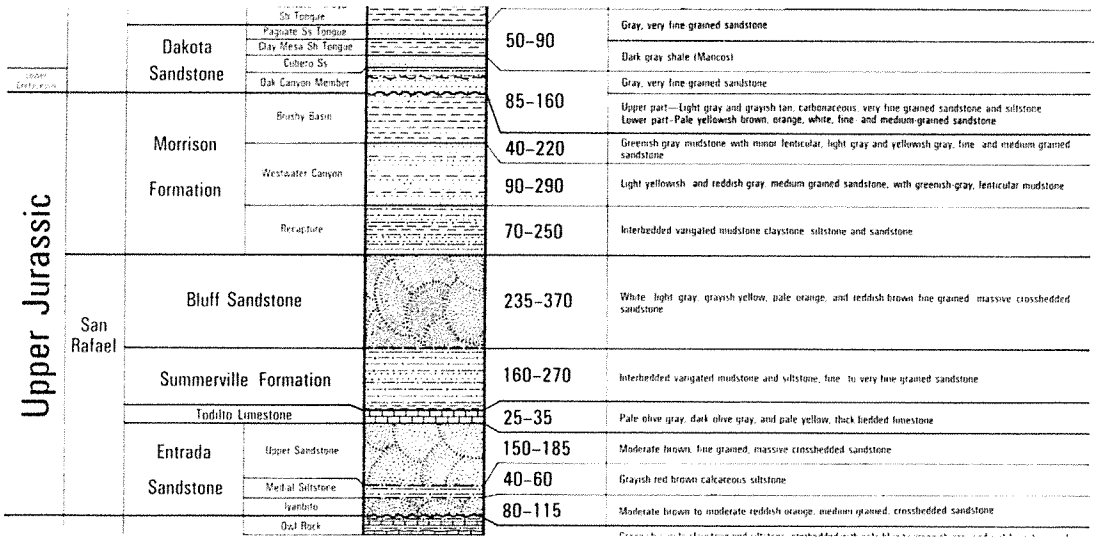


Figure 6. Detail of the Stratigraphic Section of the Ambrosia Lake Area, McKinley and Valencia Counties, New Mexico (Chenoweth, Learned, 1979).

GEOMORPHOLOGY OF SOUTHWESTERN SAN JUAN BASIN

The San Juan basin is a sedimentary basin containing Jurassic and Cretaceous sandstones and limestones (Santos, 1963). Regional faulting occurred in the early Tertiary, uplifting the Brushy Basin outcrop in the Poison Canyon area. Downfaulting a mile northwest put stratigraphically adjacent uranium deposits at ~1000 foot depth. Uplift of the Colorado Plateau in the Miocene and Oligocene resulted in regional exhumation of the area. Resultant faulting currently defines some of the edges of local mesas and plains (Connors et al., 1987).

Quaternary deposits in the area consist of alluvial, playa, colluvial, and eolian sediments (Smith & McFaul, 1997). Both study sites are on flat eolian plains, sand and silt sheets, that have developed in the past 15,000 years (Smith, McFaul, 1997). There is a present-day low rate of eolian transport (Wells et al, 1983).

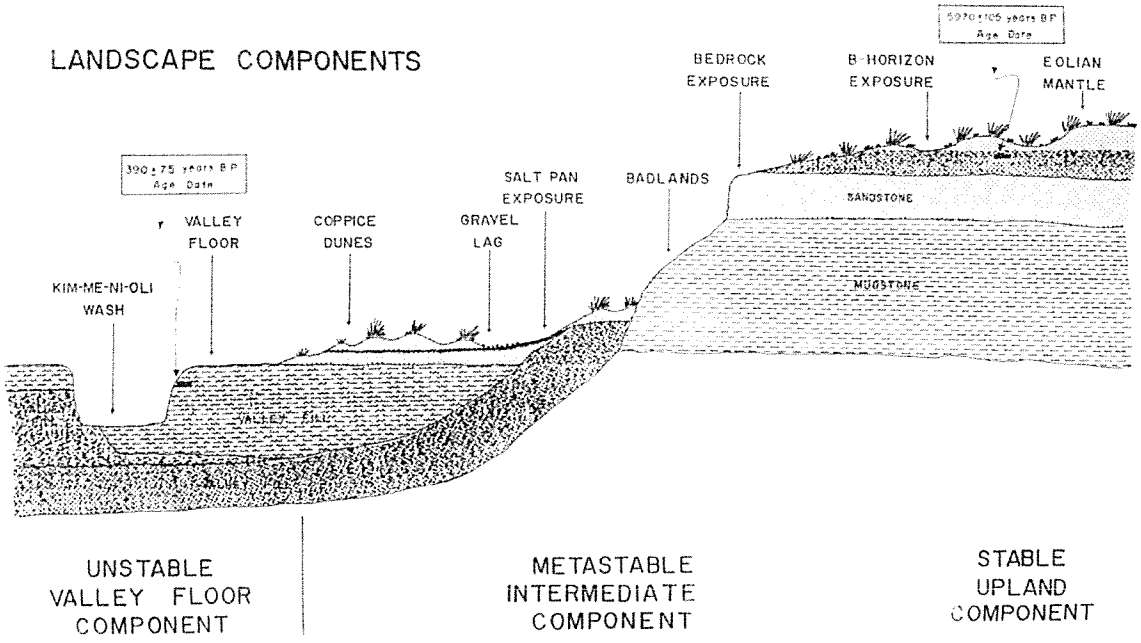


Figure 7. Cross-section of San Juan Basin landscape elements (Connors et al., 1987).

MINING HISTORY

A description of the mining techniques used gives insight into the nature of the contamination and the origins of the landforms produced. Mining operations typically disturbed the local area, resulting in a landscape containing waste rock/ mine waste piles, a disturbed plain and lowlying areas where drainage occurs.

In 1948, Poison Canyon was the first uranium mining operation in the Grants district (Melancon, 1963). By 1963, 47 mines were operating (Chenoweth and Holden, 1980). Ninety percent of all local production in 1963 was from wet-ore (below the groundwater table) bodies. Excess water was pumped and released at the surface adjacent to mine sites.

Mining Technique

In the Ambrosia Lake area, the vertical mineshaft was sunk to ore-bearing formations ranging from 600 to 1,400 feet depth. From the shaft, various levels were created in waste rock, beneath the ground-water saturated ore bodies. The mine water was pumped to the surface where it was collected for use in the mill. The volume of water pumped from each mine varied from 200 to 2,000 gallons per minute (Luthiger, 2002). Ore was cut from the ceilings of the mine tunnels. From there, it was transported to the surface and to the processing mill.

At the mill, the grayish sandstone ore, heated and dried, passed through a primary and secondary crusher and a sample tower. The ore then passed through a fine ore bin and into the rod mills which ground the ore to -28 mesh. The ore slurry (30% water added, 70% ore) was pumped to the leaching agitators where sulfuric acid and sodium chlorate were added. Uranium and any other metals that were soluble in

sulfuric acid were dissolved. The sodium chlorate oxidized the ore, which sped up the leaching process and improved the recovery. At the end of the leaching phase, the ore was pumped into cyclone classifiers for sand-slime separation (Luthiger, 2002).

The separated sand, still in a slurry state, was thoroughly washed with acid-water solution. The uranium was thus separated from the individual sand grains. The barren sand was then pumped to the tailings disposal pond. The separated ore-slurry-slime was pumped to the thickener circuit. It was washed to remove attached micro particles of uranium. Barren slime removed from the last thickener was also pumped to the tailings disposal pond. Ninety to ninety-seven percent of the ore's uranium was now in the acid-water-rock solution (Luthiger, 2002).

The leaching process also removed metals other than uranium from the host rock. The acid-water solution often contained trace amounts of vanadium, molybdenum or iron. It was necessary to extract the uranium from the acid-water solution by a liquid ion exchange process, which transferred the uranium to a solvent at three times the concentration (Luthiger, 2002). The resultant uranium-free, acid-water solution, or "raffinate," was pumped back to previous circuits as a washing solution, or to the tailings disposal pond. The uranium, in the solvent solution, was pumped to the stripping circuit. Here the uranium was stripped from the solvent and again concentrated. Ammonia, air and heat in the precipitation circuit precipitated the uranium from the solvent solution. The uranium moved through a thickening tank and a filter circuit where it was thoroughly washed and dried. The final product contained 80 to 90 percent uranium oxide in a <0.25 inch particle size (Luthiger, 2002).

In conclusion, barren acid-washed sand, barren acid-washed slime, acid-water solution with iron, vanadium, and molybdenum, and ore-dewatering groundwater pumped to the surface were added to the tailings ponds at the various mill locations. This process disturbed soils and ultimately resulted in the creation of a new landscape. The original soils were often covered over or removed. Vegetation was largely removed, and often only hardy or invasive vegetation has been able to return.

Geomorphology of the Mine Area

The post-mine landscape can be separated into four areas: waste piles, disturbed plains, drainage and/or former pond areas, and adjacent, lightly disturbed or undisturbed areas. Waste piles are made up of white, barren, homogenous medium sand from tailings and waste rock in 2 -5 meter tall piles.

Figure 8. Looking west across S27, viewing disturbed plain, with waste pile and undisturbed areas in the distance.

The ore dewatering and tailings pond or *drainage area* has a lower elevation and denser vegetation. The drainage area soil retained clays and some additional organic carbon. The *disturbed plain* is the area around the headframe and the abandoned mine site, with solid mine waste deposits over the surface soils in some areas. Areas adjacent

to the site remained *undisturbed*. Each *land use area* received different degrees and types of uranium contamination. There is waste rock uranium and leftover tailings uranium in the waste piles; uranium leached into the soils underneath the drainage areas; and blown uranium-contaminated dust over the undisturbed areas. A combination of the above, as well as refuse and truck ore-spill, impact the disturbed plain.

Figure 9. Looking east –southeast across S36, viewing undisturbed area in foreground, drainage area in middle, and existing Rio Algom uranium mill outside of study area to the east.

CLIMATE

The area has a semi-arid climate with an average annual precipitation of 10-12 inches (Soil Conservation Service, 1993). The average annual air temperature is 48-53 C, and the frost-free period 114-150 days. Short late afternoon high intensity summer rainstorms characterize precipitation. There is also a small snow contribution during the winter months, although the ground usually remains bare, not snow-covered.

SOILS

SOIL DEVELOPMENT

Six periods of eolian deposition have formed the undisturbed semi-arid soils of the San Juan basin over the last 12,000 years (Smith, McFaul, 1997). Arid soils, as they develop with time, show increases in silt, clay and calcium carbonate (Smith, McFaul, 1997). Weakly-developed soils have less potential for retarding downward movement of uranium through a soil because they lack clays and iron oxides. (Watt, 1996).

Arid soil-uranium studies found that uranium was retained in surface soil horizons (e.g. Litaor, 1995—central Co; Willett et al, 1998, 1995--Northern Territory, Australia; Shilk, 1995--Cincinnati, Oh; Watt 1996--Los Alamos, NM; Vainetti, 1996—northern Ut). More concentrated and stored uranium was found in strongly developed soils (Watt, 1996).

Studies of uranium in semi-arid soils also described the effect of different soil horizons on soil uranium distribution. A study east of the Rocky Flats nuclear plant, near Golden, Co., showed that most of the uranium was concentrated above the B horizon, located at 15-40 cm. Due to the higher clay content of the lower B horizon, uranium was retarded from further downward movement (Litaor, 1995). Highly weathered soils retained radionuclides in the surface-most few centimeters (Willett et al, 1998; Willet, 1995, and Schilk, 1995). The surface horizon had the most organic content, and water saturation caused reducing conditions. They concluded that there was no likelihood of the uranium being leached to any depth. Even in soils with weakly developed soil properties, most of

the uranium is concentrated in the upper 20 cm, within 50 m of the contaminant source

Figure 10. Section 36 undisturbed soil profile.

(Watt, 1996). A lack of water in arid areas ultimately prevents uranium from being leached further into the soil (Vaninetti, 1996).

SOIL FRACTIONS

The following soil properties influence uranium mobility: organic matter, calcium carbonate, clays (cation exchange capacity, CEC), and ferric oxyhydroxides (Elless and Lee, 1998; Watt, 1996). In one study, 20% of uranium was bound to soil carbonate, 10% to mineral oxides, and 20% to the organic soil matter (Dhoum and Evans, 1998). Uranium also binds with Fe and Mn oxyhydroxides (Watt, 1996). Clay content and mineralogy do not significantly impede dissolved uranium movement downward through a soil (Watt, 1996).

Organic Matter

Organic matter is an important reducing agent for trace elements such as uranium. However, most studies of uranium mobility in mine tailings and soils have been conducted on systems with pH <6, whereas semi-arid soils typically have pHs above 7. At high pH and high uranyl concentrations, the formation of uranyl humate is favored (Watt, 1996). The organic content of arid soils is also typically very low, often less than 1% (Vaininetti, 1996). While the organic matter that is in a semi-arid soil might be very effective in complexing uranium, the overall organic matter effect on uranium movement is probably small.

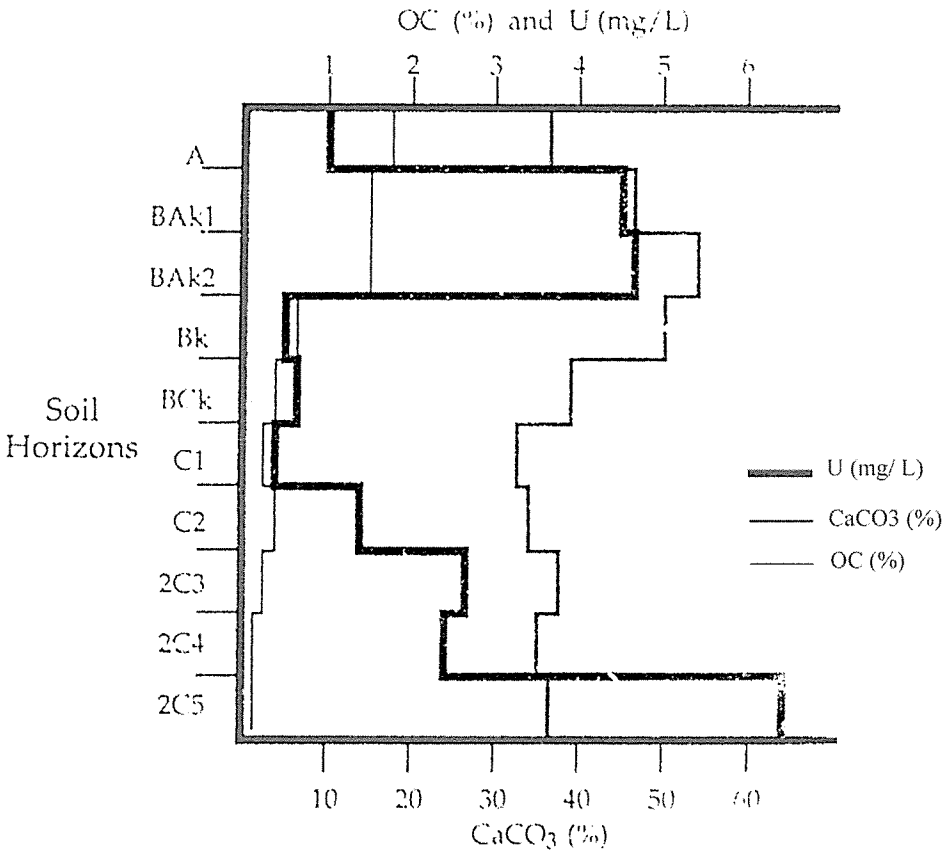


Figure 8. Vertical Distribution of OC, $CaCO_3$, and water-soluble U concentrations in a Nevadan aridisol. (Vaininetti, 1996).

Soil Carbonate

Uranyl carbonate species are highly mobile in soil solution (Langmuir, 1978; Willett, 1995). Adsorption in soil was lowest in high pCO_2 and low pH waters because of the formation of soluble U (VI) carbonates (Duff, 1996).

Evapotranspiration in arid climates tends to concentrate uranium and precipitating ligands, causing more uranium mineral formation (Langmuir, 1978). In arid climates, CO_2 pressures in soils and groundwaters also tend to be relatively low because of the paucity of soil organic activity (Langmuir, 1978). If the semi-arid soils in this study are

assumed to have low pCO_2 from a low plant density, and a high pH soil, these soils should therefore have fewer soluble uranium carbonates, and more uranium carbonate adsorption. As stated in the Soil Development section, carbonate content in a soil also relates to soil development. Most of the soils in this study showed little soil development and carbonate content.

Cation Exchange Capacity (CEC)

Uranium sorption increases with increasing cation exchange capacity. Two sources of CEC are clay minerals and organic matter. The type of aluminosilicate clay minerals and amount of organic material influence uranium sorption. Montmorillonite, a clay mineral with high CEC, adsorbs more uranyl ions than Na^+ and K^+ ions, but less than Mg^{2+} and Ca^{2+} ions (Watt, 1996). In semi-arid soils, kaolinite, a non-reactive clay, is abundant (Birkeland, 1999).

Fe and Mn oxyhydroxides

Total iron content of a semi-arid soil is typically low. Goethite is the most common iron mineral in most well-drained soils, with a yellowish-brown color (Birkeland, 1999). This tends to make up a much smaller soil fraction in semi-arid soils than another soil precipitate, calcium carbonate.

Iron and Manganese oxyhydroxides, which also occur in semi-arid soils, are complex OOH- bound soil precipitates of iron and manganese. Fe and Mn hydrous oxides are responsible for strong sorption of divalent metal cations, such as uranium (Willett, 1995). In arid soils, even though the total iron content is small, these compounds can be as or more important than CEC for uranyl absorption.

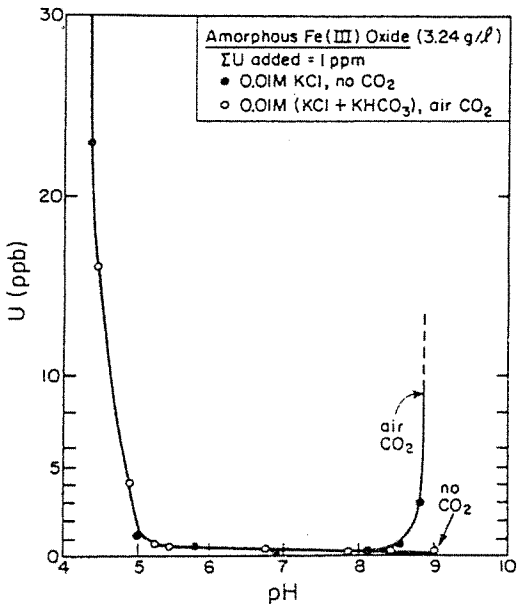


Figure 9. Adsorption of uranyl onto X-ray amorphous ferric oxyhydroxide as a function of pH (From Van der Wiejden et al., 1976, and VdW, Langmuir, 1975) (Langmuir, 1978).

Contaminant uranium concentration has been correlated with iron oxide and oxyhydroxide content, but not with total iron concentration in soils around Los Alamos, NM (Watt, 1996). More dissolved carbonate causes less U(VI) adsorption to Fe oxide and oxyhydroxide mineral surfaces (Duff, 1996). U(VI) adsorption on goethite (cis-FeOOH) increases with increasing pH in carbonate-free solutions across a large pH range (Duff, 1996). Over the pH range of 5 to 8.5, ferrihydrite ($Fe_5(O_4H_3)_3$) is a very strong scavenger of U (Watt, 1996; Birkeland, 1999).

LOCAL SOIL DESCRIPTIONS

The soils of the Ambrosia Lake quad have been mapped but not yet published by the Natural Resource Conservation Service (Tzschetzsche, 2003). Ambrosia Lake quad

soils are consistent with the published soils of the southern adjacent Dos Lomas quadrangle. The Dos Lomas quadrangle is dominated by Penistaja, San Mateo, and Sparank soil series. These are deep soils, mainly formed on cuestas, fan terraces, flood plains, and alluvial fans (SCS, 1993). Some undisturbed soils in this region have significant calcic horizon development, although not in this area (Smith & McFaul, 1997).

The undisturbed soils of this study are Penistaja type soils, as defined by the NRCS. Penistaja soils have an extent of over 1 million acres in New Mexico, and predominate in this study area. They are formed in mixed alluvium and eolian material derived from sandstone and shale (NRCS, 2003). The Penistaja soil surface layers are a brown fine sandy loam. The subsoil is a strong brown sandy clay loam, and the substratum a reddish yellow sandy loam that is occasionally slightly calcareous.

The Penistaja soil contains a thin organic A horizon overlies a slightly leached A horizon, a B and Bt horizon enriched in iron and weatherable minerals, and a lower Bk carbonate layer with >15% $CaCO_3$ deeper than 40 inches. This carbonate layer becomes progressively more indurated and less permeable with time (Birkeland, 1999). The typical pedon is a fine sandy loam with up to 15% gravel. Soils at the study site are sandy loams with pale red or yellow tones.

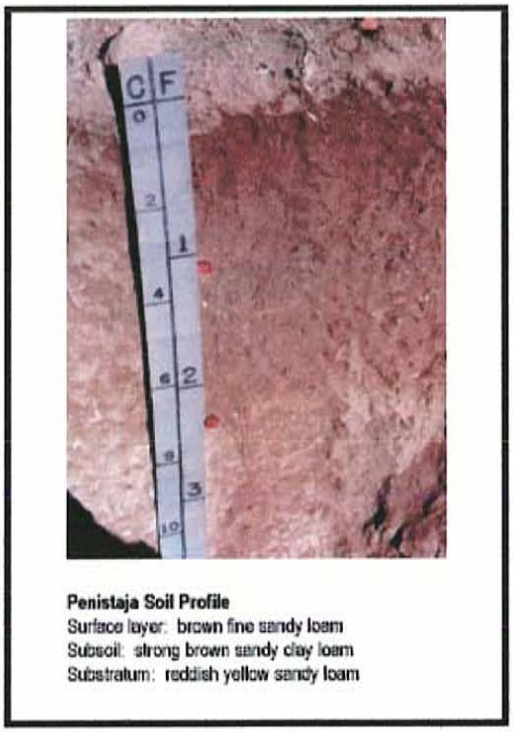


Figure 13. Penistaja Soil Profile (NRCS, 2003).

PLANTS

VEGETATION OF THE SOUTHWESTERN SAN JUAN BASIN

Vegetation in this area is primarily an eastward extension of the Great Basin desert (Dodge, 1985; Knight, 1992). It combines monostands of woody shrubs with some southern Rocky Mountain flora and New Mexico desert grassland plants. Saltbush, rabbitbrush, snakeweed, and wooly buckwheat all occur in this area as small or medium woody shrubs.

Figure 14. Indian Rice Grass, *right,* **and Spike dropseed**, *left.*

The two study sites have vegetation representative of desert grasslands and badland lowlands. Grama grass is considered a climax vegetative species (Dewitt-Ivey, 1995). Pioneer plants include tumbleweed, goathead, and spurge. In saline or alkaline lowlands, russian thistle, pepperweed (*Lepidium montanum*) and goosefoot may be present (Knight, 1992). Intermediate stages include galleta and burro grass, cactus, and mixed weeds.

In the badland lowlands, low densities of forbs and shrubs can occur (Knight, 1992). Annuals or biennials may provide additional diversity to the shrubs, but in dry years may not grow. Alkaline clay soils support spike and sand dropseed grasses, galleta grass, and blue grama grass. Sandier soils incorporate Indian dropseed grass as a major species. Shrub growth is more precipitation dependent than determined by soil type (Knight, 1992).

Figure 15. Fringed Sagebrush, ***left,*** **and Russian Thistle/ Tumbleweed,** ***right.***

PREVIOUS URANIUM-UPTAKE PLANT STUDIES

Phytoremediation utilizes plants that accumulate uranium. Plants used in uranium phytoremediation must have the ability to isolate uranium in the plant cells, preferably in above ground plant matter (Chaney, 1997). This is considered more important than high biomass of the plant, which could contribute to gross uranium extraction (Chaney, 1997).

Uranium accumulation may not always be healthy for the plant. There are two important plant reactions to a high uranium environment: detectable uranium accumulation, and anomalous growth habits (Cannon, 1951). Small amounts of uranium can stimulate plant growth, but concentrations above a very low level can be retarding or toxic. Poison effects on germination can begin at 47.6 ppm. 476 ppm can wither leaves and roots; 1% U was toxic to germination (Cannon, 1951).

The availability of uranium to plants is influenced by soil properties and the degree of uranium binding in the soil. The elemental solubility of uranium affects

uranium's availability for plant uptake (Ibrahim and Whicker, 1992). Many of the factors that are important for plant uptake of uranium, such as pH, texture, organic matter, and CEC also control uranium sorption in the soil (Mortvedt, 1994).

The uranium accumulation in the plant relative to the uranium content of the soil is represented by the concentration ratio (CR), which is a measure of the effectiveness of phytoremediation.

$$\frac{\text{(mean U concentration/ g dry vegetation)}}{\text{(mean U concentration/ g dry, underlying soil)}}$$

(Ibrahim and Whicker, 1992). Previous CR data shows that plant uptake of uranium is not linearly related to soil concentration of uranium (Hossner et al, 1992; Ibrahim and Whicker, 1992; Mortvedt, 1994). The CR depends on the plant species, and the soil variables identified in the previous section. Concentration ratios were highest for plants growing on the edge of a tailings impoundment because "acidity [pH 2-5] and water availability tend to enhance the solubility and availability of radionuclides for plant uptake," or because of saturation conditions encouraging plant growth (Ibrahim, Whicker, 1992).

Desert vegetation of the Four Corners area was sampled for uranium content and Juniper, Indian Rice Grass, and a milkvetch (*Astragalus Preussii var. arctus*) were identified as uranium accumulators (Cannon, 1951). In Texas, range plants were grown in uranium mine overburden and adjacent soils (Hossner et al, 1992). Sand lovegrass was the best uranium accumulator with 4 ug/g. Greenhouse investigations of plants with uranium contaminated soil found little uranium uptake (Baumgartner et al., 2000, Meyer, Mclendon, Price, 1998).

Brassica rapa, a mustard plant, is "a model plant for U phytotoxicity because of its ability to produce seed even at high levels of U (10,000 mg/ kg) (Saric et al., 1995). Species in the Brassicaceae family (Mustards) have been shown to have the "...ability to hyperaccumulate heavy metals such as Zn, Pb, and Cd under natural conditions" (Huang et al, 1998).

METHODS

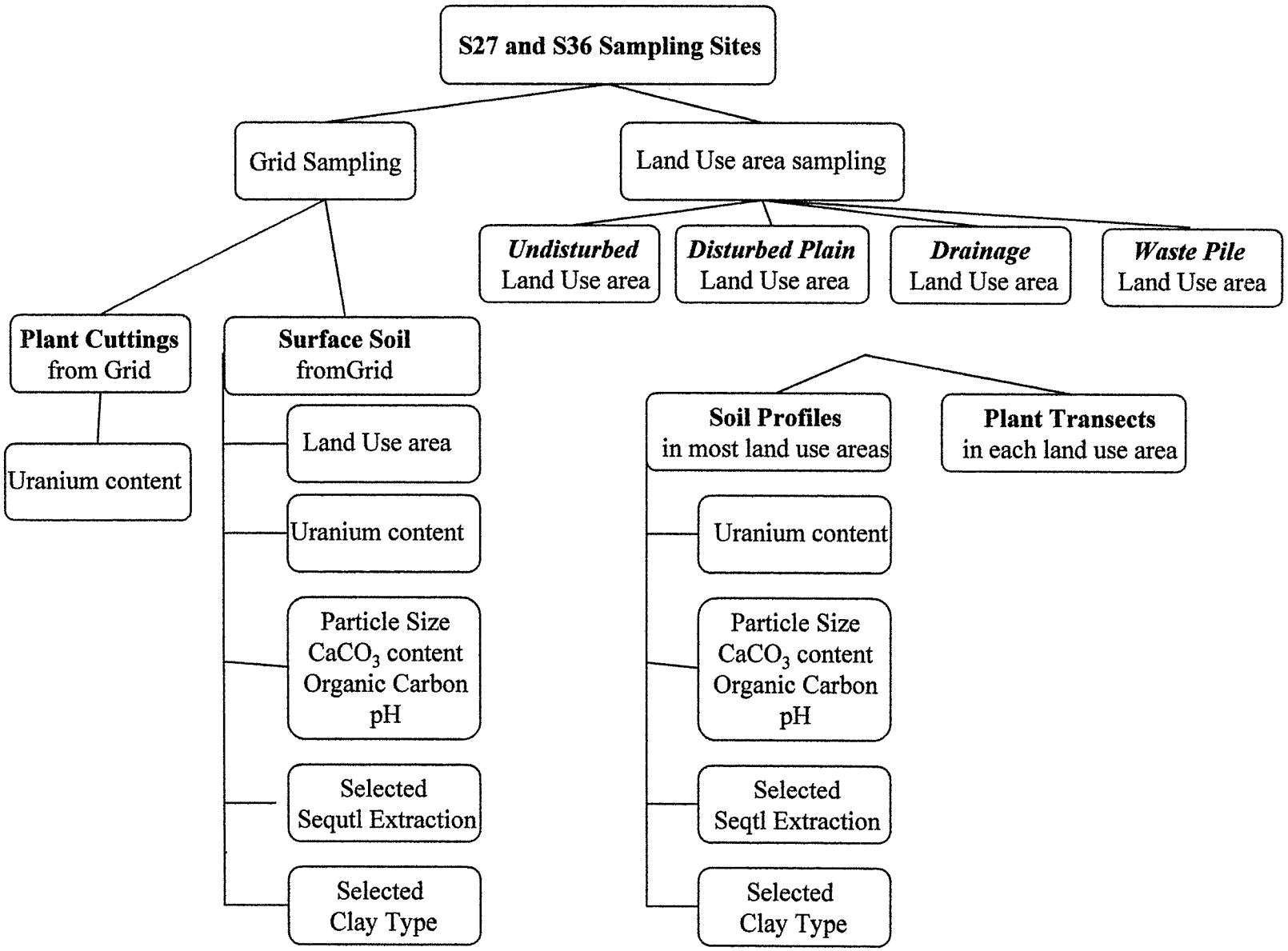
FIELD WORK

OVERVIEW

A grid was laid out over each area using a measuring tape and pace and compass mapping. Geomorphology, soil profile samples, geiger counter readings (urem/ hour), and GPS readings were described or measured at each point in this grid. Selected grid points were sampled for soil and vegetation. In the four designated land use types, plant transects were taken and soil profiles were sampled. Figure 16 details the grid and land use type sampling. These samples use the systematic and judgmental sample designs, as described in Table 1.

Approach	Relative Number Of Samples	Relative Bias	Basis of Selecting Sampling Sites
Judgmental	Smallest	Largest	Prior history, visual assessment of technical judgement
Systematic	Larger	Smaller	Consistent grid or pattern
Random	Largest	Smallest	Simple random selection

Table 1. Basic Sampling Approaches for Environmental Research and Assessment (Keith, 1991).


S27 and S36 Sampling Sites
Grid Sampling
Land Use area sampling
Undisturbed Land Use area
Disturbed Plain Land Use area
Drainage Land Use area
Waste Pile Land Use area
Plant Cuttings from Grid
Uranium content
Surface Soil fromGrid
Land Use area
Uranium content
Particle Size
CaCO3 content
Organic Carbon
pH
Selected Sequtl Extraction
Selected Clay Type
Soil Profiles in most land use areas
Plant Transects in each land use area
Uranium content
Particle Size
CaCO3 content
Organic Carbon
pH
Selected Seqtl Extraction
Selected Clay Type

SAMPLING GRID

A reference grid was established every 50 m over the study area with a compass, measuring tape, and/or pacing. This helped to compare total area of land use types and map the landforms accurately. Once the grid was established, a GPS location was taken at each point flagged in the field. Based on this information, a large number of samples was anticipated, and the plant and soil sampling design was scaled down. Plant and 'surface' soil samples were taken at approximately every other point at S27, and 60% of the points at S36.

Section 27 Grid

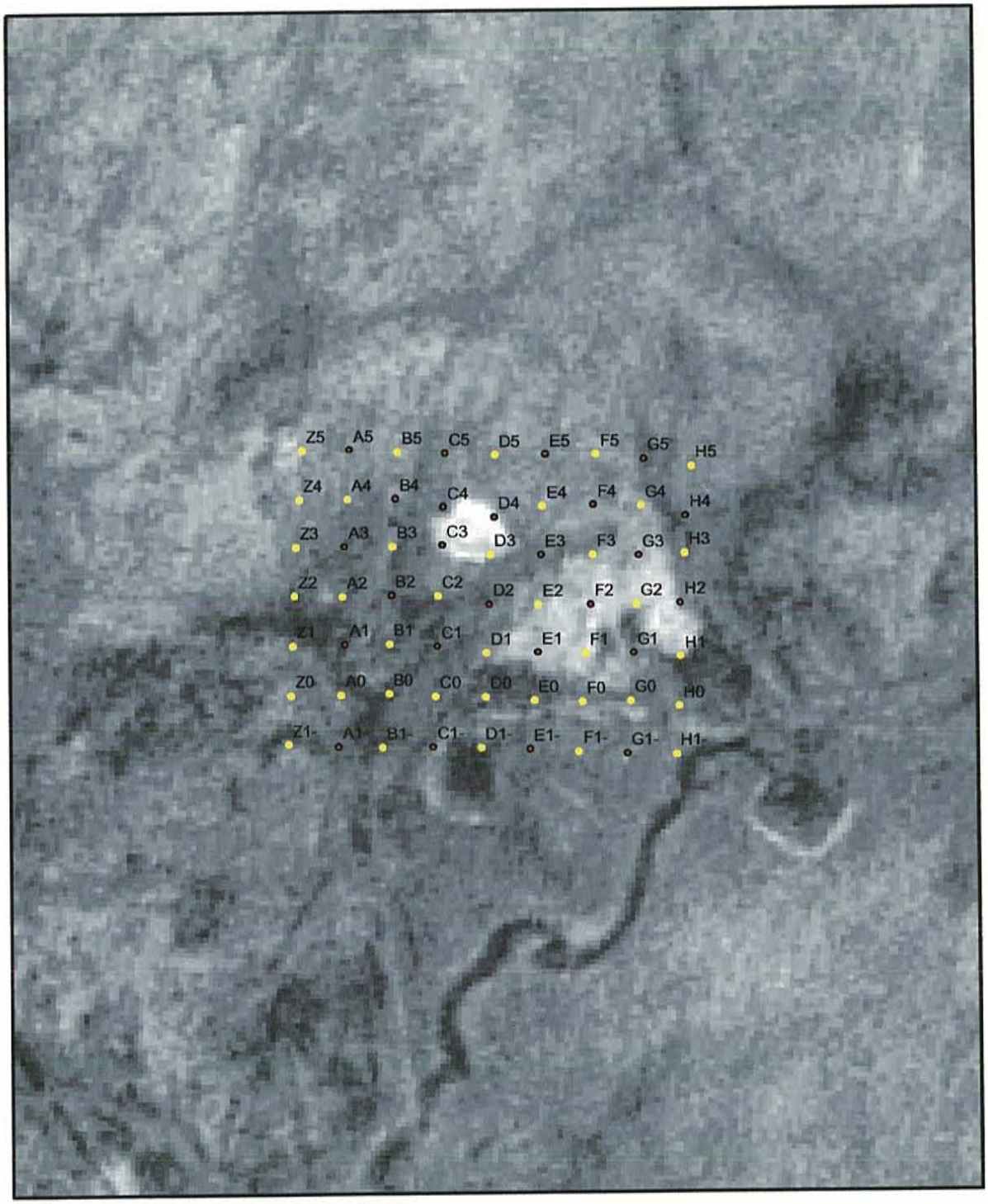
At S27, plant and soil samples were taken at 25 selected grid points in a checkerboard pattern. These 25 sampling points are shown in red on the following aerial photograph (Figure 17). An additional 73 GPS points were taken at the Section 27 mine to more accurately map the breaks in slope and drainage areas. These points were used in conjunction with the 63 initial grid points and the aerial photograph at section 27 to further map the area's land use areas: arroyo, waste pile, and disturbed plain.

Section 36 Grid

The section 36 mine had two waste piles, a large disturbed area, and a drainage area. A grid of approximately 600 x 200 m in 50-meter intervals was laid out at the site. 75 GPS points were taken, including all grid points and some topographic detail (Figure 18). Because of sample size considerations, samples were taken at 39 points in the 1, 2, 3 rows. Additional plant samples were taken along the top of the most contaminated waste pile.

GPS Measurements

After the grid was established and marked with flagging, each point was GPS'd using a Garmin 12xls GPS unit. The GPS error (+/- 2-5 m) was typically higher than the measuring tape or paced measurement error (+/- 1-m). The original GPS points for this study use the UTM NAD 1983 datum. These plot correctly on a digital aerial photograph (rgis.unm.edu). For section 27, they correlate with the expected location, just north of an eastern-running dirt road. The coordinates were transformed to the NAD 1927 datum in order to be used on a topographic map. The points were converted from Nad 1983 to Nad 1927 using the ArcToolbox program.



Section 27 grid and sample points

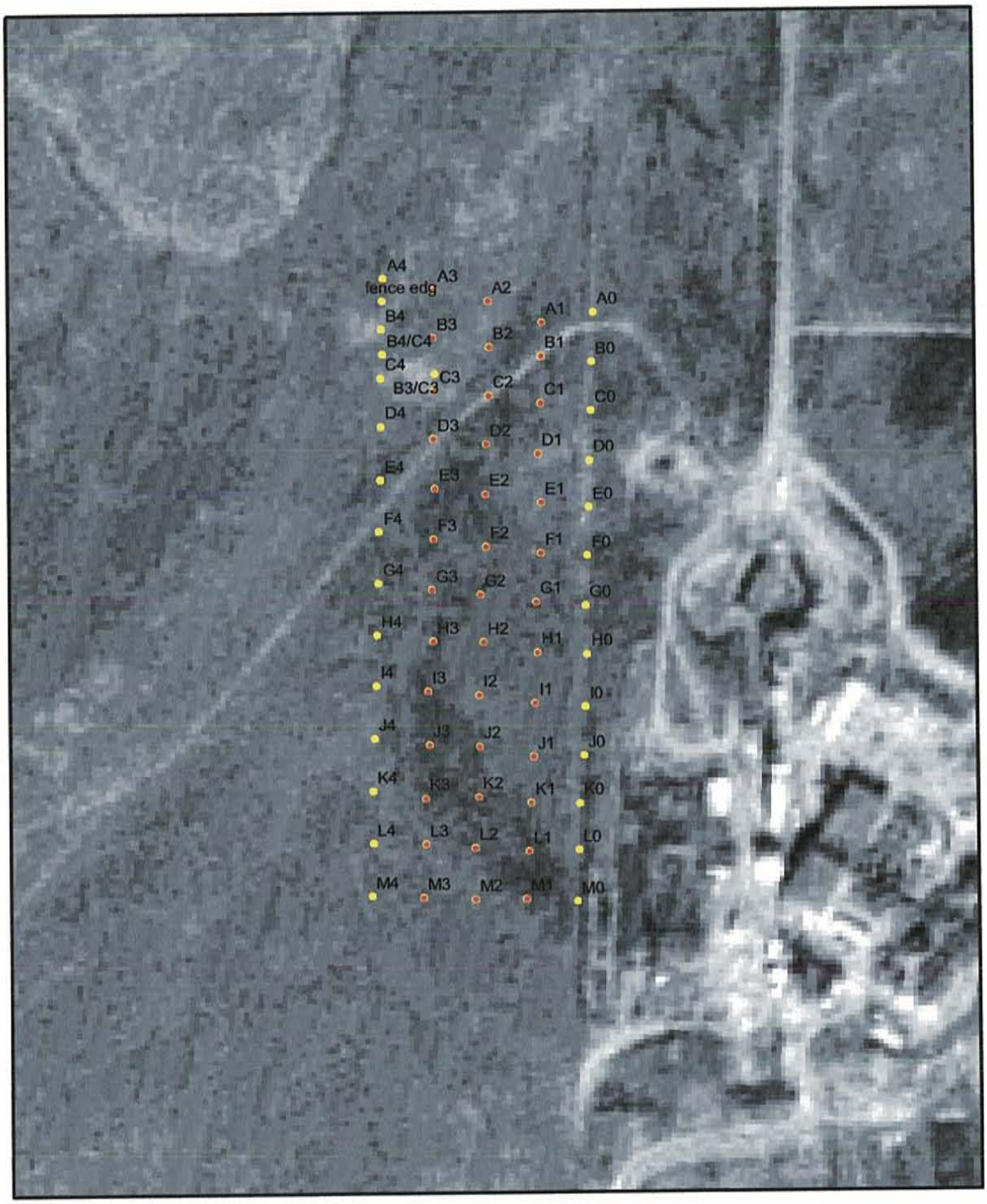
N

1:6,000

USGS Digital Orthophotos
Images taken 10/11/1996
UTM, zone 13 NAD 1983

0 0.05 0.1 0.2 Miles

0 0.05 0.1 0.2 Kilometers



Section 36 grid and sample points

N

USGS Digital Orthophotos
Images taken 10/11/1996
UTM, zone 13 NAD 1983

1:6,000

0 0.05 0.1 0.2 Miles

0 0.05 0.1 0.2 Kilometers

GRID POINT SAMPLING

Soil 'Surface' Sampling

At grid points, soil samples were taken at 0-5 cm depth, adjacent to the sampled plants. These are subsequently referred to as "surface" soil samples.

Plant Sampling

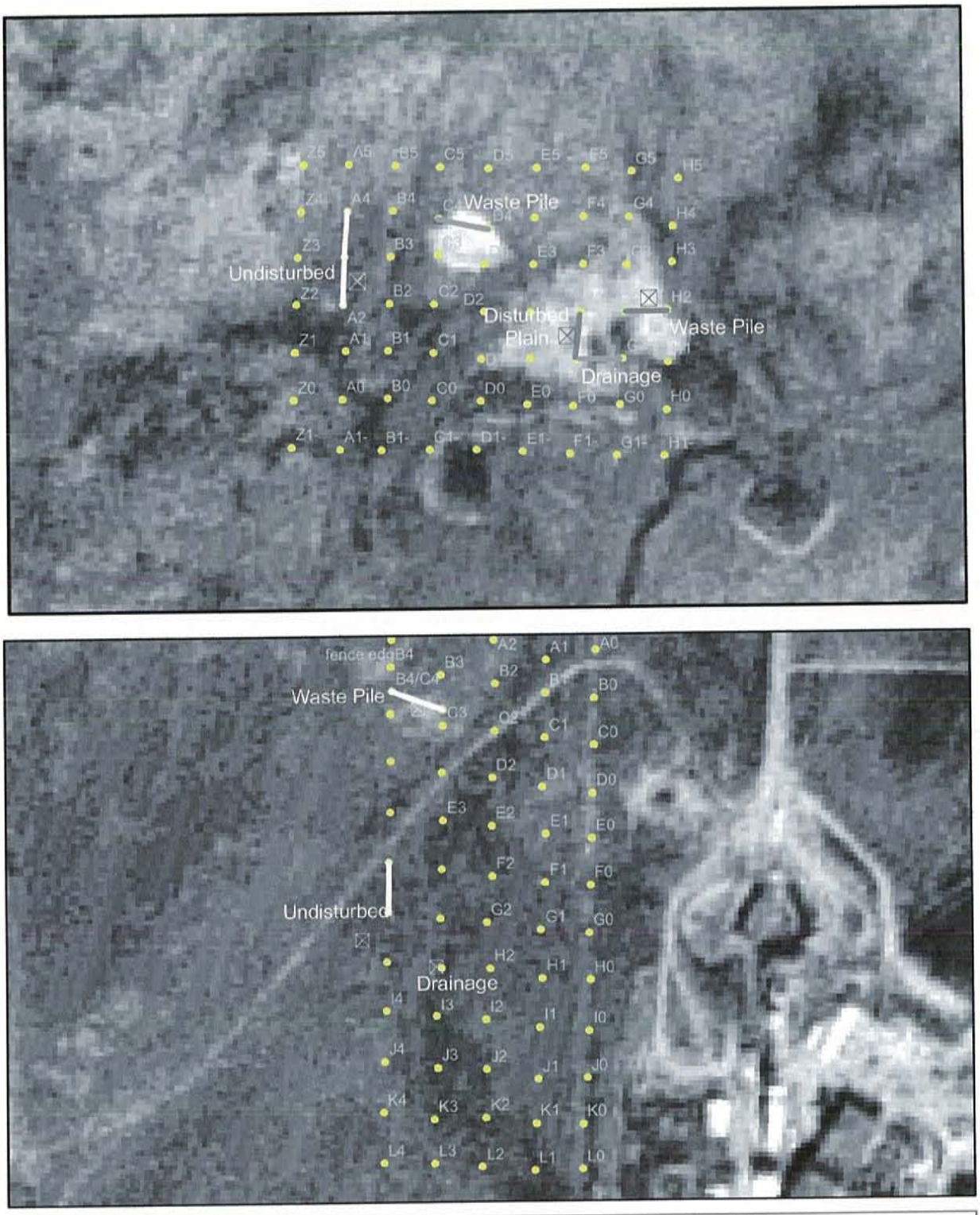
Plants were sampled above the soil surface at the grid points provided in figures 13 and 14. Three plants, those closest to the grid point, were sampled. Standard procedure was to cut these plants above the soil surface. A number of grid points had duplicate species samples.

NON GRID POINT SAMPLING

Soil Profiles

At S27 and S36, soil profile samples independent of the grid system were also taken (figure 19). These were taken to characterize the soils in the land use types: in the arroyo, waste pile, and undisturbed areas. This information was used to examine the possibility of uranium movement within the soil profile. At the section 27 mine site, soil profiles were sampled every five centimeters to 30 cm, considering uranium mobility and sample sizes. At the section 36, soil pits were dug deeper, in order to examine the soil profile at greater depths. In the S36 lowland, waste pile, and undisturbed areas, these soil pits are 60 cm deep, with samples taken every 10 cm.

In both locations, all soil pits were dug, measured and photographed. Soil horizons were identified, and soil samples taken in one 4 inch wide by 1 inch deep area at



Line plant transects and soil profile locations of Section 27 and Section 36 study sites

N

1:6,000

USGS Digital Orthophotos
Images taken 10/11/1996
UTM, zone 13 NAD 1983

0 0.05 0.1 0.2 Miles

0 0.05 0.1 0.2 Kilometers

each interval. Sampling was performed from the bottom up, in order to minimize contamination of subsequent samples.

Soil profile samples from both locations were analyzed for uranium content, pH, particle size, organic carbon, and calcium carbonate. Selected samples were analyzed for clay type and by sequential extraction for uranium partitioning between the soil fractions. These samples were selected based on high uranium values and land use location.

Plant Transects

In order to characterize the vegetation in the undisturbed areas, lowland drainage areas, and mine waste piles, vegetation transects were taken in the different land use areas at each site (figure 20). This method quantifies ground cover by species, and identifies the percent bare ground. No plants were "sampled" along these transects. These transects are a modified form of the Long Term Ecological Research (LTER) line vegetation transect (Loftin, 1999). The LTER method sums the total length of a 50-m measuring tape that is covered by each species of plant, bare ground, or litter, and gives relative percentages of each species' ground cover. Established reference grid points were used as the endpoints for the line transects. For that reason, Figure 19 showing the line transect locations uses the same reference grid as the previous diagrams.

Additional non-grid plant and soil sampling was done at the Poison Canyon study site, approximately 5-10 miles southeast of the other two sites. Because this sampling was exploratory and not done at the same scale, with designated land use types and a grid sampling system, this information is listed in Appendix E.

Figure 20. Plant transect along undisturbed section, Section 36.

LABORATORY METHODS

ICP-MS analysis was used to determine the uranium concentration of plant and soil samples. Soils 'surface' and profile soil samples were also analyzed for their particle size, organic carbon content, carbonate content, and pH. Certain soil samples were

selected for additional analyses based on land use area and uranium content. 10 soil samples were analyzed for clay type, and the uranium content of separate soil fractions was tested using 12 soil samples. For this sub-study the uranium bound in soils was separated into exchange sites, carbonate, oxides, organic, and residual fractions.

ICP-MS SAMPLE PREPARATION

The soils typically had a 1-5% moisture content, and were air dried in their sample bags. They were then sieved to <2mm. The >2mm gravels were weighed and set aside. The fine soil material was split for particle size, carbonate, organic carbon, pH, and uranium analyses.

Plant samples were air dried. After drying, a small section of the plant was removed from the total sample. For a grass, this was a few blades or a small clump from the rest of the grass plant; for a shrub it was typically a low branch, one that joins the stem close to the soil level. When the plant sampled had stems and leaves, the samples were split into leaf and stem samples. Grass samples were not split into stems and leaves. Tiny samples of small non-woody plants were taken as one sample and not divided into stems and leaves.

The stem and leaves were then separated into two piles. These were then held on wax paper and cut into <1 cm pieces. Any particulate matter generated during this process was removed. The ICP-MS plant subsample was then taken randomly from the prepared material for each sample. The prepared matter was generally > 4-10 X the sample size.

Microwave Digestion

Microwave digestions were conducted in a Milestone Plus Temperature Control scientific microwave oven with turntable, under pressure, in Teflon test tubes. Twelve samples at a time were prepared for ICP-MS analysis. These twelve samples usually included two of three quality control measures: a blank, a standard, or a sample duplicate. The temperature progression of a typical digestion is shown in Appendix H. The National Institute of Standards and Technology (NIST) reference material 8704, Buffalo River sediment, and 2709 San Joaquin soil, were used as reference soils. The NIST standard 1570a, trace element in spinach leaves, was used as reference plant matter. The content of these standards is listed in table 2. Trace metal grade chemicals were used in all NMT digestions and glassware cleaning procedures. These samples were prepared with nitric-acid cleansed glassware.

Element	BRS	stdev	2709	Stdev	2709 leach	Spinach	stdev
	%		%				
Ca	2.64	0.08	1.89	0.05	1.5	1.53	0.04
Fe	3.97	0.1	3.5	0.11	3		
Mg	1.2	0.02	1.51	0.05	1.4		
K	2	0.04	2.03	0.06	0.32	2.9	0.05
Na	0.55	0.015	1.16	0.03	0.068	1.82	0.04
	mg/kg		ug/g				
Pb	150	17	18.9	0.5	13		
Mn	544	21	538	17	470	75.9	1.9
Th	9.07	0.16				0.048	0.003
As			17.7	0.8	<20	0.068	0.01
Cu			34.6	0.7	32	12.2	0.6
Se			1.57	0.08	0.014	0.12	0.01
U	3.09	0.13					
V	94.6	4	112	5	62	0.57	0.03
Zn	408	15	106	3	100	82	3

**Extractionable fractions

As and Se volatile elements and affected by gas losses. In dried soil, ~1% mass is lost.

Table 2. for Standards used in Microwave digestion and ICP-MS analysis.

Soil sample ICP-MS preparation

Soil samples were prepared following EPA standard method 3051. The oven-dried soils were split to approximately 0.2 gram and put into Teflon sample vessels. Under a fume hood, 10 ml of RO water, 8 ml of HNO_3, and 3 ml of HCl were added to the Teflon sample vessels. As each sample vessel was filled, it was capped. The twelve samples were pressurized at local atmospheric pressure, and microwaved at 210 degrees for 20 minutes. After the samples cooled to room temperature, they were filtered and diluted to 50-ml volume.

112 soil samples were processed by ICP-MS for total uranium and other elements. This includes 66 surface soils and 46 soil profiles. Including duplicate samples, approximately 170 samples were run.

Plant Sample ICP-MS preparation

Plant samples were digested following EPA method 3052. This digests 0.4 g plant sample + 5 ml H_20, 5 ml NO_3, 2 ml H_2O_2 in a pressurized vessel at 210 degrees for 20 minutes. After cooling, under a fume hood, the sample is depressurized, filtered and diluted to 50 ml volume. 171 individual plant samples from the two mine sites were prepared for the microwave digestion. Including laboratory duplicates, approximately 400 plant samples were prepared.

ICP-MS data

These samples were analyzed by an Agilent 7500i ICP-MS (Inductively Coupled Plasma-Mass Spectrometer) for total uranium concentration and other elements present.

Elements reported varied by analysis day, but included at different times Be, B, Na, Mg, Si, K, Ca, Ti, V, Cr, Mn, Co, Cu, Zn, Fe, Ni, As, Se, Sr, Mo, Ag, Cd, Sn, Sb, Ba, Hg, Ti, Pb, Th, U. This data is listed in the appendix. Including duplicates, >1000 samples were reported.

ICP-MS data was reported in ppb (ug/ L) solution. This was converted to ppm (mg/ kg) element of plant or soil matter by the calculation:

$$\frac{\text{ug reported U}}{\text{L solution}} \times \frac{\text{1 L solution}}{\text{1000 ml}} \times \frac{\text{50 ml preparation}}{\sim.2000\text{ g orig. sample}} = \textbf{ug reported uranium / g original sample}$$

For the sequential extraction and early 2003 ICP-MS analyzed samples, residual standard deviation (RSD) values were reported for all elements. The ICP-MS measures each sample multiple times, and generates an average of these measurements for the reported sample value. The residual is the sum of deviations from a best-fit curve of all ICP-MS measurements of that sample. The residual represents the variance of these repeated measurements. A high RSD could mean that the sample that the sample reported poorly on the ICP-MS. If a sample had very little uranium, any variation would be exaggerated and the RSD becomes less useful. The RSD values were also used to identify the appropriate dilution.

The final data included elements Na, Mg, Si, K, Ca, V, Mn, Fe, Cu, Zn, As, Se, Pb, Th, U, and was prepared considering the uranium concentration, the sample dilution, and the RSD value. The specific steps used for preparing this data for analysis are listed in Appendix H.

SOIL ANALYSES

The fine soil material was split for particle size, carbonate, organic carbon, pH, and uranium analyses. Between samples, the splitter was cleaned using pressurized air, a bristle brush, kimwipes, and /or Ottawa sand. For all soil analyses except pH, the soils were oven dried for 24 hours at 105° C, and split again to obtain the exact weight for the procedure. pH soil samples were split from reserve air-dried samples.

Organic carbon

Organic carbon (OC) percent was determined by loss on ignition (LOI). Oven-dried soils are heated to 400° degrees C for 2 hours. This temperature burns off the organic carbon but not inorganic carbon. The weight difference was taken as the percent organic carbon (Rone, 2001). The LOI data presented in the results assumes that the weight loss of the samples is attributable to the total amount of OC present. It is calculated by the formula:

$$\% \text{ LOI} = \frac{((\text{sample weight before (g) -tin wt)- (sample weight after (g)- tin wt))}*100}{(\text{sample weight before (g) - tin weight (g))}}$$

$CaCO_3$

The Chittick procedure was used to determine the amount of calcium carbonate in the soils (Machette, 1986). This procedure uses glacial (6N) hydrochloric acid to convert carbonate solid into carbon dioxide gas. The amount of hydrochloric acid added, and the amount of carbonate in the soil affect the amount of carbon dioxide gas generated by the procedure (figure 21). Taking into account the barometric pressure, and the volume of the generated gas, percent carbonate in the soil can be calculated: (Machette, 1986):

$$\frac{\text{wt of carbon in } CO_3 \;\; I \;\; \text{correction factor from table:} \;\; I \;\; CO_2 \text{ evolved} \;\; I}{.3866 \;\; I \;\; \text{barom. pressure v. temp} \;\; I \;\; \text{(ml)} \;\; I \;\; I \;\; \text{sample wt (g)}} = y$$

This y value was then substituted into the equation y = mx+b where m and b were taken from a line generated by four daily carbonate standards. The final value x is given as the calcium carbonate content of the soil.

The Chittick method is typically calibrated to work for samples with 3% carbonate or above. In order to allow for these low carbonate values, lower value standards (1%, 5%) were used, as well as duplicates of most S27 and some S36 samples.

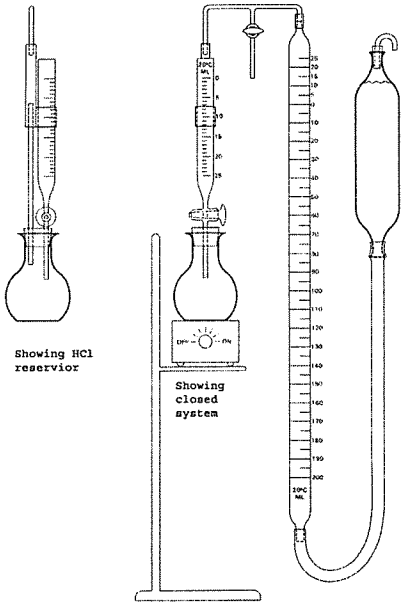


Figure 21. Chittick apparatus for measuring evolution of carbon dioxide gas from sample of soil carbonate (Machette, 1986).

Particle Size Distribution Analysis (PSDA)

Particle size was determined by removing the gravels (particles >2mm) from a sample, and then oven drying it. 20 grams of sample was added to a 250 ml Erlenmeyer

flask with 50 ml of 10% sodium pyrophosphate as a clay deflocculater. After at least 4 hours of shaking to disperse the clays, the sample was wet filtered to 63 um. The residue from this filtration was the sand fraction, which was dried and weighed. The < 63 um filtered sample was added to a 1200 ml settling tube and shaken for 45 seconds. At the appropriate settling interval, 20- 25 ml of clays in suspension were sampled at 10 cm depth, dried, and weighed. Additional clays were extracted in preparation for the clay type determination (Janitzky, 1986).

pH

Soil pH was obtained by dissolving an air-dried sample in a 1:1 reverse osmosis water solution and placing on a reciprocating shaker for 24 hours. The samples were then centrifuged and the pH of the clear liquid was taken at the Bureau of Geology's wet chemistry lab (Janitzky, 1986; SSSA, 2003).

Clay Mineralogy

Clay mineralogy was determined by x-ray diffraction analysis using a Rigaku D/Max II. Chris McKee of the NM Bureau of Geology conducted this analysis. The clay is suspended in water, then placed on a glass slide with an eyedropper, and allowed to dry. A more detailed method description is given in Appendix A. The analysis determined clay type with 10% error.

SEQUENTIAL EXTRACTION

The goal of this procedure was to identify uranium bound with different soil fractions: exchangeable, carbonate, Fe-Mn oxides, organic carbon, and residual metals (Tessler, Campbell, and Bisson, 1979). This procedure was conducted at NMSU's

Department of Agronomy & Horticulture Soil Chemistry lab, and is listed in detail in Appendix A. The procedure uses specifically targeted chemicals to extract the uranium bound to different soil fractions of the same soil sample (Ramos, 1994). For the first three steps, the chemical is added and the samples are agitated for one hour or more. The samples are then centrifuged and the supernatant is removed. Each of the first three steps is repeated to ensure the complete extraction of the associated metals. Tube, cap, and sample weights are necessary at each step to account for water and soil carryover between the tests.

The first step analyzed for exchangeable or soluble cations. 25 ml of 1 M magnesium chloride ($MgCl_2$) were added to each tube. The samples were shaken, centrifuged, and the supernatant solution poured off for uranium analysis.

Carbonate bound uranium was analyzed for next. 25 ml of 1 M sodium acetate (NaOAc; pH 5) was added to each sample. The sample was shaken and centrifuged, the pH was measured, and the supernatant fluid poured off for analysis.

In the third step, the oxide bound fraction was analyzed for with 25 ml of 0.4 M NH_2OH- HCl (in 25% acetic acid). The sample was again shaken and centrifuged, and the supernatant poured off for analysis.

The fourth fraction analyzed for the organic bound uranium. This used 5 ml of 0.1 M Nitric Acid (HNO_3), and then 1 ml of 30 % H_2O_2. These samples were left uncapped for several hours, and then another 1 ml of 30% H_20_2 was added. After effervescence ended, the sample tubes were heated in a water bath at 50° C until bubbles disappeared. At this point 20 ml of DI water was added, the sample was centrifuged, and the resulting fluid was poured off for analysis.

The last fraction looked for any residual uranium in the soil. What was left of the original soil sample was washed into an aluminum container, dried and weighed. A total soil digest procedure was conducted that mirrored the above microwave soil digestion for ICP-MS analysis. All of these samples were then diluted 1:5 and run for uranium content on the NM Tech ICP-MS.

STATISTICS

This study aims to identify new uranium accumulating plants, and to identify the effects of semi-arid soils on uranium uptake in plants. Previous parts of this methods section identified land use type, soil uranium content, soil pH, texture, and OC and $CaCO_3$ content as well as plant uranium content as potentially important variables. Relationships between these variables can be meaningfully tested using correlation and linear regression.

CORRELATION ANALYSIS

Correlation assigns a number approaching 1 as the degree of linear relationship increases between two variables (Ramsey, Schafer, 2002). It does not identify independent or dependent variables. A correlation matrix can quickly be generated from a table of data, looking at every combination and identifying significant ones for further consideration. However, correlation analysis cannot account for nonlinear relationships, such as $y = x^2$.

In this study the final data included 15 elements and 7 soil properties. Correlation was used as a summary measure to suggest relationships between variables. At both

mine sites, pH, organic carbon, silt, clay, and land use have normally distributed data sets. Gravels, clay, and uranium data are skewed towards low numbers. In order to create a numerical relationship, land use types were ranked with respect to disturbance:

undisturbed	1
lowland/drainage	2
disturbed plain	3
waste pile	4

Correlation relationships are then further tested with regression analysis. The relationship between soil properties and uranium was tested in this way.

REGRESSION ANALYSIS

Regression analysis describes the distribution of values of one variable (the *response*) as a function of other *explanatory* variables (Ramsey, Schaefer, 2002). It defines a linear relationship where one variable is dependent upon, and can be predicted by other independent variables. Regressions can support inference about nonrandom relationships. It is a useful way of summarizing a relationship between variables that may be suggested but not conclusively obvious from a scatterplot of the data.

The significance of regression relationships is tested by the p-value and the r-squared value. The p-value tests the equation's ability to accurately account for all given data. The r-squared value is very useful for interpretation of regression equations. It quantifies the degree of variation of the response variable (for example, U) that can be predicted by the explanatory variables (for example, clay content and organic carbon). For example, the r-square value of an equation U = 2.3 + 0.79 OC - .33 clay % is 53 %. This suggests that 53% of the uranium concentration is explained by, or affected by, the soil organic carbon and soil clay content, taken together.

Simple regression looks at the influence of a single explanatory variable. Multiple regression models the response variable as a function of several explanatory variables (Ramsey, Schaefer, 2002). A 'Best Subsets' regression can be generated from multiple variables. This shows different combinations of explanatory variables as predictive equations of the same response variable, and each equation's significance and explanatory effectiveness. In a stepwise regression, the operator sets the variables to be considered. The program Minitab then determines which of the designated explanatory variables are significant, and generates an equation with the response variable.

Multiple regressions are used here to model relationships between the soil properties of interest (uranium concentration, depth, land use type) and other soil properties. Predictive equations (soil properties predicting uranium value) were then generated in the format **y = b + mx1 + mx2 + ...,** where **y** is the dependent variable. The dependent variable is the outcome to be explained in these regression analyses. Any change in the dependent variable is viewed as a function of changes in the independent variable.

RESULTS

LAND USE TYPES

LAND USE MAPS

Land use types were mapped in the field at the two major sampling locations. These maps were used to test the differences in soil properties and uranium distribution. The Section 27 sampling area covered a range of 2-8 points in each land use area, while the Section 36 grid sampling area covered 3-16 points in each land use area (Table 3).

Section	Undisturbed	Lowland	Disturbed plain	Waste pile	TOTAL
27	8	2	8	7	**25**
36	16	16	3	4	**36**

Table 3. Sampling Points by Land Use type

Figure 22 shows a view from atop the S27 waste pile looking east, viewing disturbed plain and unsurveyed, undisturbed land. Figures 23 and 24 show two land use areas of S36; the lowland area and the waste pile, as well as their soil profiles. The following figures (figures 25 and 26) map out the S27 and S36 land use types. First the

following figures (figures 25 and 26) map out the S27 and S36 land use types. First the land use types are presented, and in Figures 25b and 26b the land use types are overlain on aerial photographs.

Figure 22. Waste pile and undisturbed area, looking west, S27.

Stars on figures 25 and 26 show the sampling points overlain on the grid pattern and the aerial photographs of each sampling site. These photos (figures 25b, 26b) show the higher vegetation and less bare ground of the lowland land areas, and the slightly lighter undisturbed areas. The waste pile and disturbed plain land use area have more bare ground and lower percent vegetation cover. On Figure 25b, showing Section 27, the difference between the disturbed plains and waste piles versus the lowland and undisturbed areas is shown in the darker color of the latter areas. On Figure 26b,

showing Section 36, the differences between land use types are less obvious on the aerial photos. The lowland area still has more vegetation and ground surface cover, resulting in a darker photo of that area. The waste pile, current road through the area, and current Uranium milling operations to the east of the photo all have less vegetative cover and thus more albedo on the aerial photo.

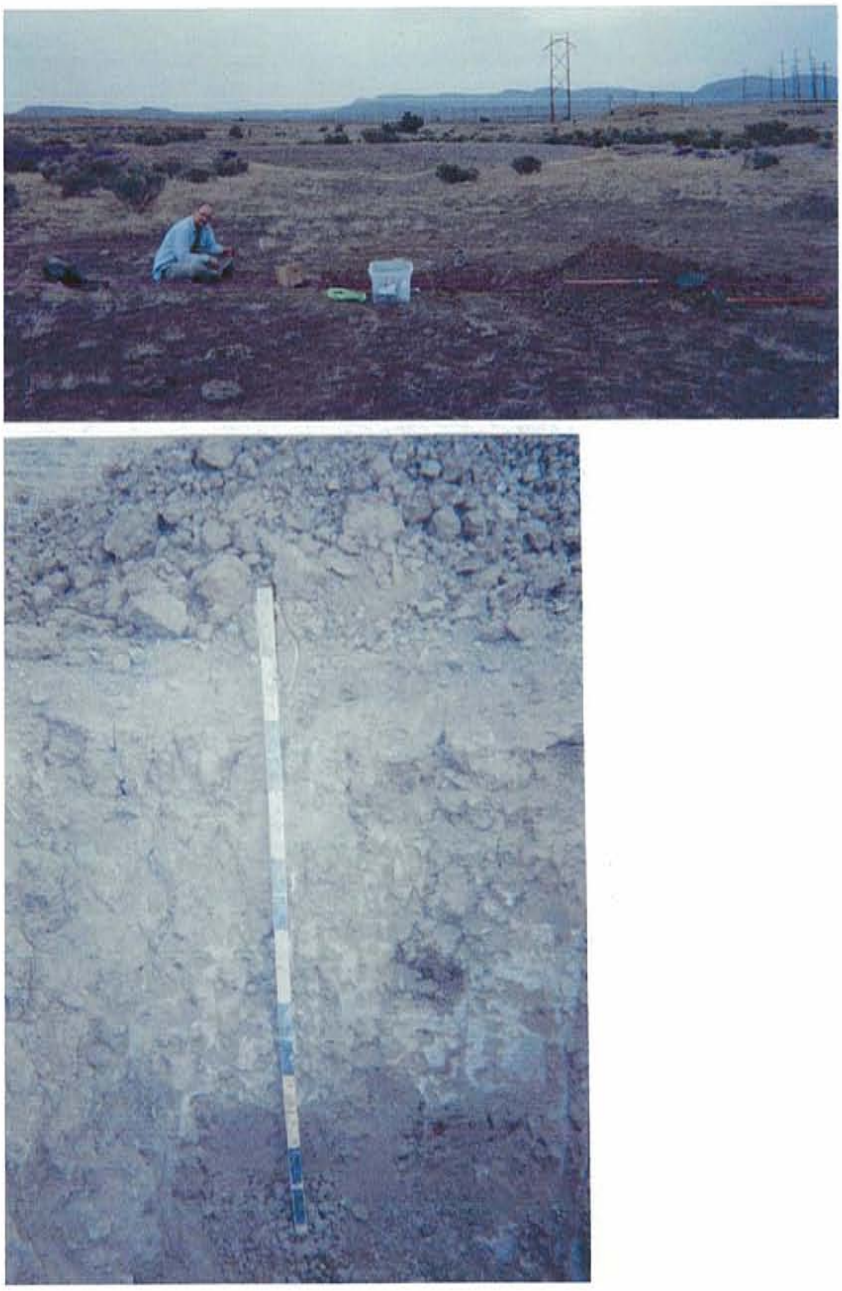


Figure 23. S36 northern end of lowland area and lowland soil profile.

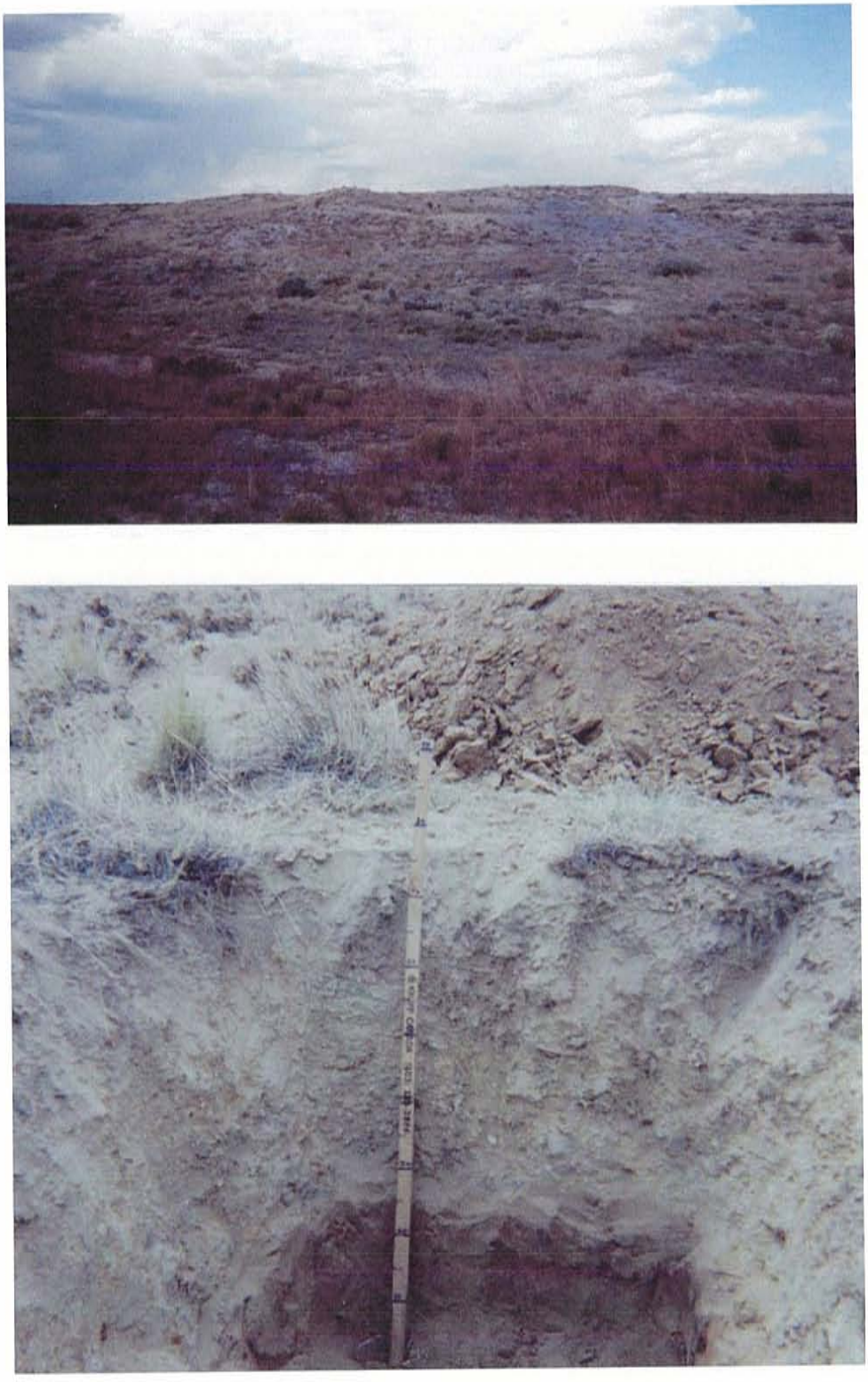
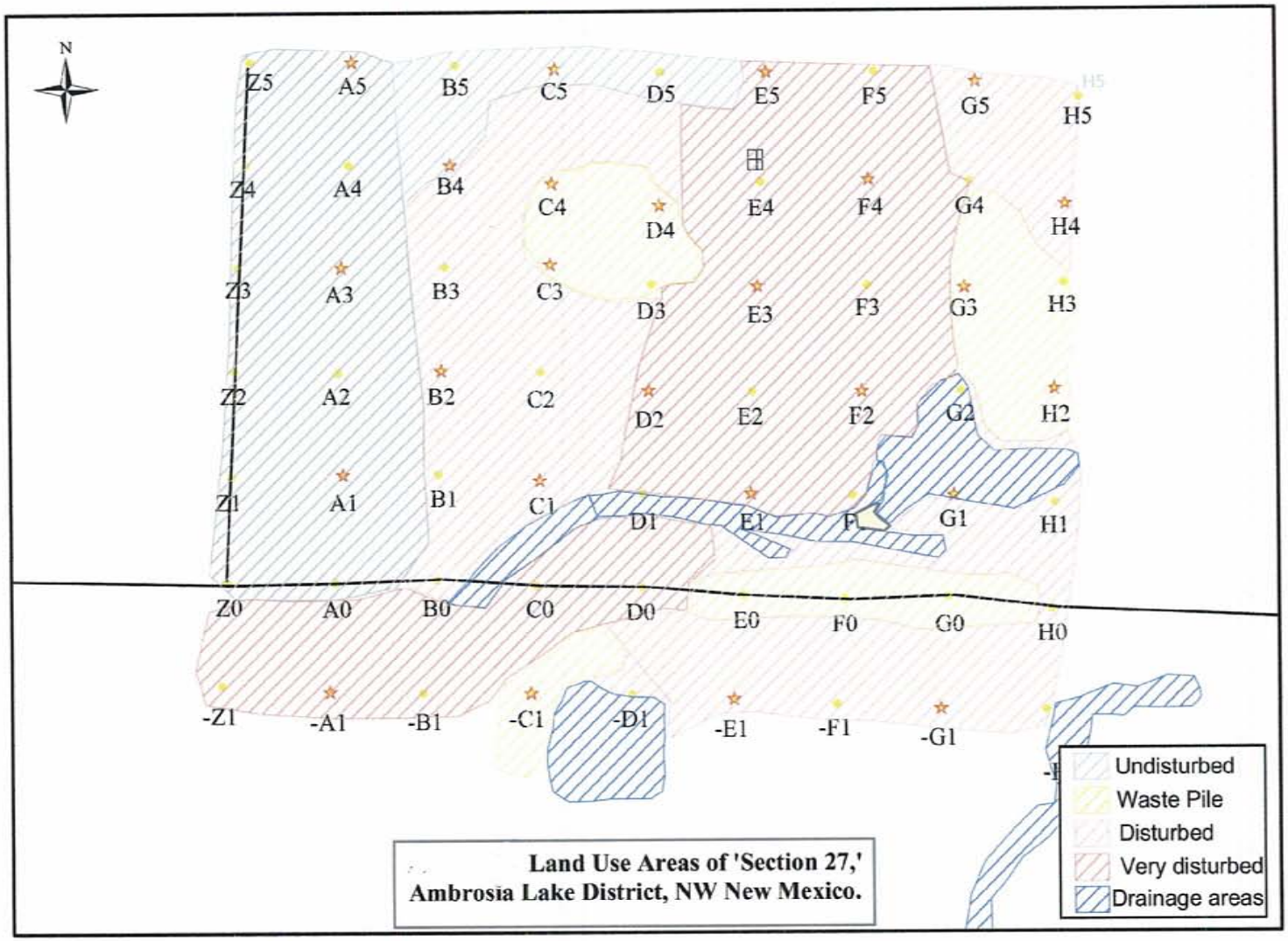


Figure 24. S36 Waste pile and soil profile.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-B1
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-D1
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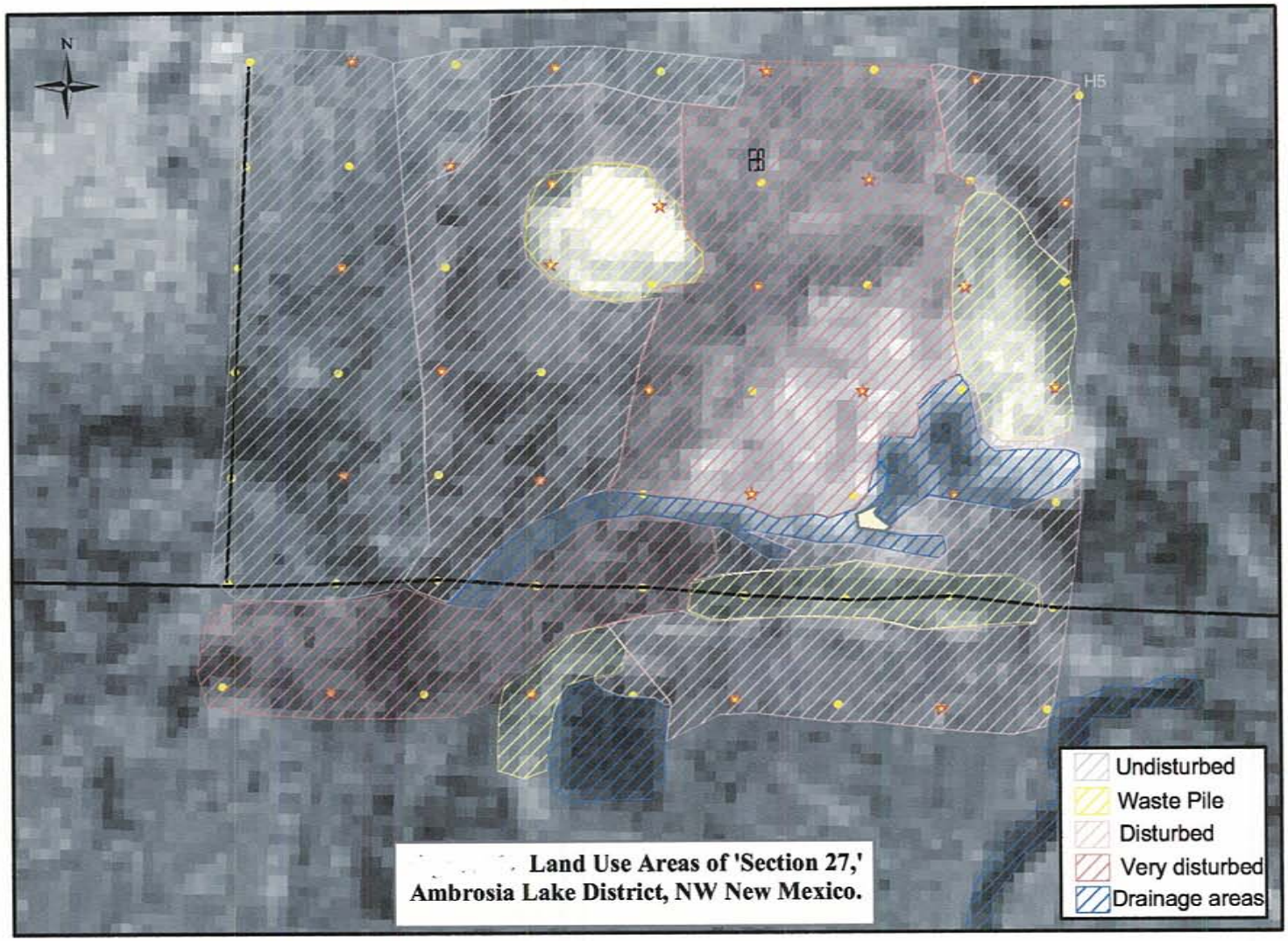
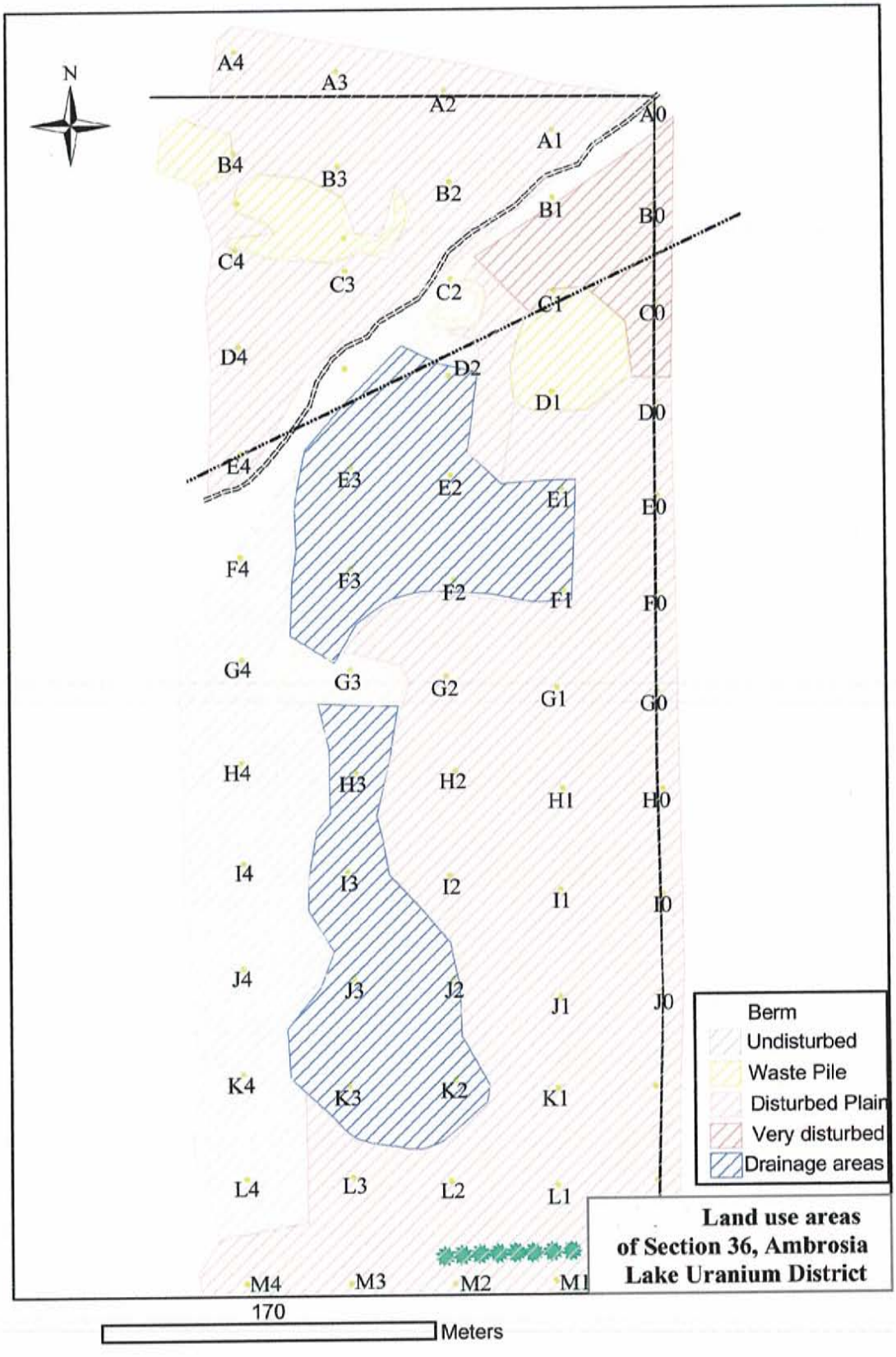
-G1
Undisturbed
Waste Pile
Disturbed
Very disturbed
Drainage areas
Land Use Areas of 'Section 27,'
Ambrosia Lake District, NW New Mexico.



Land Use Areas of 'Section 27,'
Ambrosia Lake District, NW New Mexico.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M4
M3
M2
M1
Berm
Undisturbed
Waste Pile
Disturbed Plain
Very disturbed
Drainage areas
Land use areas of Section 36, Ambrosia Lake Uranium District
170
Meters

At Section 36, the presence of kaolinite suggests a highly weathered environment; however the presence of illite and mixed layered clays at this site also documents some resistant material (Birkeland, 1999). While the soils here have in general less kaolinite than S27, there is almost no smectite, meaning that the CEC is greatly reduced. Because both sites contain clay minerals with low CEC, other methods of uranyl sorption, such as organic matter, may take on increased relative importance in the soil.

Section 36 Surface	Illite	Kaolinite	Smectite	Mixed Layered Clays
Drainage	25	75	negl	Negl
Disturbed Plain	25	75	negl	Negl
Waste Pile	~2.5	80	~2.5	~15

Table 6. Section 36 Surface clay mineralogy, estimated at 10% per Chris McKee and duplicate samples.

pH

Soil pH varied very little at either site, S27 or S36. The range of pH values at S27 was ~7.6-8.1. The range of pH values at S36 was ~ 7.4-8.0. At both locations, the undisturbed land use areas (marginally) had the highest pH. The drainage areas at both locations were relatively intermediate, and the disturbed plain and waste pile locations had the lowest pHs. All of the average pH values between land use types had standard deviations large enough to suggest that there is no significant variation between land use type (figure 30).

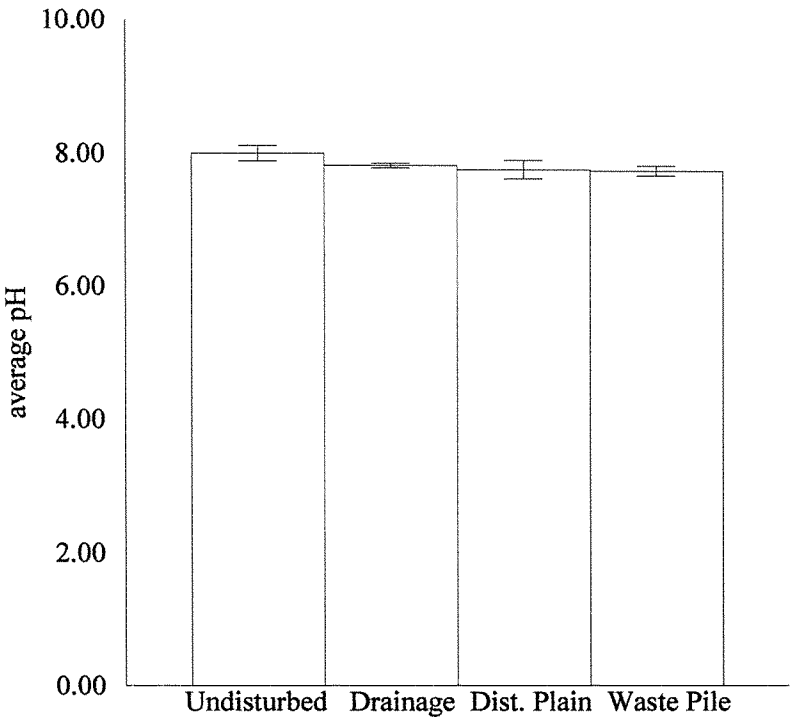

Figure 30a. S27 0-5 cm soil pH, averaged by Land Use type

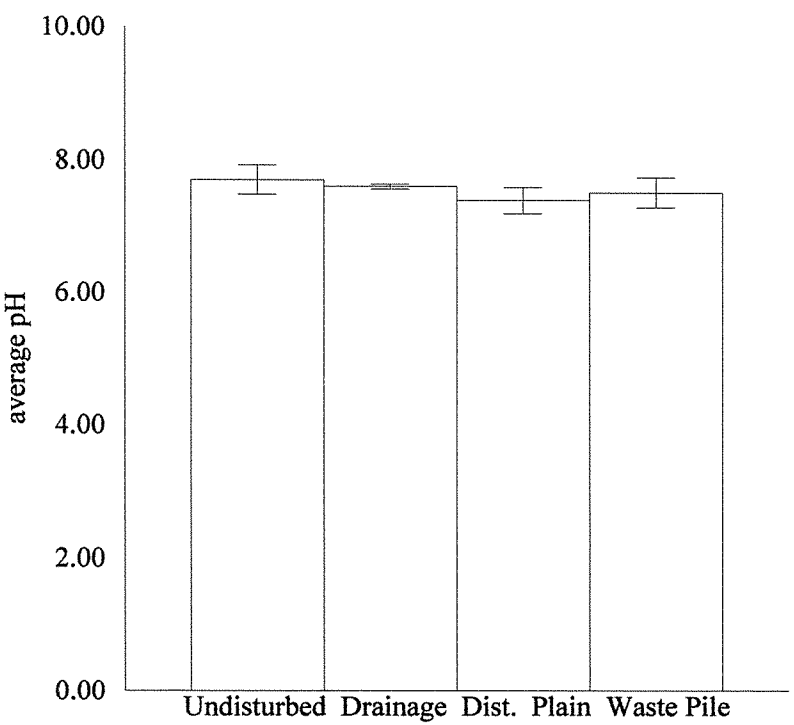

Figure 30b. S36 surface soil pH, averaged by Land Use type

Surface Soil Uranium Samples

S27

Very little difference can be seen in the surface soil uranium values of the undisturbed, drainage, and waste pile land use areas. Average surface soil uranium differentiated the disturbed plain by 120 ppm. However, this large difference was captured in 25% (2) of the sample points in the disturbed plain area (8 total). The only difference of these two point is in their uranium value (Figure 31a). However, the variability of the uranium concentration of the disturbed plain land use type can be seen in its' low average value when those two points are excluded:

	All S27 surface pts		S27 surface excl. F2, D4	
Land Use	U avg	U stdev	U avg	U stdev
Undisturbed	61.37	*62.6*		
Drainage	73.77	*92.88*		
Dist Plain	253.12	*393.43*	31.73	*26.08*
Waste Pile	78.71	*59.66*		

Table 7. S27 Surface soil uranium value, averaged by land use type.

S36

Overall surface soil uranium content was much lower than section 27 in section 36. While S27 did not have obvious differences between the land use types in surface soil uranium content, in S36 the undisturbed and drainage soils have soil uranium content more than one standard deviation lower than the soil uranium content of the disturbed plain and waste pile surface soils. All of this uranium content is very low, below 15 ppm (figure 31b).

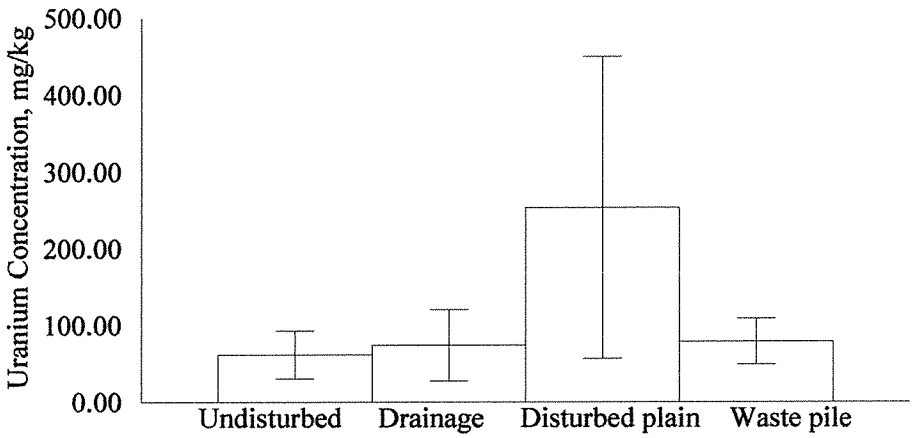

Figure 31a. S27 0-5 cm soil Uranium averaged by Land Use

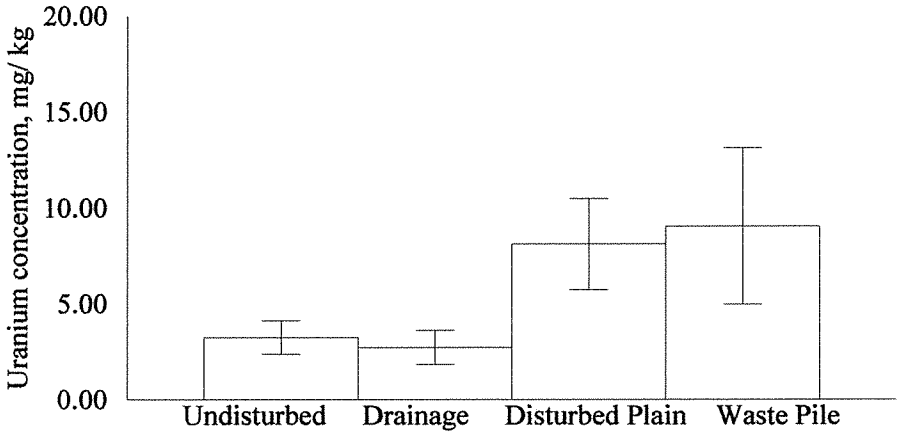

Figure 31b. S36 0-5 cm soil Uranium averaged by Land Use

Surface Soil Uranium measurement

Surface soil uranium concentrations were originally measured with a gamma ray meter. These measurements helped define the uranium concentrations in the field, and varied from 0~1500 uRem/ hr. Surface soil uranium concentrations by ICP-MS analysis varied from 0-1050 ppm. These uranium concentrations did not correlate in all cases with the gamma ray readings, primarily at the S36 site, which only had high gamma ray readings on top of the waste pile, and nowhere else. The waste pile soil profile later had a ICP-MS uranium concentration of 47.6 ppm. The surface soil uranium (ppm) at S36 shows high uranium readings at 3 locations (approximately 20 ppm).

Uranium is primarily mined for the low-concentration isotope U-238. This isotope is the main source of gamma rays. U-235 and U-234 constitute ~95% of naturally occurring uranium ore. They do not emit gamma rays. For this reason concentrations of uranium -235, and U-234 in the soil may not be accurately measured by a gamma ray meter. All uranium isotopes are important targets for soil remediation. The S36 waste pile may have had more mine tailings and U-238, which is why it had a high gamma ray reading. Less disturbed locations that may have been contaminated by windblown dust from an adjacent processing facility did not have elevated gamma ray readings, perhaps because the soil contained different relative concentrations of uranium isotopes. This could have been caused by wind-blown uranium dust, possibly from the nearby processing facility. Because of these concerns, the ICP-MS uranium concentration information is used when analyzing the surface contours of uranium concentrations for both the S27 and the S36 study sites.

Contour maps of the ICP-MS uranium values were made to further examine the surface distribution of uranium. These contour maps, in both locations, did not help to distinguish between the four land use types. For simplicity, the contour maps of uranium concentration are presented here without additional overlays. Both contour maps are oriented north in the upper left-hand corner, and are plotted using the same 50-m separated grid points as figures 25 and 26.

At S27, the disturbed plain is in the west-central and southeast portions of the grid. The undisturbed area is around the edges of the grid, and the waste piles also in the west-central and southeast portions of the grid. Considering this land use information, the S27 contours on figure 32 can help distinguish the disturbed plain land use type and not the three other types.

At S36, the central portion of the grid is drainage area. Disturbed plain is primarily in the northern part of the grid, with the waste pile central in the northern grid. The undisturbed portion is along the west side of the study area. In the S36 contour map, the contours do not match closely to any land use type (Figure 33).

Please Note
contour MAPS are
omitted ... Newer surfer
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SOIL PROFILE ANALYSES

Organic matter

S27

The S27 soil profiles varied by land use type in their organic carbon content. The undisturbed soil had 3-4% organic carbon, which did not change significantly with depth (figure 34). The disturbed plain and waste pile profiles had less than 1% organic carbon throughout their soil profiles.

S36

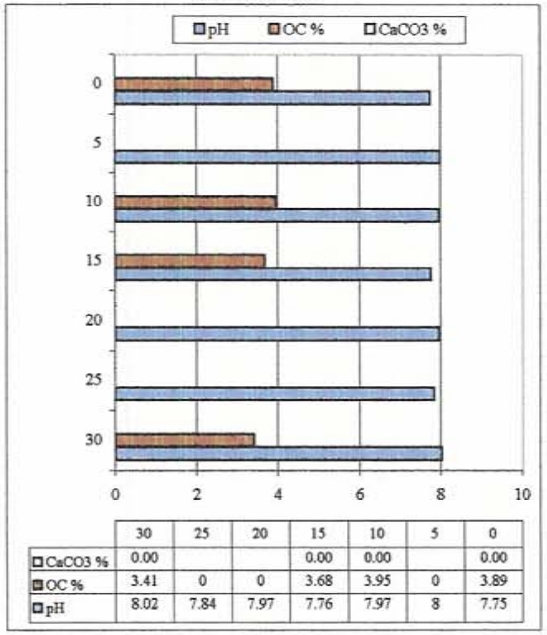
The S36 soil profiles varied by land use type in their organic carbon content. Here, in contrast to S27, the undisturbed profile had the least organic carbon, 2% or less throughout the profile (figure 35). In the drainage land use type soil profile, OC was very high at the top of the profile (8%) and decreased to 3.7 % at 70 cm. The waste pile land use type soil profile had organic carbon increase with depth to 3% at 70 cm. In the top 30 cm the waste pile profile had < 2% organic carbon. Study area S36 could have had more water available to develop the drainage land use type soil profile. The waste pile soil profile organic carbon at depth is probably affected by the tailings layers at 60-70 cm.

Calcium Carbonate

S27

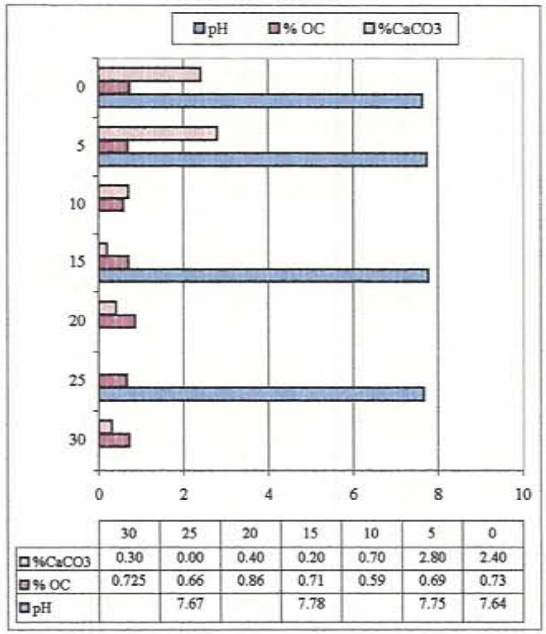
The S27 soil profiles contained very little carbonate. The disturbed plain had up to 2.8% in the surface layers. However, because the overall content of these profiles was so small, there are no significant differences between the profiles (figure 34).

Undisturbed



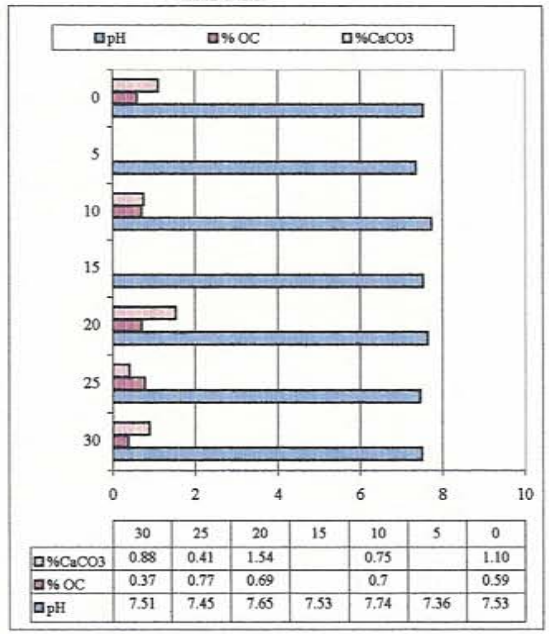
	30	25	20	15	10	5	0
CaCO3 %	0.00			0.00	0.00		0.00
OC %	3.41	0	0	3.68	3.95	0	3.89
pH	8.02	7.84	7.97	7.76	7.97	8	7.75

Disturbed Plain



	30	25	20	15	10	5	0
%CaCO3	0.30	0.00	0.40	0.20	0.70	2.80	2.40
% OC	0.725	0.66	0.86	0.71	0.59	0.69	0.73
pH		7.67		7.78		7.75	7.64

Waste Pile



	30	25	20	15	10	5	0
%CaCO3	0.88	0.41	1.54		0.75		1.10
% OC	0.37	0.77	0.69		0.7		0.59
pH	7.51	7.45	7.65	7.53	7.74	7.36	7.53

S36

The S36 soil profiles contained up to 3.3% calcium carbonate (figure 35). This is also very little carbonate, although it is slightly higher than the carbonate at S27. The undisturbed profiles had carbonate above 3% in the bottom three layers. These depths were not sampled at S27. This suggests a small amount of soil development at both sites. Again, these carbonate contents are very small and it is difficult to draw major conclusions from these minor variations in carbonate content.

pH

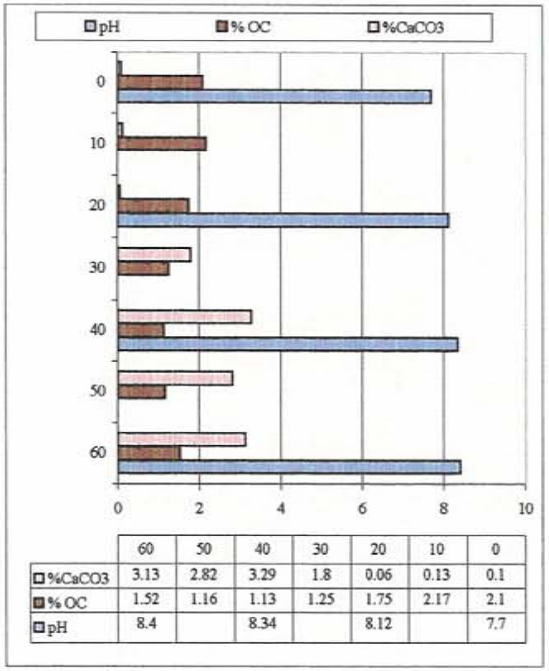
S27

The pH content of the S27 soil profiles also had very slight differences between the land use types' soil profiles (figure 32). The undisturbed profile had 4/7 samples near pH 8; the disturbed plain had an average pH 7.7; and the waste pile soil profile had 6/7 samples near pH 7.5. The small variations in pH are probably due to the relative soil development and parent material differences of these three soil profiles. In this case, the undisturbed soil would be slightly more developed, as its pH is slightly higher and the soil profile has been left under stable condition for a longer period of time.

S36

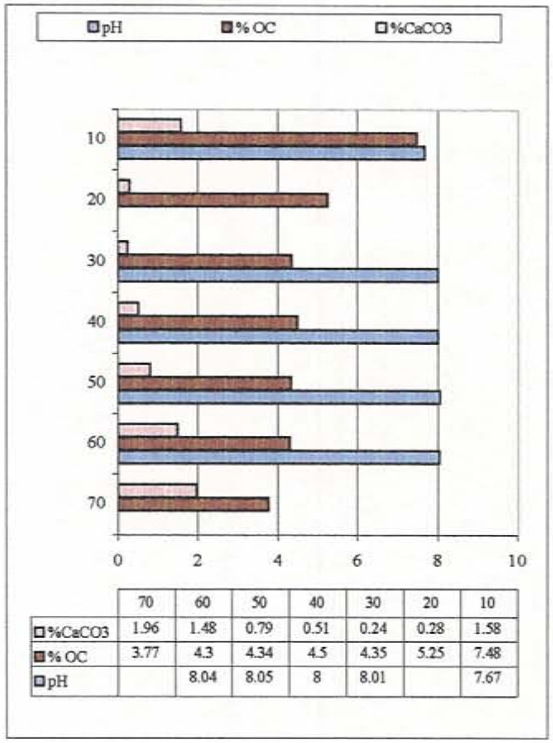
The pH content of the S36 soil profiles had very minor variations, similar to the S27 soil profile pHs (figure 33). However, the S36 pH variations also had the same slight decreasing-with-disturbance trend as the S27 soil profiles. The S36 undisturbed soil profile pH increased with depth to pH 8.4 at 60 cm. The S36 drainage soil profile had pH 8 with the 30-60 cm soils. The S36 waste pile soil profile had very low pHs at 35-60 cm

Undisturbed



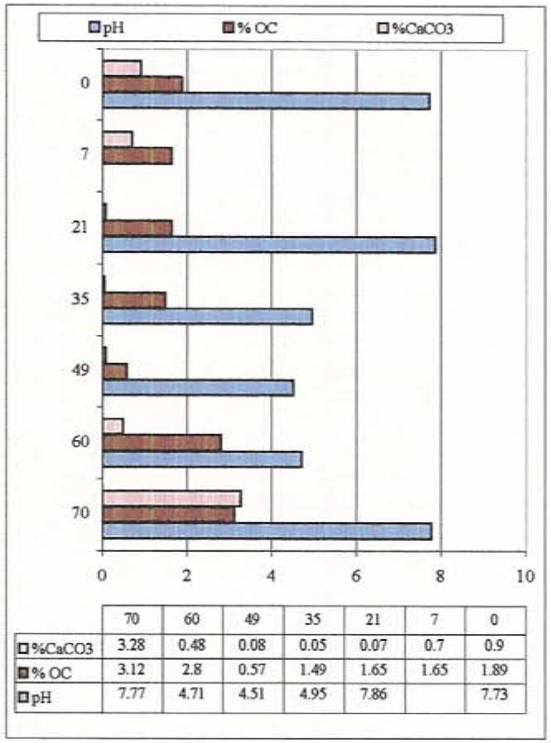
	60	50	40	30	20	10	0
%CaCO3	3.13	2.82	3.29	1.8	0.06	0.13	0.1
% OC	1.52	1.16	1.13	1.25	1.75	2.17	2.1
pH	8.4		8.34		8.12		7.7

Drainage



	70	60	50	40	30	20	10
%CaCO3	1.96	1.48	0.79	0.51	0.24	0.28	1.58
% OC	3.77	4.3	4.34	4.5	4.35	5.25	7.48
pH		8.04	8.05	8	8.01		7.67

Waste Pile



	70	60	49	35	21	7	0
%CaCO3	3.28	0.48	0.08	0.05	0.07	0.7	0.9
% OC	3.12	2.8	0.57	1.49	1.65	1.65	1.89
pH	7.77	4.71	4.51	4.95	7.86		7.73

(pH 4.5-5). This is probably due to the buried tailings layer at 60 cm depth in the S36 waste pile. The slight increasing-with-disturbance trend in pH probably also reflects the relative age of these soils. The undisturbed is the oldest, the drainage soil profile younger, and the waste pile definitely less than 100 years old.

Particle Size Distribution Analysis

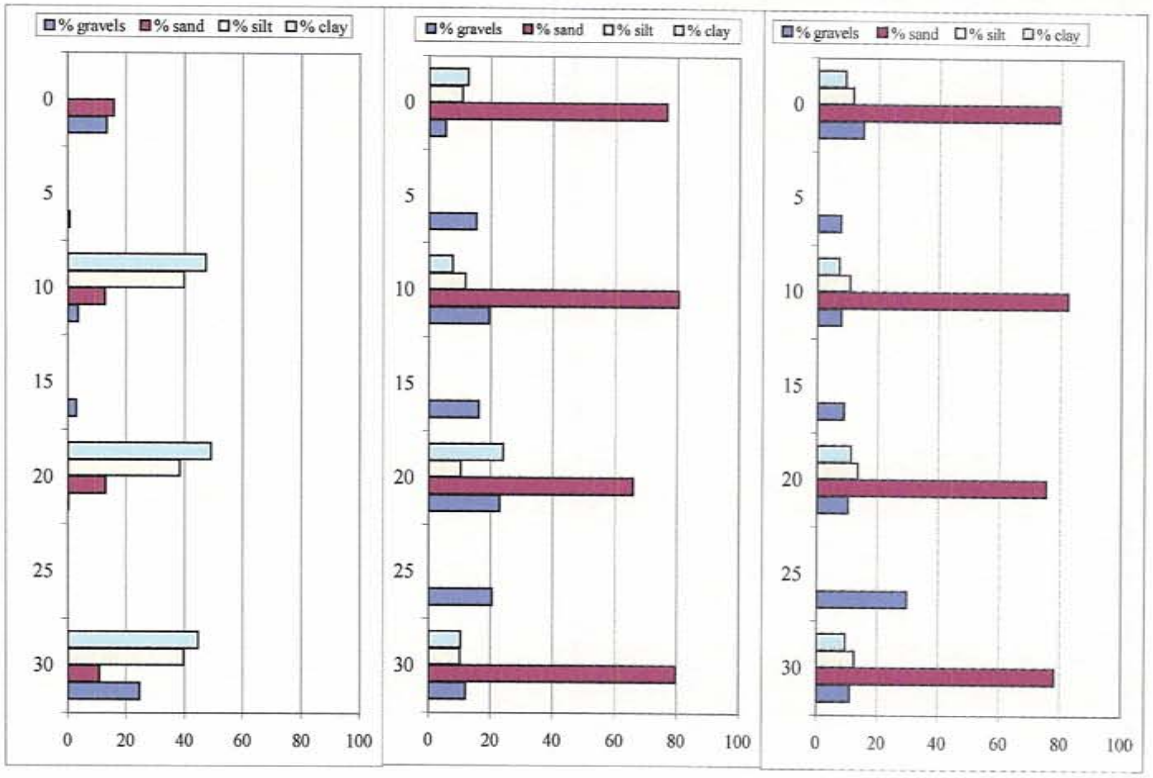
S27

At S27, the undisturbed soil profile is distinct from the other two soil profiles (figure 36). The disturbed plain and waste pile soil profiles are defined by their high sand content (approximately 80% sand). This sand is most likely a byproduct of mining the uranium from a sandstone ore. The undisturbed profile has almost equal amounts of silt and clay (38- 48% each) and less than 20% sand. Clay and silt presence in the undisturbed profile show the effects of weathering and eolian transport on the undisturbed soil profile development.

S36

The S36 soil profile particle size values vary between land use types (figure 37). The drainage soil profile texture is very different from the undisturbed and waste pile soil profiles' soil textures. While the waste pile and undisturbed soil are predominated by sand (55-87%), the drainage soil profile has 33-79% silt. The waste pile also has significant amounts of clay that increase with depth. The difference between the undisturbed and drainage soils could be attributed to the variability of soil formation across a landscape (catena), and the effects of soil formation in a small natural drainage with additional water.

Land Use	Undisturbed				Disturbed Plain				Waste Pile			
depth	Gravel	Sand	Silt	Clay	Gravel	Sand	Silt	Clay	Gravel	Sand	Silt	Clay
0	13.38	15.84	---	---	5.26	76.57	10.78	12.65	14.96	79.5	11.6	8.93
5	0.57				15.25				7.47			
10	3.59	12.75	39.75	47.3	19.24	80.49	11.8	7.71	7.83	82.3	10.61	7.09
15	2.75				16				8.76			
20	0.27	12.95	38.31	48.94	22.77	65.9	10.27	23.84	10.24	75.45	13.36	11.19
25	0				20.3				29.61			
30	24.56	10.83	39.63	44.53	11.93	79.62	10.1	10.28	10.93	78.06	12.41	9.53



The uppermost part of the soil horizons of the undisturbed and waste pile soil profiles appear very similar in texture. However, this similarity of the waste pile and undisturbed profiles does not continue at depth. The waste pile has a well defined, deep red-brown, fine-grained and high uranium layer at 60 cm depth. This is probably buried mine tailings. At this depth, the waste pile soil profile's sand content drops >37%, and the gravel content increases 4%. The undisturbed layer reduces its sand content by approximately 17% at 60 cm depth, which does not match the change in the waste pile soil profile at that depth.

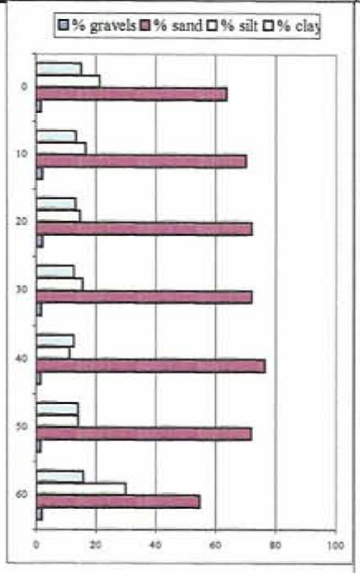
It is possible that the shallow soil horizons of the waste pile are composed of surface soils removed from an adjacent area, and used to bury the tailings layer. This could help explain some of the similarities in texture between the undisturbed and waste pile soil profiles at S36.

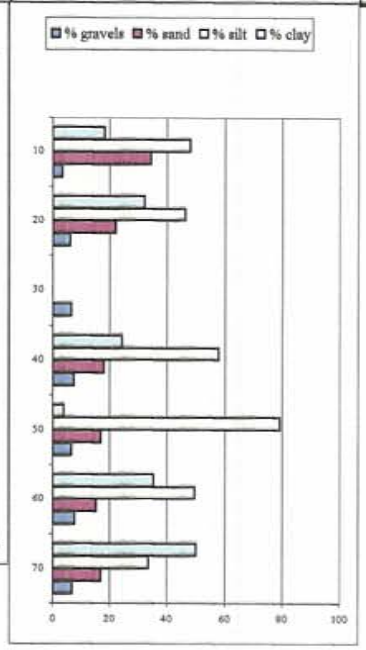
Clay Mineralogy

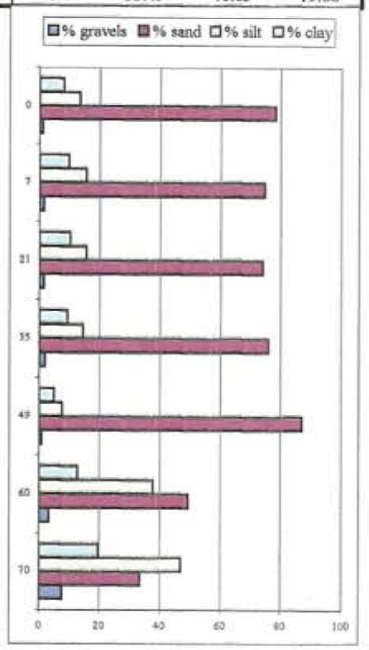
S27

At S27, the disturbed plain soil profile was selected for clay mineralogy analysis based on its high uranium content (figure 38). This profile contains mainly kaolinite, at the surface and at 30 cm depth. For a < 40 ya soil, it is very weathered. There is slightly more weathering with a small smectite increase at 30 cm depth.

Land Use	Undisturbed				Drainage					Waste Pile			
depth	Gravel	Sand	Silt	Clay	Gravel	Sand	Silt	Clay	WP depth	Gravel	Sand	Silt	Clay
0	1.63	63.57	21.33	15.1	---	---	---	---	0	1.1	78.2	13.63	8.17
10	2.23	69.95	16.55	13.51	3.41	34.06	47.79	18.15	7	1.48	74.53	15.62	9.85
20	2.17	72	14.78	13.22	5.94	21.92	46.19	31.89	21	1.53	74	15.65	10.35
30	1.79	71.95	15.47	12.58	6.38	---	---	---	35	1.86	75.85	14.68	9.47
40	1.46	76.44	11.04	12.52	7.41	17.95	57.85	24.2					
50	1.53	71.76	14.09	14.14	6.33	16.96	79.18	3.86	50	0.79	87.13	7.92	4.95
60	1.96	54.59	29.74	15.67	7.53	15.37	49.4	35.23	60	3.08	49.41	37.68	12.91
70					6.55	16.81	33.21	49.98	70	7.77	33.49	46.83	19.68







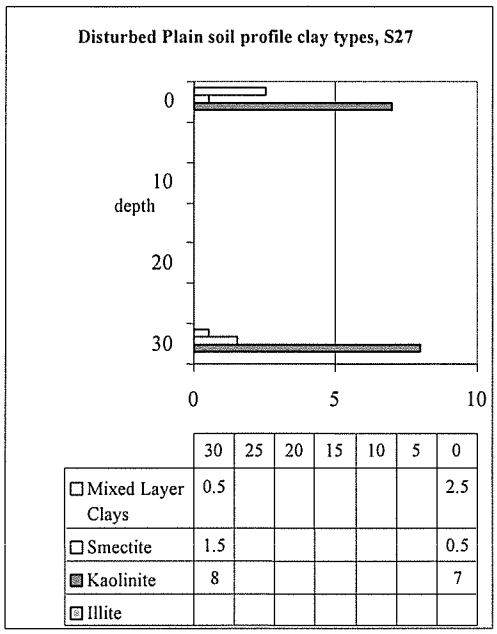


Figure 38. Clay Mineralogy of the S27 Disturbed plain soil profile.

S36

The S36 waste pile soil profile was selected for clay mineralogy analysis based on its relatively high uranium content. The clay mineralogy of this soil profile is predominantly kaolinite (Figure 39). There is a slight increase in illite, a 2:1 layer clay,

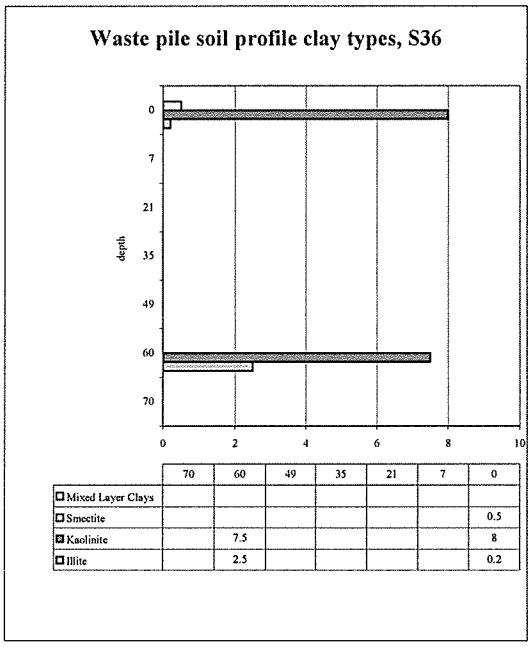


Figure 39. Clay mineralogy of the S36 Waste Pile soil profile.

at 60 cm depth. This corresponds with a marked increase of uranium (200 ppm) at this depth.

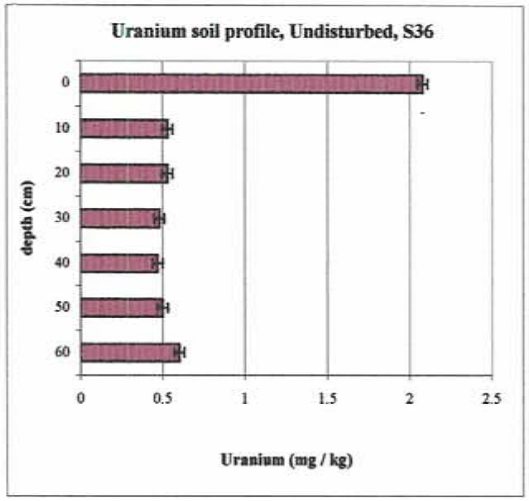
Soil profile uranium data

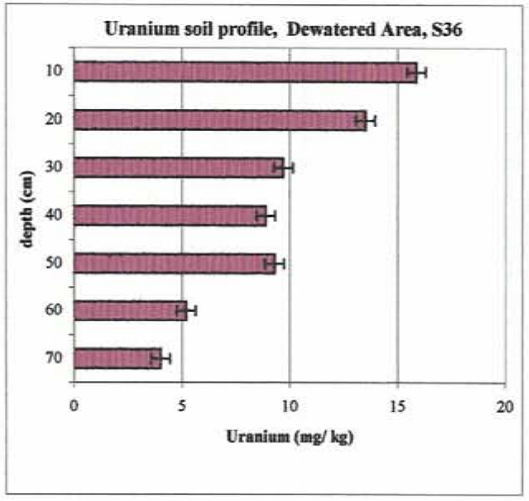
S27

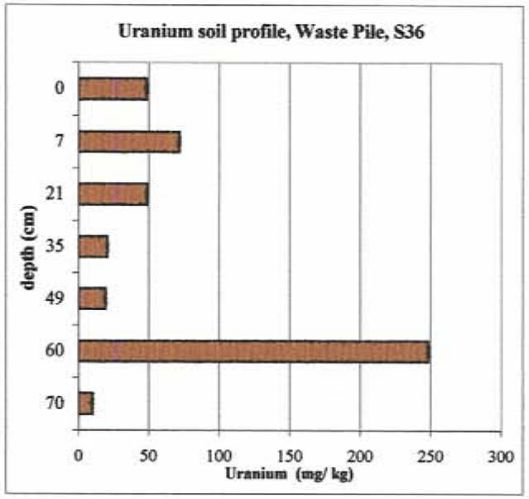
The S27 soil profile uranium content varies in magnitude between the different land use area soil profiles (figure 40). While there is no clear trend of uranium with depth, each of the land use types can be identified based on the magnitude of the uranium content in each profile. The S27 undisturbed soil profile contains uranium from 2-6 ppm. The S27 disturbed plain soil profile contains uranium from 200-500 ppm, with one sample containing 1200 ppm uranium. The S27 waste pile soil profile contains uranium from 28-80 ppm, making it intermediate and distinguishable from the other two soil profiles.

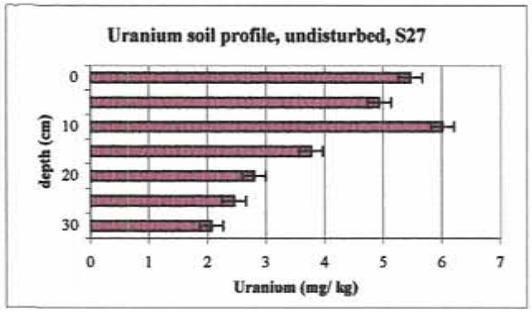
S36

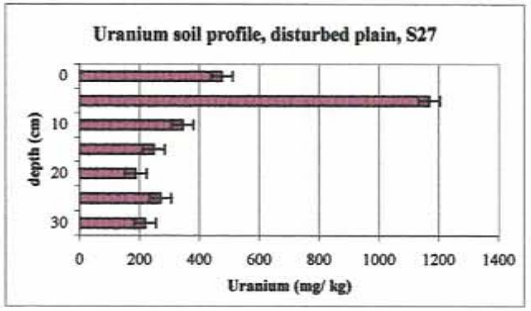
The same definition of land use types based on average uranium content in the soil profile is possible at S36. There are no clear trends of uranium with depth; however, the total uranium content of the land use types varies as shown by the soil profiles (figure 41). The S36 undisturbed soil profile contains from 0.5- 2 ppm uranium. The S36 drainage soil profile contains from 4-16 ppm uranium, and the S36 waste pile soil profile contains 15-70 ppm uranium, with the 60 cm sample containing 250 ppm uranium. The uranium concentration differences between each land use types' soil profile make it possible to distinguish land use type based on soil profile uranium content.

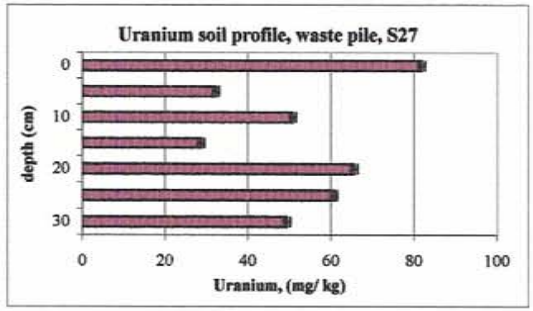

Uranium soil profile, Undisturbed, S36
depth (cm)
0
10
20
30
40
50
60
0
0.5
1
1.5
2
2.5
Uranium (mg / kg)


Uranium soil profile, Dewatered Area, S36
depth (cm)
10
20
30
40
50
60
70
0
5
10
15
20
Uranium (mg/ kg)


Uranium soil profile, Waste Pile, S36
depth (cm)
0
7
21
35
49
60
70
0
50
100
150
200
250
300
Uranium (mg/ kg)


Uranium soil profile, undisturbed, S27
depth (cm)
0
10
20
30
0
1
2
3
4
5
6
7
Uranium (mg/ kg)


Uranium soil profile, disturbed plain, S27
depth (cm)
0
10
20
30
0
200
400
600
800
1000
1200
1400
Uranium (mg/ kg)


Uranium soil profile, waste pile, S27
depth (cm)
0
10
20
30
0
20
40
60
80
100
Uranium, (mg/ kg)

SEQUENTIAL EXTRACTION

'Surface' soil and soil profile samples were selected for Sequential extraction analysis based on the ICP-MS uranium content and field location. The samples' identifying information is listed in table 8. Because of high uranium values, the disturbed plain soil profile for S27 and S36 were selected.

Site	Sample	Land Use	U (ppm)	%gravels	% OC	% CaCO3
27	0 cm	disturbed plain	527.35	5.3	0.7	2.4
27	10 cm	disturbed plain	344.9	19.2	0.6	0.7
27	20 cm	disturbed plain	187.7	22.8	0.9	0.4
27	30 cm	disturbed plain	218.8	11.9	0.75	0.3
27	C1	lowland	174.4	3.3	1.1	0.35
27	G1	lowland	139.5	2.3	0.6	1.3
27	D2	disturbed plain	621.9	5.7	1.5	0
27	F2	disturbed plain	1040.45	2.2	0.4	0
36	0 cm	Waste pile	7	1.1	1.89	0.86
36	21 cm	Waste pile	3.39	1.53	1.65	0.07
36	49 cm	Waste pile	0.53	0.79	0.57	0.08
36	60 cm	Waste pile	6.21	3.08	2.80	0.48
36	B1	Waste pile	1.39	n/avail	1.58	1.54
36	H3	Lowland	16.72	n/avail	5.47	1.20

Table 8. Background information on selected samples for Sequential Extraction.

The sequential extraction information reported uranium values somewhat different from those listed in table 8. After dilutions and blanks were taken into account, the data is reported below in terms of a ratio of each uranium value to the others. This relationship emphasizes the role of the calcium carbonate soil fraction in binding uranium. In general, the organic fraction was the second most important source of uranium, with the exchangeable fraction binding more uranium at depth.

	average	average	average	average	average
	Exchangeable	Carbonate	Oxide	Organic	Residual
	F1 %	F2 %	F3 %	F4 %	F5 %
27-2-0	2.88	80.29	3.38	12.91	0.55
	0.17	*4.95*	*0.59*	*4.49*	*0.04*
27-2-10	5.36	74.41	5.97	13.66	0.60
27-2-20	22.51	47.90	8.42	20.05	1.12
27-2-30	14.57	42.03	10.18	31.72	1.50
36-1-0	4.12	52.33	21.04	21.84	0.67
36-1-21	6.68	65.17	15.19	11.73	1.23
36-1-42	29.72	45.11	11.48	12.60	1.09
36-1-60	54.29	35.53	5.22	4.72	0.24
27+C1	10.44	46.34	11.82	30.12	1.28
27 + D2	13.46	51.05	13.16	20.02	2.31
	0.39	*1.28*	*1.69*	*3.37*	*0.01*
27+G1	3.64	67.27	5.82	21.74	1.53

Table 9. Percent uranium for each Sequential Extraction fraction.

It is not intuitively obvious that the carbonate fraction of these soils, which is such a minor part of these soils, would be the major source of uranium bonds in these soils. At high pHs uranyl carbonates are more easily formed; and < 3% total $CaCO_3$ in the soil is still enough carbonate to bind < 1000 ppm uranium. The same is true with the small amounts of organic material in these soils, which were the second most important source of uranium bonds.

Sample	U (ppm)
NMSU Deionized water	0
Exchangeable fraction blank	0.04
Carbonate fraction blank	0.04
Oxide fraction blank	0.01
Organic fraction blank	0.04
Residual fraction blank	0.02
BRS Standard	0.64

Table 10. Sequential Extraction blanks are valid.

PLANT ANALYSES

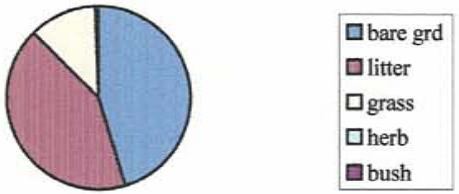
PLANT TRANSECTS

Plant transects were conducted to compare the ground cover and plant types of the different land use types (figure 42). At S27, the two undisturbed plant transects show that the undisturbed areas had litter covering half of the unvegetated soil surface (approximately 40% litter and total 84% unvegetated area). Grass covered 12% of the undisturbed soil surface.

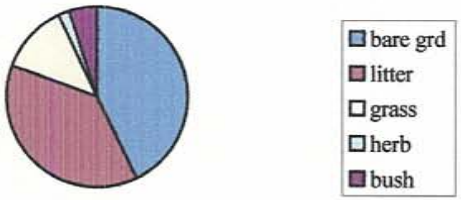
Both the litter and the grass content distinguish the undisturbed plant transect from the other land use types' plant transects. The drainage land use area had more grass (21%), but much less litter (5%) than the undisturbed land use area. The drainage area also had almost 5% bushes, and 1% herbaceous plants. The disturbed plain and the waste piles were predominatly bare ground (92-99%). The disturbed plain had almost 7% grass and 1.7% herbaceous plants. The waste piles had 0.1-4% grasses, and 0- 0.8% herbaceous plants. There were also differences between plant species in the different land use areas. For example, Indian Rice Grass was the one grass species found on the waste piles. This grass had twice the patch size of the other species and land use types--25 cm versus 8-13 cm.

At S36, two plant transects were recorded--one undisturbed and one across the waste pile (figure 43). Both had more plant cover, and more species variety than the S27 transects. The undisturbed plant transect was almost evenly split between grass cover, soil litter, and bare ground (25.8%, 22.7%, and 32.6% respectively). Blue grama grass predominated the grass patches (269/ 281 grass points recorded). The S36 waste pile plant transect is different from the S36 undisturbed area with its increased bare ground

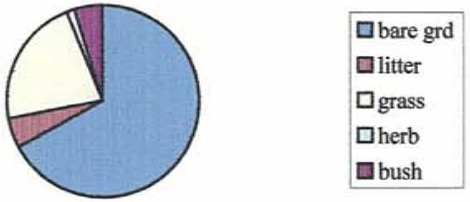
Undisturbed area, S27, transect 1



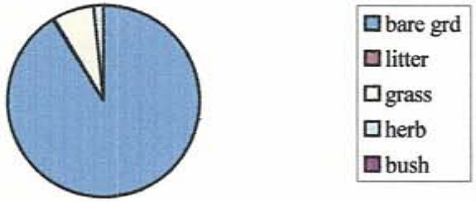
Undisturbed area, S27, transect 2



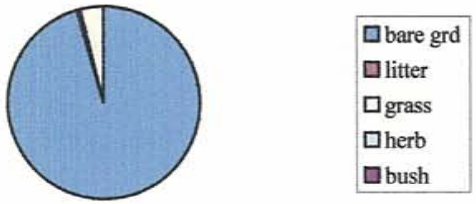
Drainage, S27



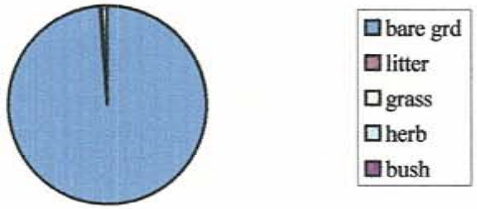
Disturbed Plain S27

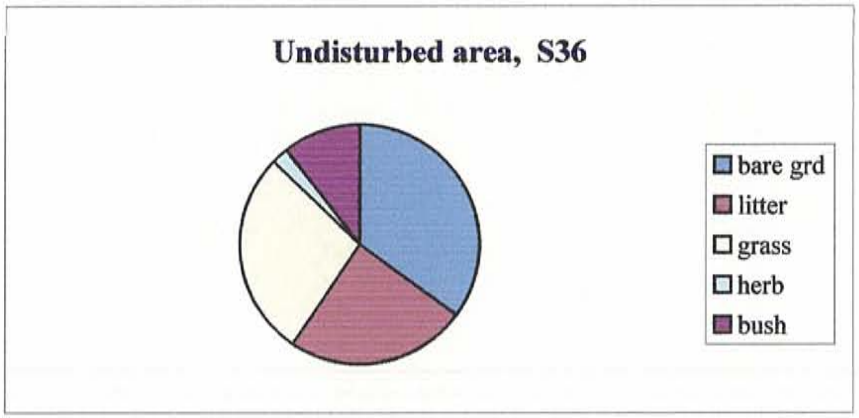


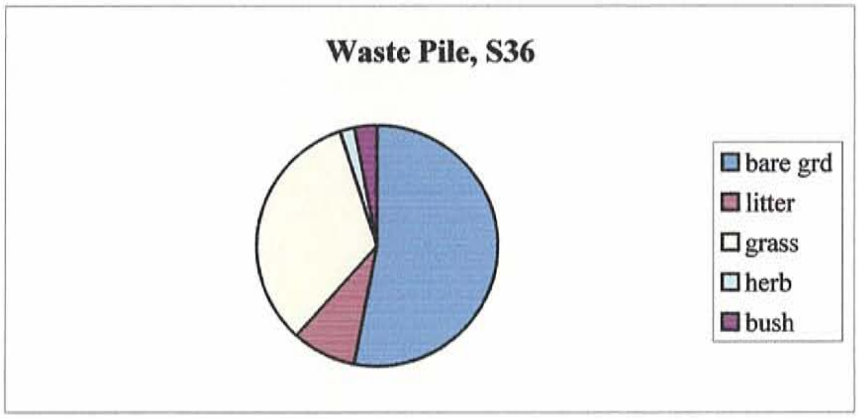
Waste Pile, S27, transect 1



Waste Pile, S27, transect 2




Undisturbed area, S36
bare grd
litter
grass
herb
bush


Waste Pile, S36
bare grd
litter
grass
herb
bush

(52.8%), decreased litter (8.6%) and decreased bush cover (3.3%). This waste pile vegetation transect has more vegetation and more variety than the S27 waste pile transects. This is probably due to time since disturbance--S36 had been abandoned at least 20 years prior to S27. The waste pile at S36 also has a central depression which may serve to collect precipitation and promote plant growth.

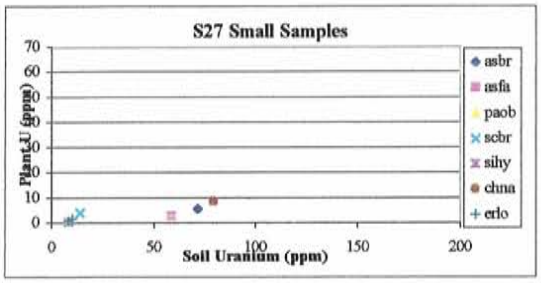
PLANT URANIUM CONTENT

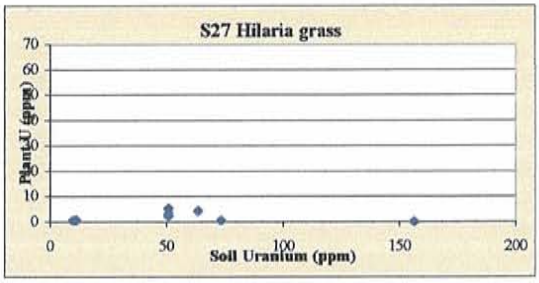
S27

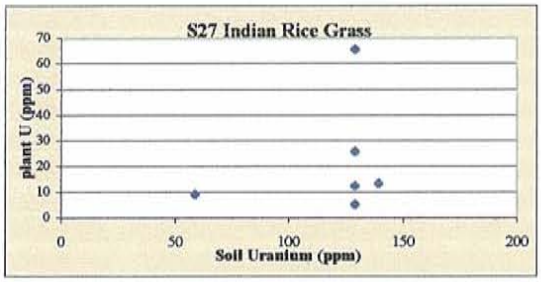
Three plants were taken at the established grid sampling points. These three plant samples included three different species at most points, and occasionally duplicate plant samples of the same species at the same point. These samples were also duplicated in the laboratory (Table 11).

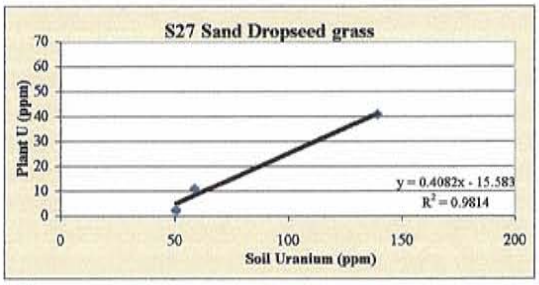
Plant Type	Species	# Field Pts	# Fld Samples	Analyzed	Graphed
Grasses	Tobosa grass	8	10	16	6
	Vine Mesquite	1	1	2	1
	Burro grass	1	1	1	1
	Squirreltail	2	2	2	1
	Sand Dropseed	4	4	7	3
	Indian Rice grass	3	3	3	6
	Blue Grama	1	1	3	0
Herbaceous	Wooly Buckwheat	2	2	5	1
	Tansy Mustard	3	3	5	3
	Stickleaf Blazing Star	2	4	6	2
	Curly Cup Gumweed	1	1	2	0
	Heath Aster	1	1	3	1
	Milkvetch	1	1	2	1
Shrubs	Rabbitbrush	1	1	2	1
	Fourwinged Saltbush	6	7	35	5
	Snakeweed	7	9	17	7
Weeds	Tumbleweed	5	6	12	4
	Kochia weed	9	13	17	8

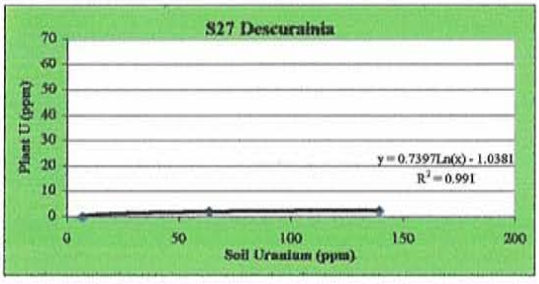
Table 11. Frequency of plant occurance at S27 sampling points, and of field sampling and ICP-MS analysis per plant species.

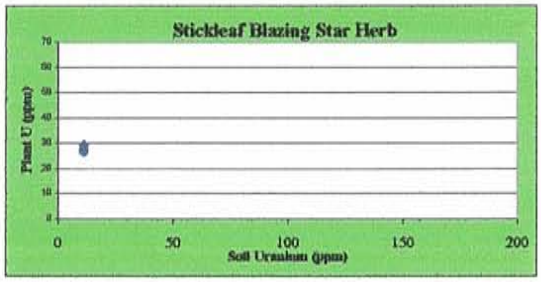

S27 Small Samples
Plant U (ppm)
Soil Uranium (ppm)
asbr
asfi
paob
scbr
sihy
chna
erlo

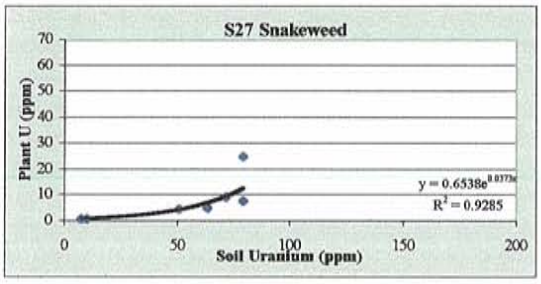

S27 Hilaria grass
Plant U (ppm)
Soil Uranium (ppm)

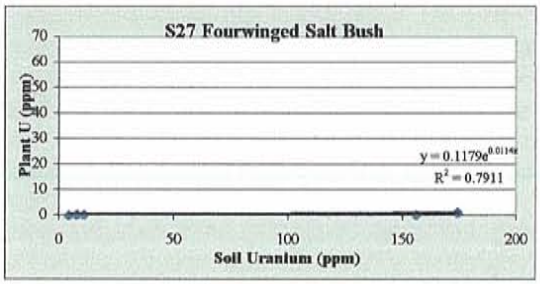

S27 Indian Rice Grass
plant U (ppm)
Soil Uranium (ppm)

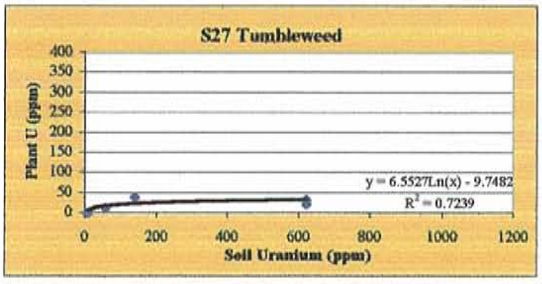

S27 Sand Dropseed grass
Plant U (ppm)
Soil Uranium (ppm)
y = 0.4082x - 15.583
R² = 0.9814


S27 Descurainia
Plant U (ppm)
Soil Uranium (ppm)
y = 0.7397Ln(x) - 1.0381
R² = 0.991


Stickleaf Blazing Star Herb
Plant U (ppm)
Soil Uranium (ppm)


S27 Snakeweed
Plant U (ppm)
Soil Uranium (ppm)
y = 0.6538e^0.0373x
R² = 0.9285


S27 Fourwinged Salt Bush
Plant U (ppm)
Soil Uranium (ppm)
y = 0.1179e^0.0114x
R² = 0.7911


S27 Tumbleweed
Plant U (ppm)
Soil Uranium (ppm)
y = 6.5527Ln(x) - 9.7482
R² = 0.7239

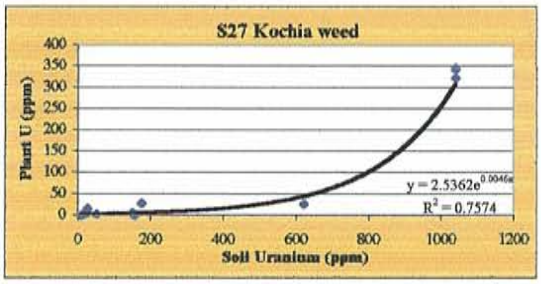

S27 Kochia weed
Plant U (ppm)
Soil Uranium (ppm)
y = 2.5362e^0.0046x
R² = 0.7574

Figure 43 shows the relationship of plant uranium with soil uranium for 16 species at S27. S27 had higher soil uranium values (0-1000 ppm) than S36. Because of the higher soil uranium, the plant response to uranium is more indicative of potential phytoremediation applications. Eight of the ten graphs in figure 44 are at the same scale. These graphs indicate that there is a difference between species in plant uptake of soil uranium. A high ratio of plant U : soil U is a useful indicator for further phytoremediation studies. In the top eight graphs of figure 43, this high ratio is shown most clearly in the Stickleaf Blazing Star herb samples, which have a >100% (>1) plant uptake: soil uranium ratio. The high samples of the Indian Rice grass, Snakeweed and Sand Dropseed grass also have 0.46, 0.33 and 0.27 plant uranium concentration ratios. Most plant samples in these top eight graphs of figure 43 do not show significant uranium uptake.

The bottom two figures in figure 43 have scales approximately six times smaller than the above graphs in that figure. Tumbleweed's concentration ratio decreases with increasing soil uranium. Below 200 ppm soil uranium, tumbleweed accumulates up to 25% of soil uranium. At 600 ppm, it accumulates approximately 8.3% of soil uranium. Kochia weed appears to accumulate more plant uranium with increasing soil uranium. At the soil uranium high value (1050 ppm), Kochia weed accumulated approximately 31% of soil uranium in the plant material.

S36

More plant species were sampled at S36. Some species, such as Blue grama grass, Tansy mustard, Kochia weed, and Winterfat shrub occurred in abundance. Other species were sampled only a few times. The sampling duplication is listed in table 12.

Plant Type	Species	# Field Pts	# Fld Samples	Analyzed	Graphed
Grasses	Blue Grama	19	19	20	19
	Mountain Muhly	3	4	4	3
	Sand Dropseed	10	10	10	10
	Threeawn grass	2	2	2	2
	Tobosa grass	4	4	6	4
	Squirreltail	2	2	2	2
Herbaceous	Cleome serrulata	2	2	5	0
	Goosefoot-C. lepidium	3	3	6	3
	Gilia	2	4	6	0
	Scarlet Globemallow	1	1	2	1
	Mustard-D. pinnitifida	9	10	11	9
Shrubs	Fourwing Saltbush	1	1	3	1
	Willow	1	1	1	1
	Rabbitbrush	5	5	10	5
	Winterfat	10	11	35	10
	Snakeweed	2	2	4	2
	Fringed Sage	1	1	3	1
Weeds	Tumbleweed	1	1	1	1
	Kochia weed	11	15	15	11
Other	Lichen	2	2	2	2
	Bulrush	1	1	1	1

Table 12. Frequency of plant occurance at S36 sampling points, and of field sampling and ICP-MS analysis per Plant Species.

Because of the additional species and smaller average sample size per species at S36, more species were grouped together on single graphs. S36 also had much less soil uranium than S27. Up to 3 ppm can be considered "background" soil uranium values (reference). This allows fewer conclusions about plant uranium uptake and suggestions for phytoremediation.

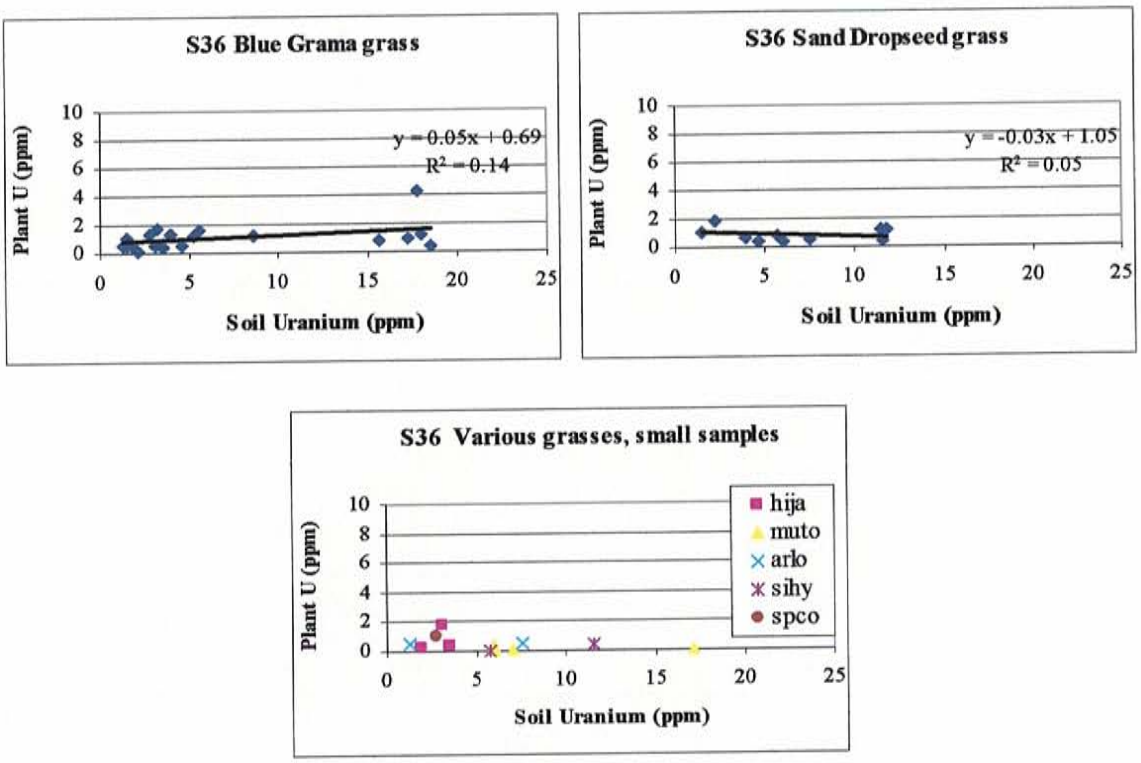


Figure 44. S36 Plant uranium concentration versus soil uranium for 7 species.

Figure 44 shows S36 grass uranium uptake. Three-awn, Mountain Muhly, Squirreltail and Spike dropseed grasses accumulated very little uranium. While none of these grass samples has "elevated" grass uranium concentrations, a few samples did show uptake at background soil uranium concentrations. Blue Grama, Tobosa, and Sand Dropseed grasses all had a point or a few points which accumulated 2 ppm plant U for less than 5 ppm soil U. Both the Blue Grama and Sand Dropseed grasses were frequently sampled and this 40% plant uranium concentration ratio did not continue with increasing soil uranium. In the Tobosa grass, only one of four graphed points showed this level of uranium uptake.

Six herbaceous species, and one sedge, were sampled at S36. Only one of these species, Tansy Mustard, had enough samples to allow trend analysis. The plant and soil uranium values for these samples are listed in figure 46.

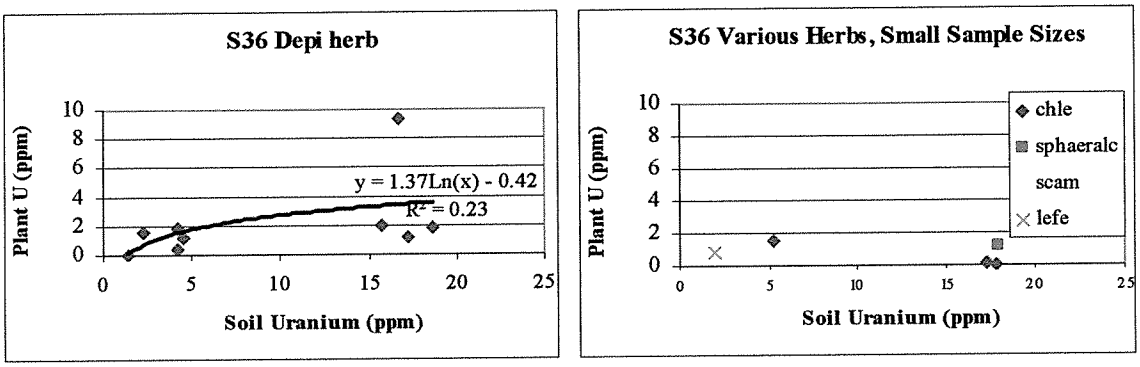


Figure 45. S36 Plant Uranium versus soil U concentration for five herb species.

Tansy Mustard was the only herbaceous species to accumulate more than 2 ppm uranium (figure 45). One Tansy Mustard sample accumulated 9 ppm plant uranium per 17 ppm soil uranium, a concentration ratio of 0.53. However, no linear or other plant uptake trend for Tansy Mustard could be established, and most points accumulated less than 2 ppm uranium.

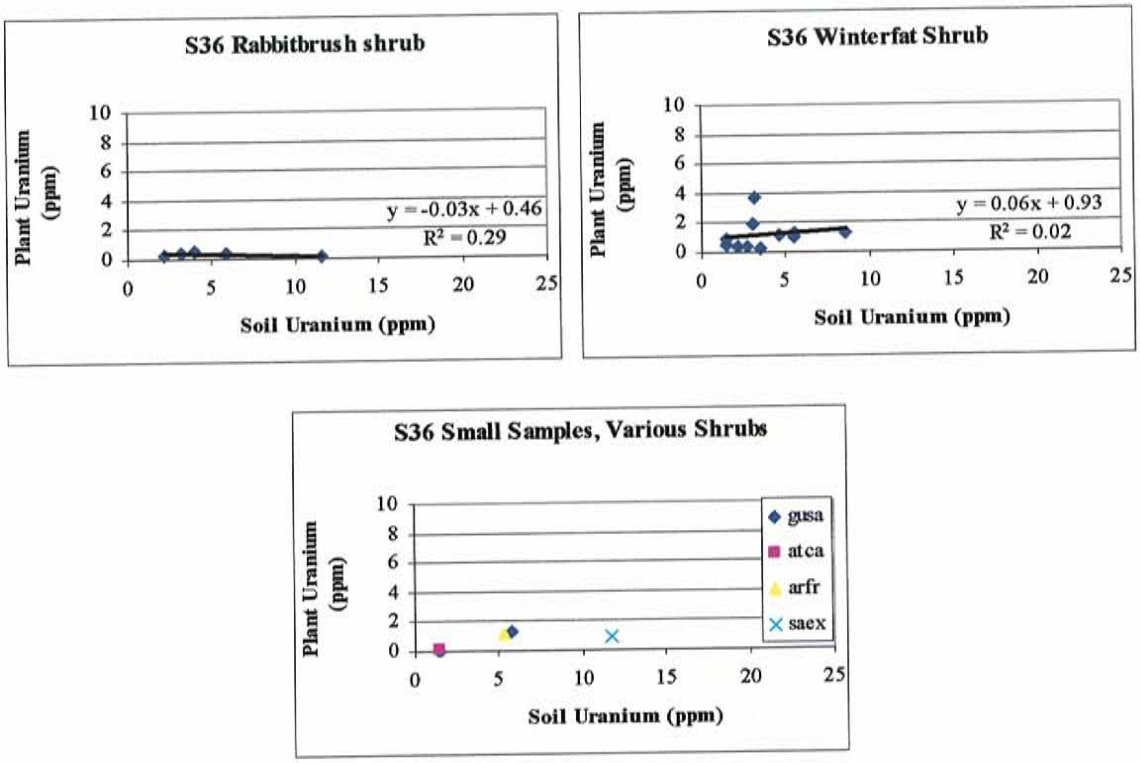


Figure 46 . S36 Plant uranium uptake versus soil uranium for six shrub species.

Six shrubs were sampled at S36; these plant and soil uranium values are listed in figure 47. All shrubs had plant uranium values below 2 ppm. The Winterfat shrub showed a slight decrease of accumulated plant uranium with increasing soil uranium.

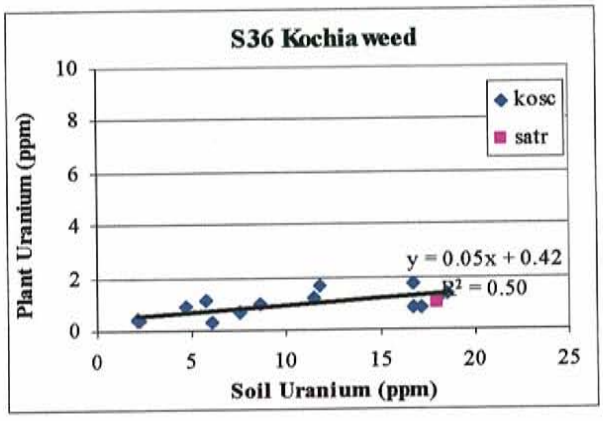


Figure 47. S36 Plant Uranium uptake versus soil uranium for two weed species.

Two weedy species were also sampled at S36: Kochia weed and Tumbleweed (figure 48). Both accumulated very little soil uranium at S36. Kochia weed, which had some high uranium uptake at S27, increased 1 ppm plant uptake over a 17 ppm soil uranium spread. Kochia weed did not show indications of high uranium uptake potential at S36.

S36 Waste Pile Plant Sampling

Nine species were additionally sampled along the waste pile plant transect line. This was done because of the low uranium values across most of S36, and the high values within the waste pile. These plant samples had slightly higher uranium values than the S36 grid samples (table 13). The shallowest sample of the waste pile soil profile contained approximately 48.6 ppm uranium. Assuming this concentration is constant across the waste pile transect, the Red Three-awn grass and Blue Grama grass have accumulated the most uranium of the plants in this table. These two samples had concentration ratios of 0.19 and 0.27. These ratios are higher than almost all grid samples.

sample point	Plant Species	U (ppm)	avg U ppm	stdev
W10	Blue Grama grass	2.26	*5.65*	4.79
W10	Blue Grama grass	9.04		
W15	Threadlead Groundsel	0.37	*0.19*	0.26
W15	Threadlead Groundsel	0.00		
W25	6-wks Three-awn grass	4.38	*4.89*	0.72
W25	6-wks Three-awn grass	5.40		
W25	Spike Dropseed grass	0.50		
W30	Red Three-awn grass	13.14		
W30	Indian Rice grass	2.14		
W35	Indian Rice grass	2.65		
W40	Russian Tumbleweed	1.79	*1.32*	0.66
W40	Russian Tumbleweed	0.86		
W40	Herbaceous Stickleaf	2.64		
W45	Winterfat Shrub	3.78	*3.29*	0.64
W45	Winterfat Shrub	2.36		
W45	Winterfat Shrub	3.47		
W45	Winterfat Shrub	3.56		
n/a	std	0.00		

Table 13. Uranium content of Waste Pile plant samples, S36.

DISCUSSION

DIFFERENCES BETWEEN THE LAND USE TYPES

Surface soil properties, soil profiles, vegetation transects, and vegetation samples were all used to test for differences between the land use types. The surface soil properties --particle size, pH, calcium carbonate, organic carbon, pH, and clay type--in almost all cases did not significantly distinguish the land use types. There were descriptive differences between the land use types in the soil profiles, however.

Land use types were also distinguishable topographically and with differing vegetation density. The waste pile and the lowlands can be distinguished based on respective topographic highs and lows. The disturbed plain and waste pile can be distinguished based on decreased vegetation, a lack of surface soil color, and an increase in relative surface soil sand content from waste rock and mining activity.

SURFACE SOILS AND SOIL PROFILES

Most of the soil sampling for this study was done at shallow depths (0-5 cm), in order to sample the exact rooting soil of the plants. One difference between arid and temperate soils is the higher activity and vertical movement of surface particles in the semi-arid soil. Certainly one insight from this study is that surface soil samples, for the purposes of phytoremediation, do not give a complete insight into the soil properties at depth. This is probably due to the active soil surface in this semi-arid area. This is further supported by the strong winds common to the area, and experienced during fieldwork.

URANIUM IN SURFACE SOILS

At S27, the most soil uranium content occurs along an old road included in the disturbed area. A small drainage channel now follows part of this road. Uranium is slightly lower here than on the waste pile surface samples. One disturbed area surface sample had 500+ ppm U. One undisturbed surface sample also had 50 ppm uranium. These two points illustrate some of the variability of the surface soils, and the difficulty using the surface soils to distinguish land use types. Ore loss from trucks and eolian transport may be two different surface processes confusing the picture of uranium occurrence across this site.

Uranium in the S36 surface soils distinguished between disturbed and less disturbed areas. The undisturbed and lowland areas had lower surface soil uranium than the disturbed plain and waste pile areas. However, this difference was approximately 2 ppm between the less and more disturbed surface soils over a range of 18 ppm.

SOIL PROFILE DIFFERENCES

While having much more limited sample sizes, the soil profiles provided more insight into the differences between land use types. Based on the soil profiles, the different land use types are distinguishable within each mine site, but not comparable between mine sites. The undisturbed soil profiles at S27 had higher relative organic carbon. The S36 undisturbed soil profile had higher relative $CaCO_3$ that increased with depth. Both undisturbed soil profiles had typically slightly higher pH values. The disturbed profiles typically had slightly lower pHs, low $CaCO_3$ content and high sand content.

S27 Soil Profiles

The undisturbed soil profile has gravels from 0-24%, predominately below 5%. It also contained mostly silt and clay, and had 3-4% organic carbon, but no $CaCO_3$. The disturbed plain and waste pile soil gravels, by contrast, are typically above 10%. These two profiles have organic carbon < 1% and high sand content, which suggests burial and little plant growth on these two disturbed soils.

S36 Soil Profiles

The undisturbed soil profile had gravels below 5% in all samples to 60 cm. There was ~2% organic carbon throughout this profile, and soil carbonate increased with depth to 3.1% at 60 cm. The S36 lowland and waste pile soil profiles had more relative carbonate at the surface and less relative carbonate at depth. The carbonate at the surface suggests the short development time of these two disturbed profiles. The S36 drainage soil profile has low sand and high organic carbon relative to all the other soil profiles, including both undisturbed profiles. This could be because of the effects of additional mine release water that flowed over this area while the mine was active and dewatering the underground uranium ore.

URANIUM CONTENT IN SOIL PROFILES

In the soil profiles, total uranium concentration differs for each land use type. As with the above soil profile samples, the sample sizes here are small. Highly variable urnaium concentration in some of the soil profiles suggests that the samples may represent highly variable uranium concentrations throughout the study area. However, the profiles suggest some differences between land use types.

The undisturbed profiles at each location had uranium concentrations below 6 ppm. Uranium decreased with depth at both undisturbed sites. The disturbed plain soil profile (S27) varied from 200-1100 ppm with most values ~350 ppm U. Both the S27 disturbed plain soil profile and the S36 drainage area soil profile had uranium decreasing with depth. The two waste piles also had patterns of uranium decreasing with depth. This was highly variable at the S27 waste pile soil profile. In the S36 waste pile soil profile, uranium decreasing with depth is interrupted by a high-uranium layer at 60 cm. This layer contains fine-grained tailings material, and is not a naturally developed soil layer.

VEGETATION AMOUNTS

The amount of vegetation is a good indicator of past land use. The more heavily disturbed the area, the less total vegetation was recorded by the vegetation transects. Vegetation communities, as measured by the vegetation transects, also differentiated the land use types. The undisturbed vegetation transects are characterized by equal amounts of bare ground and litter, while all other transects are dominated by bare ground. The S36 lowland area has a high diversity of species, but still lots of bare ground.

It is interesting that both the vegetation transects and the soil profiles helped to define the land use areas. There is not enough data here to support a direct link between the soil profile and vegetation transect of one land use area. However, it is possible that the variations in the soil profiles between each land use type affect the vegetation of each land use type. This suggests that perhaps vegetation here is more affected by variations in subsurface soil properties than the surface soils.

SEMI ARID AREA PLANTS AND URANIUM UPTAKE

In these samples, few plants appeared to be accumulating uranium. Of the plants with enough samples to plot on a graph, most did not increase in uranium concentration with increasing soil uranium.

Of the uranium that was found in the plants, it was often found at twice the concentrations in the leaves than the stems of the plants. Leaves grow faster and have a higher 'osmotic potential' than stems, because they are the primary site of transpiration. The leaf area within the plant could therefore be the site where uranium enters plant cells, as uranyl ions dissolved in water. This water flows from the plant stem xylem into leaf cells for tranpiration and photosynthesis. This process may cause the uranium to be stored at a higher rate in the leaf cell vacuoles as plant waste.

Uranium concentrations in the plants were low in general, except for two Kochia samples at S27. The surface soils taken to relate to the plant uranium concentrations may in some cases not be the best measurement of available soil uranium. For example the rooting depth of large shrubs such as the saltbush or rabbitbrush may make deeper soil uranium available to the plant. However, even without the measurement of that deeper soil uranium, in the samples given in this study, most plants did not show elevated uranium concentrations. These species do not show special promise for phytoremediation.

In many cases, plants do not show linear uptake of plant uranium with soil uranium. This could be because these plants are genetically programmed to limit uranium uptake. Selection of uranium tolerant plant samples in the field may yield a uranium accumulating variant of that particular wild species.

Plants that did show uranium uptake, in this study, did not follow a consistent pattern. At S27, Sand Dropseed grass and Indian Rice grass both had some plant uranium uptake at soil concentrations ~140 ppm. However, the Sand Dropseed appeared to follow a linear uptake pattern, while the Indian Rice Grass sample was just one of six samples, 5 of which were not significant accumulators. The herb Stickleaf Blazing Star accumulated lots of uranium at a low soil concentration. For sheer uranium removal, this plant could be rated the best overall, with a CR of >2. However, this may be because the soil uranium was not measured accurately on the waste pile relative to this plant, and should have been measured at greater depth. Or, it could mean that the Stickleaf herb, is especially good at catching eolian dust particles, with some possible uranium content.

S36, which has been left undisturbed for ~ 20 years longer than S27, had more species sampled. It also had less overall uranium, and fewer species with any indications of uranium uptake. The Tansy Mustard and the Winterfat Shrub both had singular samples from the population which had CRs of ~0.5 and ~1 respectively. Kochia weed did not show uranium uptake at this mine site.

PLANT URANIUM UPTAKE RELATED TO SOIL PROPERTIES

. Six plant species sampled at the two study sites had large enough sample sizes for statistical comparison of plant uranium uptake with soil properties, including the relevant 'surface' soil properties. These species were Kochia weed, Sand Dropseed grass, Snakeweed, Tumbleweed, and Galleta grass.

Soil characteristics of the 0-5 cm surface soil samples were compared with the concentration ratio of plant:soil uranium. These plant samples were related to the soil properties pH, OC, $CaCO_3$, particle size, and uranium content.

These analyses only use the soil properties of 'surface' soil samples. Surface soils were previously proven to not have significant differences between land use types. For these comparisons, the land use type designations were set aside.

For all species, plant uranium uptake was related to pH:

		r-square
Kochia	**S27 U CR = -8.27 + 1.08 pH**	75.5 %
	S36 CR = -100.1 + 15.2 pH	45.3%
Snakeweed	**S27 U CR = 0.399 - 0.393 pH**	4.4 %
Tumbleweed	**S27 U CR = 1.81 - 0.21 pH**	7.2 %
Sand Dropseed grass	**S27 U CR = 2.62 + 0.35 pH**	66 %

The other soil properties affected the different species' uranium uptake differently. Best fit equations for the different plant species were found in many cases to incorporate more than one soil property. Tumbleweed S27 U CR was controlled by organic carbon and calcium carbonate:

Tumbleweed S27 U CR = 0.15 - 0.07% OC - 0.1% CaCO3

(p = .11, .14; r-sq = 86.5%).

Galleta grass's uranium uptake responded to organic carbon and silt in the soil:

Hija S36 U CR = 6.94 - 1.3 OC - 0.05 silt p = 0.03, 0.07, r-sq = 99.93%

Uptake of uranium in winterfat, a small shrub responded to soil silt content:

Winterfat S36 U CR = 2.23 - 0.015 silt p = 0.089, r-sq = 31.82%

Sand dropseed grass occurred frequently at both S27 and S36. At S27, the CR regresses with calcium carbonate:

Sand Dropseed S27 CR = 0.42 - 0.2 % CaCO3 ($p = 0.055$, r-sq = 89.31%).

At S36, sand dropseed grass CR regressed with organic carbon:

log Sand Dropseed S36 CR = 2.12 - 0.275 OC ($p = .155$, r-sq = 30.6%).

Soil pH rises with calcium carbonate and drops with the presence of organic carbon. The uranium concentration ratio of Sand Dropseed grass at these two study sites appears to form a negative relationship with both calcium carbonate and organic carbon presence. This may seem counterintuitive; however, uranium does form different ionic complexes at different pHs. But between these two sites, the pH does not vary greatly. This plant species' uranium uptake may be reacting to soil property interaction effects. As one property (CaCO3) increases, another (OC) decreases. So the uranium uptake of this plant may be competing (negative relationship) with the dominant form of soil carbon at a particular site.

Snakeweed is a very common, low-growing (to ~ 2 feet) perennial shrub. It has long pinnate leaves and persistent yellow blossoms. At S27, scatterplots of total uranium plant CR and leaf CR did not suggest any relationships with measured soil characteristics. Plant stem CR data also does not regress significantly with soil variables. The best relationship suggests that pH can explain 4.4% of Snakeweed's uranium concentration.

SUMMARY

Significant influences of soil properties vary by plant species and mine site. Kochia weeds' uranium uptake was influenced by soil pH variations at both sites. Sand dropseed grass's uranium uptake was influenced by soil calcium carbonate content at S27. Also at S27, Tumbleweed's uranium uptake was influenced by both organic carbon and

calcium carbonate. At S36, the Galleta grass and the winterfat shrub's uranium uptake were influenced by soil silt content. Galleta grass was also influenced by organic carbon.

pH is an important factor in soil chemistry and in phytoaccumulation. Except for Kochia weed, it is not the predominant factor affecting these plant's uranium uptake. Carbon forms in the soil --organic carbon or calcium carbonate--seem to have more extensive influence on plant uranium uptake.

RAMIFICATIONS FOR PHYTOREMEDIATION

This study specifically investigates diffuse surface uranium contamination. At background levels of uranium concentration, a number of species uptake small amounts of uranium. Species for further investigation, and possible genetic selection studies include Kochia weed, and Galleta, Sand Dropseed, Red Three-awn and Indian Rice grasses. The Winterfat shrub and Tansy Mustard, Stickleaf herbs may also have certain plants within the species that are more tolerant of uranium and could be cultivated for possible phytoaccumulation.

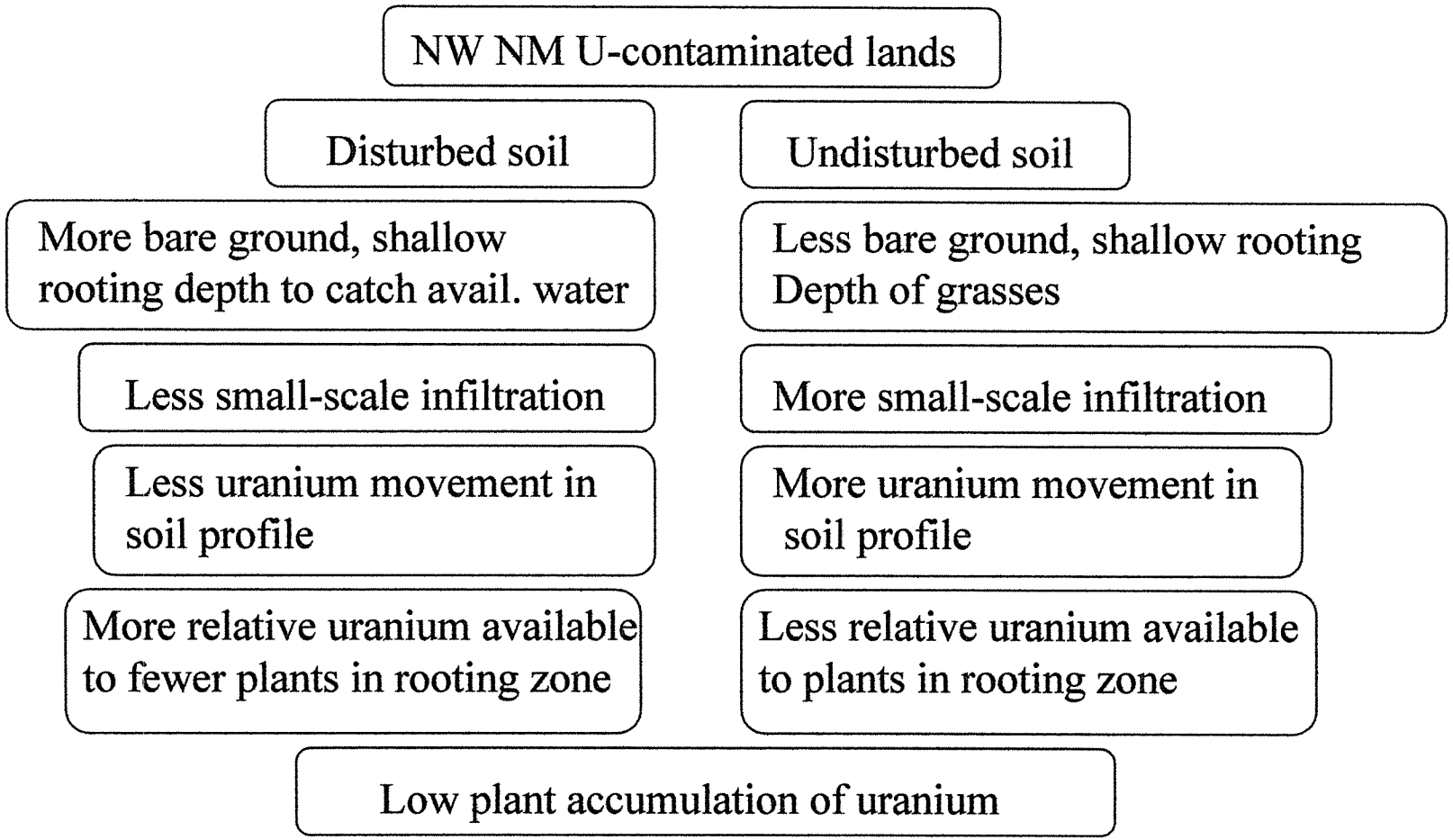
Land use type influences plant species distribution across these two sites. An overall lessening of plant growth on the more disturbed land use areas was seen in this study. Phytoremediation approaches could benefit by considering the various land use types of semi-arid areas proposed remediation sites. The land use types can influence the success of vegetation, the soil texture, and the movement of uranium through the soil profile. Soil profiles are useful for phytoremediation as well because some of the plants considered for phytoremediation were shrubs with rooting depths of up to 1 m.

URANIUM PHYTO-UNDER-ACCUMULATION IN SEMI-ARID SOILS

The soil profiles suggest that non-surface soils can be defining characteristics of the differences between land use types. The land use types also reflect differences in the vegetation communities. Based on this information, we can suggest but not prove a link between the two. If the two were linked, soil horizons could possibly affect uranium movement in semi-arid soils in different ways in disturbed and undisturbed soils (Figure 49). Undisturbed soils might allow little uranium availability to plants because of their relatively higher water infiltration and resultant uranium transport deeper into the profile, away from plant roots. Disturbed soils would allow little uranium uptake because of the harsher conditions for plant growth.

For example, undisturbed soils in this study have typically more grass content and more total vegetation cover. This will allow relatively more water infiltration on a small scale (Rone, 2001). These relatively higher amounts of water infiltration may carry uranium to deeper depths within the soil profile (as seen in figure 40, S36 drainage profile and S27 disturbed plain profile). This greater depth of uranium in the soil profile may make it less available to plants for potential uptake. While the area probably has more total plant biomass, it may have less uranium concentration in plants because of the deeper sequestration of uranium in the soil profile.

Disturbed soils will exhibit less soil development ($CaCO_3$ content), and have more shrub growth and bare ground on the soil surface. This results, typically, at smaller scales, in less water infiltration and more runoff (Rone, 2001). Less water infiltration into the soils would create less uranium movement into deeper soil horizons, but plant


NW NM U-contaminated lands
Disturbed soil
Undisturbed soil
More bare ground, shallow rooting depth to catch avail. water
Less bare ground, shallow rooting Depth of grasses
Less small-scale infiltration
More small-scale infiltration
Less uranium movement in soil profile
More uranium movement in soil profile
More relative uranium available to fewer plants in rooting zone
Less relative uranium available to plants in rooting zone
Low plant accumulation of uranium

uptake of uranium in disturbed soils would still be low, based on the lower amounts of plant cover, and (potentially) shallower rooting depth of these plants. Fruitful future work could concentrate on intraspecies variations in uranium phytoaccumulation. A focus on root zone definition and description relative to soil properties, soil uranium content, and plant uranium uptake could also be insightful.

POTENTIAL CAUSES FOR VARIABILITY

Because of the grid sampling pattern, the number of samples varied in each land use type, as well as for each plant species sampled. These sampling size considerations limit the strength of the conclusions. Future sampling should be targeted on one specific question of investigation in order to increase the strength of the conclusions.

Alternative sampling strategies could be completely random sampling, completely stratified sampling, or stratified random. Stratified random (based on land use type) would be the best to test the differences between the land use types. Non-grid, nonrandom sampling (based on plant species) would be the best to test the differences between the plant species. The combination of grid sampling and non-grid land use type sampling used here allows both land use type and plant sampling to be conducted as part of a unified study. Because of these different lines of inquiry, the sample sizes were overall large, but barely sufficient for the plant/ soil properties comparison. Future studies might benefit from a narrowing of the questions of investigation, and targeting the sample sizes to answering one or two questions.

Because the number of plant species sampled was not limited, but instead maximized, many of the plant species have small sample sizes. This makes statistically

valid conclusions difficult. One way to estimate the variability of a population is through the standard deviation measurement.

The plant samples were put through a number of steps; sampling in the field, preparation in the lab, and analysis on the ICP-MS. Standard deviation (σ) can be measured for field samples where two plants of the same species were sampled at the same grid point. Numerous duplicates were also prepared in the laboratory. The ICP-MS also analyzes each sample multiple times and provides an average of these samples, as well as a residual standard deviation (RSD) value. The total standard deviation for a sample can be calculated as:

$$\sigma_{Total} = \sigma_{Field} + \sigma_{Laboratory} + \sigma_{ICP\text{-}MS}$$

Unfortunately field and laboratory measurements can only be reported after they have been measured on the ICP-MS. Therefore the above equation becomes

$$\sigma_{Total} = \sigma_{Point\ (ICP\text{-}MS\ values).}$$

For example, the high uranium Kochia weed in Section 27 had three plant samples at the same point. These two plants had uranium values of 323.6, 343.6, and 347.7. The total standard deviation for these plant samples is 12.91. A more typical, lower uranium point at section 27 had plant values of uranium 5.9, 6.4, and 16.4 and standard deviation 5.9. A typical, low uranium point at S36 had plant values of uranium 0.9, 1.8 and standard deviation 0.64 (Keith, 1991).

SOIL SAMPLING

Western U.S. state Soil Surveys (Wyoming, Oregon) typically advise sampling a soil by taking multiple samples (< 1 kg) in an area, mixing them together, and then splitting out a subsample for analysis. In this study, single samples were typically larger than 1 kg. These samples were then split into one or more subsamples for analysis. While the study might benefit from multiple blended soils into each sample, this is difficult to accomplish for different plant sizes, with different rooting radiuses and depths, without entire excavation of each sampled plants' rooting soil.

The soil samples split for analysis for uranium analysis split a ~0.2 g dried soil sample from a sample > 1 kg. This analysis was subsequently done by using grinding, instead of splitting, in order to do the analysis. For simplicity and duplication of the sample, ground soil preparation is probably a preferable method to choose in the future.

CONCLUSIONS

LAND USE TYPES

Land use types show differences in their uranium content. These differences are reflected in increased uranium concentrations in increasingly disturbed soil profiles. Land use type differences in uranium concentration are not seen in surface soils.

The soil profiles and plant transects show differences between land use types. The undisturbed transects of both locations showed much more soil litter than the disturbed transects. Both undisturbed soil profiles had slightly higher soil pH's. The S27 undisturbed soil profile had higher OC and clay content than the disturbed soil profiles. The S36 undisturbed soil profile had more carbonate at depth than the disturbed soil profiles.

Surface soil sampling did not reflect differences between land use types. Sample sizes were much smaller in the soil profiles. Soil profile sample sizes limit the significance of the conclusions.

URANIUM IN SOILS

Uranium concentration did not vary consistently in proportion to changes in soil properties. While uranium activity in the soil and vegetation appears to be affected by

soil properties, uranium concentration is probably influenced more by previous disturbance.

URANIUM IN PLANTS

Some plants show more uranium accumulation than others, but intraspecies variations also exist. Kochia weed at S27 had two samples with 30% uranium accumulation where the soil uranium was 950 ppm. All other Kochia samples showed much less uranium accumulation. Conclusions about any species are limited because of the small number of samples for each species. At S27, Indian Rice Grass, Sand Dropseed grass, and Snakeweed shrub show promise based on their plant: soil uranium ratio. No plants at S36 accumulate uranium beyond background levels. Some plant species appear to accumulate uranium relative to different soil properties for each species.

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APPENDIX A

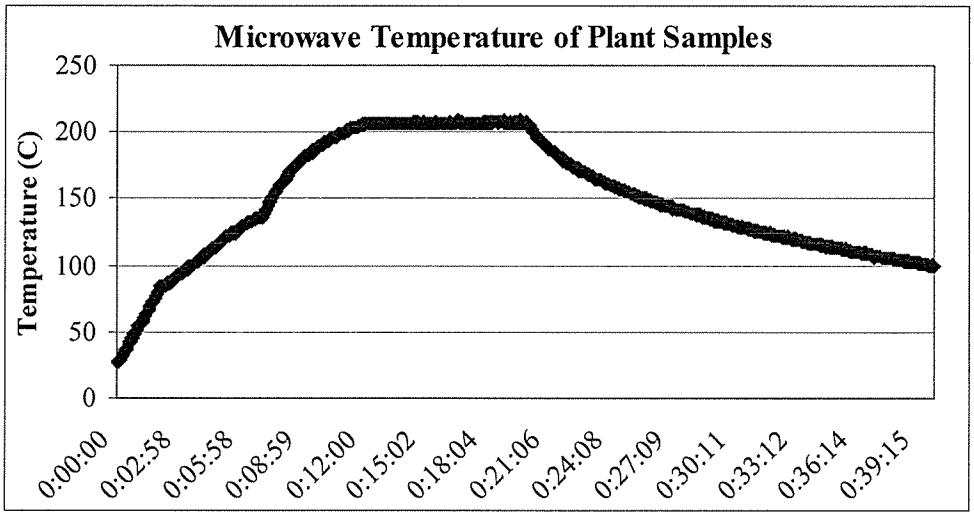
Additional Laboratory Methods

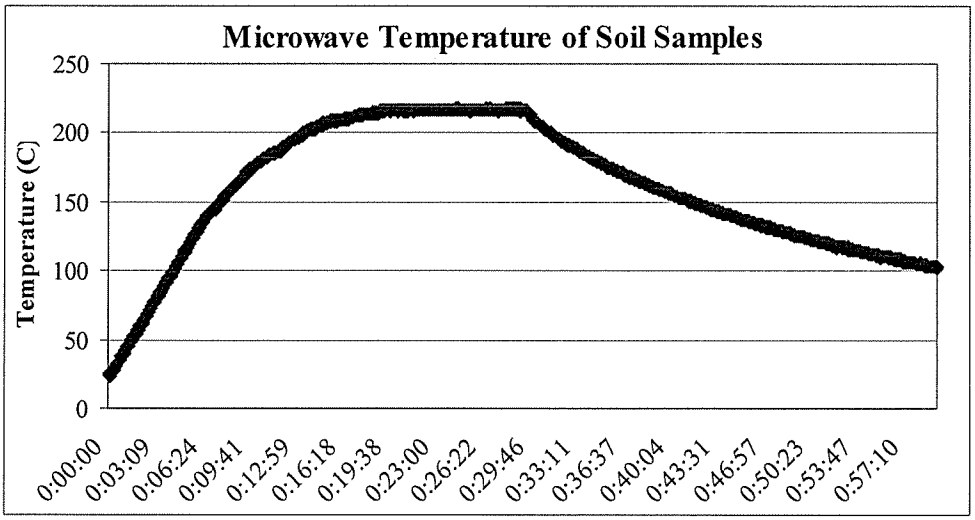
XRD CLAY TYPE ANALYSIS

Procedure for preparation of oriented clay mineral aggregates

1. Place a small sample (20 to 25 g) in a 100 ml beaker with distilled water. Mix and wait 5 minutes.
2. If the clay flocculates or settles out, pour off clear water, add more water, and remix. If the clay does not disperse, repeat this step several more times.
3. If the clay still flocculates, add a few drops of dilute solution (50g/L) of sodium hexametaphosphate (Calgon) and remix. If the clay flocculates, repeat step 2.
4. Centrifuge for 4 minute, wash with distilled water, and centrifuge again as often as needed.
5. Once the clay is in a dispersed state, allow the beaker and its contents to remain undisturbed for 10 minutes. At the end of the period, use small pipette (1-2 ml) to draw off enough suspension from the surface to cover a glass slide completely. This decanted fraction is < 2um. Prepare at least two slides and allow to air dry.
6. Use petrographic glass slides that have a high melting point.
7. If clay slurry flocculates on the slide surface, remake slide.
8. Run the slide of oriented clay on diffractometer at 2° 2θ/minute from 2° to 35° 2θ with monochromatic or Ni-filtered Cu radiation. Subsequent runs (glycolated and heat tratment) will vary depending on the mineralogy and nature of the information needed.

MICROWAVE SAMPLE DIGESTION FOR ICP-MS ANALYSIS





ICP-MS DATA ANALYSIS

Dilution Selection

For each sample analyzed, the ICP-MS prepared two auto-dilutions, approximately 1:5 and 1:100. The ICP-MS then reported uranium values at these two different concentrations. For high uranium values, the more diluted concentration was typically more accurate. For low uranium values, the less diluted concentration was typically more accurate. For high uranium concentration in the soil or plant, (> 5ppm) the concentration was reported using the highly autodiluted sample (1:105.9) versus those samples with expected low uranium values (which were autodiluted 1:5). Where other elements were reported, the RSD was also checked to be below 10%. If the RSD was not below 10%, the other dilution was used.

Procedure to Prepare Data for Analysis

a) Assemble appropriate information into one table. This includes ICP-MS data from different days, and the relevant laboratory data from different digestion runs.
b) Calculate uranium ppm.
c) Based on uranium ppm, choose appropriate dilution for final uranium concentration. For ICP-MS data after ~9/17/02, two dilutions of each sample were run --~ 1:5 and 1:100. Only one dilution for the final data assembly is desired. Where uranium is > 5 ppm, the 1:100 dilution is a more accurate measurement. Where uranium is < 5 ppm, the 1:5 dilution is a more accurate measurement.
d) Check residual standard deviation (RSD) values for uranium and all other elements. The ICP-MS analyzes each sample multiple times (~12-24). Each value in the ICP-MS report is an average of these analyses. The residual is the difference between each individual analysis and the average. The residual

standard deviation is the standard deviation of all residual values for that element, for that sample.

e) Eliminate all RSD values above 10%. Each sample has an RSD reported for each element (after 9/17/02). Samples before 9/17/02 did not have RSD values reported. Each RSD for each element for each sample must be checked to be below 5%.
f) Substitute ppb values from the other dilution, if the RSD value for that element is below 10%. The uranium values and RSD's were closely watched during the ICP-MS laboratory run of each sample. However, other elements can be 1000 times less or more than the uranium value. While one dilution for a sample was selected based on the Uranium value, other elements may indicate consideration of the other dilution's value for that element. Where necessary, this was done.
g) Calculate ppm for all elements.
h) Remove all RSD values from the table. Residual standard deviations are a data quality check. Once it has been ensured that all the data are of good quality, the RSD value is distracting to the analyses. These values are listed in the appendix.
i) Calculate averages for duplicated samples. Calculate standard deviations for all elements for duplicated samples.
j) Separate final data into tables of common soil elements and relevant soil elements and metals.

SEQUENTIAL EXTRACTION FOR HEAVY METALS PROCEDURE

Draft procedure expanded from M.J. Blaylock, Edenspace, N.J. May, 2001
Adapted from Ramos et al., 1994.

Goal: Identify metals bound with each soil fraction: Exchangeable, Carbonate, Oxide, Organic, and any residual metals. Used here specifically for uranium, but originally developed for lead.

Procedure: Use increasingly aggressive chemicals to extract metals from the same soil sample. For the first three steps, the chemical is added, the samples are agitated for 1 hour or more, and then the samples are centrifuged and the supernatant (remaining clear

liquid) is removed. These first three extraction steps are repeated once to ensure complete extraction of the associated metals. Tube, cap, and sample weights at each step are necessary to account for water and metal carryover between fractions.

Materials: per sample: 2.5 g oven dried soil sample

8 50 mL centrifuge tubes

50 mL 1 M $MgCl_2$ *(Magnesium Chloride)*

50 mL 1 M NaOAc (pH 5) *(Sodium Acetate)*

50 mL 0.04 M NH_2OH-HCl (in 25% Acetic Acid)

(Hydoylamine HCl)

5 mL 0.1 M HNO_3 *(Nitric Acid)*

6 mL 30% H_2O_2 *(Hydrogen Peroxide)*

10 mL 1:1 HNO_3

5 mL concentrated HNO_3

for procedure:

reciprocating shaker

automatic dispenser (0-50 mL)

1 mL and 5 mL pipettes

Vortex (automatic shaker)

centrifuge to 3,000 rpm

50 ^{o} C water bath

glass funnels

filter paper

pH paper or pH probe

DI water

Steps:

1.0 Exchangeable/ Soluble Cations (F-1)

1.1 Mix each sample thoroughly to achieve homogeneity. For each digestion batch, a minimum of one sample should be duplicated and one NIST Standard Soil or

other repeated sample should be included for every 20 samples. Samples may be finely ground or sieved to < 2mm. Sieve preparation may result in more floating (lost during procedure) organic matter.

1.18 Weigh sample to the nearest 0.01 g and transfer to a centrifuge tube 2.5 g of sample. Record the weights of the sample, tube and cap all together.

1.2 Alternatively, weigh and record the empty tube and cap, and then the sample, cap, and tube together.

1.3 Pouring down the side of the centrifuge tube, add 25 mL of 1 M $MgCl_2$ to each tube. Vortex samples for complete mixing.

1.4 Shake 2 hours on the reciprocating shaker. Use caution that the same approximate time is used throughout the procedure.

1.45 Centrifuge 2,000-3,000 rpm for 10 minutes. Watch the bottoms of the tubes. They may dimple. If necessary, the centrifuge can be run at lower rpms for a longer time, as long as the total is approximately 30,000 g-minutes.

1.5. Using funnels, separate supernatant solution into new, labeled vial (**F-1a** for the first run; **F-1b** for the repeated run). Use filter paper if necessary to separate floating organic matter.

1.6 For the original sample, repeat steps 1.2-1.5.

2.0 Carbonate Bound (F-2)

2.1 Pouring down the side of the centrifuge tube, add 25 mL of 1 M NaOAc (pH 5) to each sample.

2.2 Shake 2 hours on the reciprocating shaker.

2.25 Centrifuge at 2,000-3,000 rpm for 10 minutes.

2.3 Measure pH with pH paper or probe.

2.4 With funnels, separate supernatant solution into new, labeled vials (**F-2a** for the first run; **F-2b** for the repeated run). Use filter paper if necessary to separate floating organic matter.

2.5 Weigh and record the original sample with the tube and cap.

2.6 If pH is < 6, go to 3.0. If pH is > 6.0, repeat steps 2.1-2.5.

****when stopping for the evening, remove supernatant samples, including original soil tubes, to dark, cold room (4o C is preferable).*

3.0 Oxide Bound (F-3)

3.1 Pouring down the side of the centrifuge tube, add 25 mL of 0.4 M NH_2OH-HCl (in 25% Acetic Acid).

3.2 Shake 2 hours on the reciprocating shaker.

3.25 Centrifuge at 2,000-3,000 rpm for 10 minutes.

3.3 With funnels, separate supernatant solution into new, labeled vials (**F-3a** for the first run; **F-3b** for the repeated run). Use filter paper if necessary to separate floating organic matter.

3.4 Weigh and record the original sample with the tube and cap.

3.5 Repeat steps 3.1-3.4.

4.0 Organic Bound (F-4)

4.1 Pouring down the side of the centrifuge tube, add 5 mL of 0.1 M HNO_3, then 1 mL of 30% of H_2O_2.

4.2 Vortex mix, then place the cap loosely on the tube and allow to stand several hours. If overnight, leave samples at room temperature and not in cold room.

4.3 Add additional 1 mL of 30% H_2O_2. When effervescence ceases, place tube in a beaker with water and heat at 50 o C until bubbles disappear. This can take upwards of an hour.

4.4 Add 20 mL of DI water.

4.5 Centrifuge (2,000-3,000 rpm for 10 minutes).

4.55 Using funnels, separate and save supernatant solution into new **F-4** marked vials. Filters are probably not necessary by this point.

4.6 Weigh and record the tube, cap and sample.

5.0 **Residual Fraction (F-5)**

5.1 Conduct 'Total' Metal Analysis beginning on step 2.

This method is adapted from EPA Method 3050, HNO_3/ H_2O_2 Acid Digestion.

5.15 Use DI or RO water to rinse sample from centrifuge tube into little aluminum bucket.

5.18 Set in oven at 110 ° C to dry until no water is present.

5.2 (same as step 2, TMA) Add 10 mL of 1:1 HNO3 to the sample.

Heat the sample to 95 ° C and reflux for 15 minutes without boiling.

Add 5 mL of concentrated HNO_3.

Reflux for 30 minutes.

Add 5 more mL of concentrated HNO_3 and reflux for 30 more minutes.

(This is to ensure complete oxidation).

Allow the solution to evaporate to 15 ml.

***Note**: 5 mL of concentrated* HNO_3 *may be added instead of 10 ml of 1:1* HNO_3. *However, in some samples with high organic matter this results in a very vigorous reaction and the sample may overflow the tube. Evaporation of the excess water and the corresponding reduction in volume helps prevent loss of sample from excessive frothing when the peroxide is added in step 3. It is not absolutely necessary to evaporate the water but extra care is needed in step 3.*

5.3 (TMA step 3) After the sample has cooled, add 1 ml of 30% H_2O_2.

Return the tube to the hot plate for warming and to start the peroxide reaction.

Care must be taken that losses do not occur due to excessively vigorous effervescence.

Heat until effervescence subsides.

Remove the tube from the hot plate.

***Note:** For samples with apparently high organic matter, it may be advantageous to reduce the aliquot volume of H2O2 to 0.5 ml. This will help prevent sample loss by effervescence. It is also sometimes helpful to allow the samples to stand at room temperature for several hours or overnight after the first peroxide addition. Then place them on the hot plate. This will decrease the speed of the reaction and lessen the chances of sample loss.*

5.4 (TMA step 4) Continue to add 30% H_2O_2 in 1-ml aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged.

Note: *Do not add more than a total of 10 ml 30% H_2O_2.*

5.5 (TMA step 5) Dilute the sample to 50 ml in the folin tube.

5.6 (TMA step 6) Particulates in the digestate that may clog the nebulizer should be removed by centrifugation at 2,000-3,000 rpm for 10 minutes or by filtration.

5.7 (TMA step 7) The diluted sample has an approximate acid concentration of 5.0% (v/v) HNO_3. The sample is now ready for analysis.

APPENDIX B

Poison Canyon study site description and data collection

VEGETATION ON URANIUM MINES IN THE POISON CANYON AREA, AMBROSIA LAKE, NM

Goal

The objective of this investigation was to find locations (natural or old mines) with high uranium concentration in this area southeast of Ambrosia Lake and northwest of Grants, New Mexico. Soils and plants would then be sampled in these high uranium areas.

This area was the first discovered and may have been the first abandoned during the uranium boom and bust of the 1960's through the early 1980's. As potentially some of the first abandoned uranium mining areas, some of these old mine sites may have had a larger vegetative recovery and possibly exhibit more plant diversity. Occurence of new, previously uninvestigated plant species could possibly yield a new native phytoaccumulator of uranium in semi-arid soils.

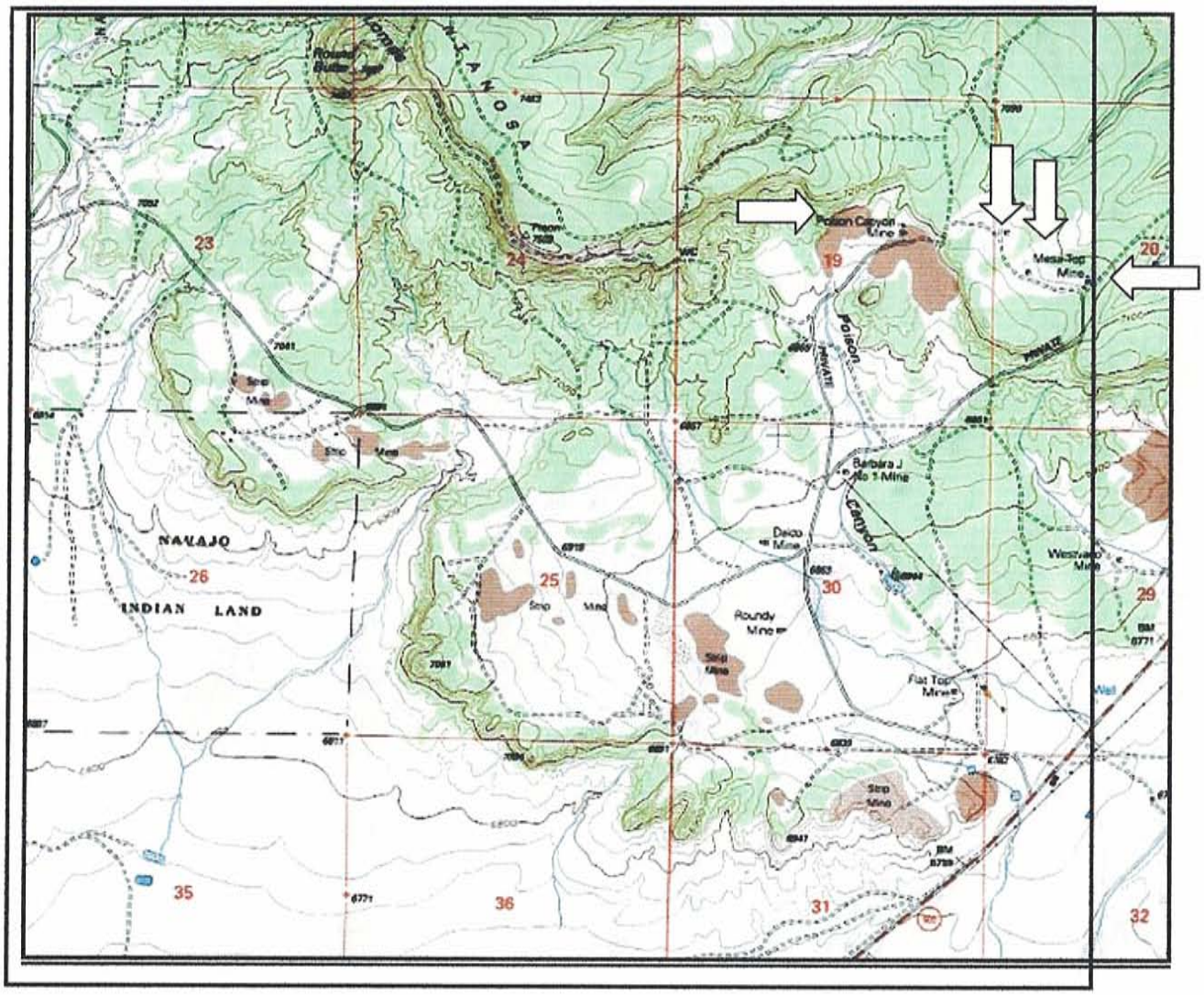
Methods

A gamma ray counter, GPS unit, and camera were used to identify and describe each site. Plant samples were taken and pressed in newspaper within 12 hours of sampling.

Results

Four mine sites were investigated: the Mesa top mine, two unnamed mines, and two adjacent Poison Canyon mine sites. GPS coordinates (in the UTM projection, NAD 1927 datum) for one corner of three areas are listed below.

Mine Site	Northing	Easting	corner
Mesa Top mine	13S02433920	3914189	southeast
unnamed	13S0243684	3914455	northeast
Poison Canyon S	13S0242835	3914524	south-southwest



A. The Mesa top mine had an extent of approximately 250 m by 400 m. The entire area sloped approximately 15 degrees to the northwest. It contained numerous little mounds of mixed tailings and ore/ waste rock. There was also one 3 m high waste rock pile, one iron mine ventilation shaft, one open adit (poorly fenced), and some scattered

wood and metal machine parts. The waste rock was an yellow-orange sandstone, and the ore a fine white-gray ash-like powder. Uranium readings in the area read ~10 uRem/ hr or less background; ~ 20 uRem/ hr around the edges; and 50-200 uRem/ hr within the mine area. Not all mounds had high readings, nor was there an obvious pattern between the mounds. One area approximately 2 m x 10 m had a high reading, of up to 400 uRem/ hr. This area was in a sandy arroyo 1 m deep running southwest downslope from the northeast corner of the mine. The area was also downslope of the old headframe and open pit. This area was not noticably vegetated.

Enhanced picture of Mesa Top mine, Poison Canyon area. Dog for scale is obscured in Pinon tree in right-center of picture.

There are quite a few Pinon and Juniper trees growing within the old mine site. While there are a few Indian Rice grass plants growing on the piles, there is a low grass species diversity across the area. Black and Blue grama grasses predominate, and ~20 - 30% of the soil surface is covered with vegetation. Opuntia cacti, Blazing star (stickleaf) and Muhly grass were also noted at the site, but low-growing shrubs such as snakeweed,

rabbitbrush or winterfat were absent. Anecdotal new species at this mine site are reported in the table below. Pictures, but no samples, were taken at this site.

Common name	***Species***	**notes**
Pine Spiderwort	*Tradescanta pinetorum*	unusual for area
Four-o-clock	*Mirabilis multiflora*	low-growing form
Spiny bush	*Tetradymia spinosa*	leaves in clumps on stem
Sanvitalia	*S. abertii*	<10 cm tall
Annual goldenweed	*Machaeranthera gracilis*	abundant
Spurge or Rattlesnake weed	*Chamaesyce albomarginata*	succulent leaves

B. The next two mine sites were located between the two named mines. The first unnamed mine site is approximately 75 x 75 m. A middle disturbed plain is surrounded by 2-3 x 2-3 x 1-2 m waste piles, with a small arroyo draining the area to the north. Uranium readings were 200-300 uRem/ hr over much of this site. In the 50 cm deep arroyo, outside of the main mine area, 100+ uRem/ hr was recorded. Vegetation in this area was not terribly diverse. Black grama and fourwing saltbush predominated, with some Indian rice grass, one annual Goldenweed, the same Spiny bush, and dead or tiny Snakeweed. One large Pinon tree grew on the west side of the mine (@ 100 uRem/ hr). Nine plant and three soil samples were taken at this site, but no pictures.

Common name	***Species***	***U (uREm/ hr)***	**notes**
Four o'clock		90	also surface soil sample
Fourwing saltbush	*Atriplex canescens*	~800	also surface soil sample
Black grama		625	also surface soil sample
Hilaria		240	southeast mine
Sand dropseed	*Sporobolus cryptandrus*	200	southeast mine
Spiny bush		60	southwest mine
Pinon	*Pinus edulis*	100	southwest mine
XXXa		60	southeast of mine proper

XXXb 60 southeast of mine proper

C. This mine site was very small (30 x30 m) and probably consisted of waste rock drilled up for a ventilation shaft and dumped on the surface. The uranium readings were barely above background (20uRem/ hr) and no vegetation was collected.

D. There are two mine sites at the Poison Canyon mine location. The first site is much larger, at least 600 m long by 400 m wide. This site was all tailings that had been formed into a relatively flat plain. There were three 15 m x 15 m tanks at low points within this plain. All of the material was white powder and sand. The average uranium reading in this area was 30 uRem/ hr, with a range of 10-60 uRem/ hr. Minor arroyos and the tanks were not necessarily high points. The few high points (60) were apparently randomly distributed. Vegetation covered 10% or less of the surface and was not diverse. Primarily there was a grazed and short probably seeded grass, probably Kentucky bluegrass (*Poa praetensis*). Healthy Fourwing saltbushes also covered the site, but nothing else except a few small Indian rice grasses.

View from above of first Poison Canyon site. Note extent of disturbed area, lack of vegetation, and telephone poles for scale.

The second site at the Poison Canyon location includes a large mine pile (20 x 80 x 4 m) and three small depressions (10x 10m) adjacent to a cliff-forming sandstone. The site is much smaller, possibly up to 100 m x 250 m. The average uranium reading is 50 +/- 20 uRem/ hr. Some areas of outcrop, drainage and plain are up to 80 uRem/ hr--but it is spatially variable and not consistent w/in the landscape. One 30 cm square spot held up to 300 uRem/ hr. This spot was unvegetated and otherwise completely unremarkable. The outcrop itself was also within this uranium reading range (30-70 uRem/ hr). The site was generally predominated by Grama grasses and Fourwing saltbush. There were a few Indian rice grass, Annual Goldenweed, and Stemless Evening Primrose at this site as well as some New Mexico sunflowers, but not at significant levels of uranium concentration.

Second Poison Canyon mine location. Note telephone pole for scale, and waste pile. The waste pile obscures two small ponds between the outcrop and the pile.

ICP-MS Uranium Concentrations

At Poison Canyon, plants were sampled relative to Field gamma ray meter readings. Three soil samples were taken at the locations shown on figure __. Of the samples listed in Table __.

	Avg Plant U	Stdev
Brickel Bush	1.81	*1.77*
Big Leaf	1.47	
Pinon Pine	2.04	*0.21*
Saltbush	11.15	*0.50*
Pofe	0.99	*0.58*
Black grama	0.61	
Nyctag	1.295	*0.76*
5	0.76	
Tobosa Grass	2.27	
Oxalis	7.6	
Point	**Soil U (ppm)**	**stdev**
T1	1921.1	*13.9*
T2	236.2	*27.9*
T3	191.5	*27.3*

Table __. ICP-MS Uranium content of plant and soil samples, Poison Canyon.

Discussion and Conclusion

The goal of this field investigation was to identify whether new and different plants grew on high uranium areas in Poison Canyon. Single or rare occurrences of plant species new to this study have been identified here. However, these mines, at different stages of being grown over, did not exhibit first-order differences in vegetation cover from the other two sites (with the exception of the Pinon-Juniper). Any first order differences were more in missing species diversity instead of additional diversity. These sites had no Russian thistle, Kochia, Snakeweed, Winterfat, little Rabbitbrush, and very little grass diversity.

Additional areas could be investigated, as outlined in the appendix. However, it is likely that these areas experienced disturbance at the same time as the mines investigated here, and in mining the same geologic units. Therefore, one might expect the same vegetation at additional sites in the immediate area.

Appendix

Land access permission was obtained from the Schmitt brothers, especially Bob Schmitt, 505-287-2266. Bob Schmitt and Terry Fletcher also provided instructions as to where to look in Poison Canyon. Paula Watt, Earth Science Instructor for UNM-Gallup, provided initial field suggestions (pwatt@gallup.unm.edu). Her suggested location was not apparent until the end of the field session.

She suggested looking for a noticeable landmark rock spinnacle on the left at the mouth of Poison Canyon. This was as one entered a private land from the south via a gully. In the lower part of the outcrop on the left side of the mouth of Poison Canyon, there are areas of low grade uraninite and pitchblende in sandstone. Adits and shafts and associated activity in the lower part of the canyon are all covered over. Higher in the geologic section, there is an oxidized zone with autinite as the principal uranium-bearing member. In this flat area, there is a short adit. Paula Watt suggested that there might be high readings for a small area surrounding this adit.

This adit is upslope stratigraphically and topographically from the rock spinnacle. It is in the Red Brushy Basin (RBB) member of the Morrison formation. The RBB also has uranium minerals that will fluoresce with black light (in the adit, where natural light is diffused). This rock spinnacle is visible from the Poison Canyon mine. It is 1 mile

west. The mesa top where Paula Watt's suggested adit is found is not marked as having a mine; it should be stratigraphically similar with the Mesa top mine that was investigated here. Paula Watt also suggested that carnotite could be found in the Todilto Formation Limestone, on the other side of a faint dirt road.

APPENDIX C

Grid Layout Description

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
1			decimal degress, (NAD 27)			Longitude	(NAD 27)		Latitude												Nad 1983				
2			Longitude	Latitude		deg	min	sec	deg	min	sec		zone	NORTH 1983	EAST 1983		Zone	North 1927	EAST 1927		orig Northings	dup	orig eastings	dup	error (ft)
3	Z0	1	-107.7812424	35.4097977		107	46	52.47	35	24	35.27		13S	247390	3922048		13S	247439.78	3921844.25		247391	390			5
4	Z1	2	-107.7812576	35.4102554		107	46	52.53	35	24	36.92		13S	247390	3922099		13S	247439.78	3921895.25		247393	390	3922104	99	5
5	Z2	3	-107.7812805	35.410717		107	46	52.61	35	24	38.58		13S	247390	3922150		13S	247439.78	3921946.25		247395	335	3922151		5
6	Z3	4	-107.7812958	35.4111671		107	46	52.66	35	24	40.2		13S	247390	3922200		13S	247439.78	3921996.25		247397	390	3922204		5
7	Z4	5	-107.7811966	35.4116096		107	46	52.31	35	24	41.79		13S	247400	3922249		13S	247449.8	3922045.25		247401	400	3922254		5
8	Z5	6	-107.7812119	35.4120598		107	46	52.36	35	24	43.42		13S	247400	3922299		13S	247449.8	3922095.25		247404	401	3922297		5
9	A5	7	-107.7806625	35.412075		107	46	50.39	35	24	43.47		13S	247450	3922299		13S	247499.8	3922095.25		247453	452			5
10	A4	8	-107.7807541	35.4116211		107	46	50.71	35	24	41.84		13S	247440	3922249		13S	247489.8	3922045.25		247451	449	3922195	198	5
11	A3	9	-107.7807388	35.4111786		107	46	50.66	35	24	40.24		13S	247440	3922200		13S	247489.8	3921996.25		247447	447	3922148	149	5
12	A2	10	-107.7807236	35.4107208		107	46	50.6	35	24	38.59		13S	247440	3922149		13S	247489.8	3921945.25		247445	445	3922099		5
13	A1	11	-107.7807083	35.4102783		107	46	50.55	35	24	37		13S	247440	3922100		13S	247489.8	3921896.25		247447	443	3922051	50	5
14	A0	12	-107.7806931	35.4098091		107	46	50.5	35	24	35.31		13S	247440	3922048		13S	247489.8	3921844.25		247443	443			5
15	B0	13	-107.7801437	35.409832		107	46	48.52	35	24	35.4		13S	247490	3922049		13S	247539.8	3921845.25		247492	492	3922099		5
16	B1	14	-107.780159	35.4102898		107	46	48.57	35	24	37.04		13S	247490	3922100		13S	247539.8	3921896.25		247493				
17	B2	15	-107.7801743	35.4107399		107	46	48.63	35	24	38.66		13S	247490	3922150		13S	247539.8	3921946.25		247495				
18	B3	16	-107.7801895	35.4111938		107	46	48.68	35	24	40.3		13S	247490	3922200		13S	247539.8	3921996.25		247497				
19	B4	17	-107.7802048	35.4116325		107	46	48.74	35	24	41.88		13S	247490	3922249		13S	247539.8	3922045.25		247500	499			
20	B5	18	-107.7801132	35.4120674		107	46	48.41	35	24	43.44		13S	247500	3922297		13S	247549.8	3922093.25		247503		3922299		
21	C5	19	-107.7795639	35.4120636		107	46	46.43	35	24	43.43		13S	247550	3922295		13S	247599.8	3922091.25		247551		3922297		
22	C4	20	-107.7796555	35.4115639		107	46	46.76	35	24	41.63		13S	247540	3922240		13S	247589.8	3922036.25		247549		3922246		
23	D4	21	-107.7789917	35.4114799		107	46	44.37	35	24	41.33		13S	247600	3922229		13S	247649.8	3922025.25		247601		3922240		
24	C3	22	-107.7796402	35.4112129		107	46	46.7	35	24	40.37		13S	247540	3922201		13S	247589.8	3921997.25		247548		3922195		
25	C2	23	-107.7796249	35.4107437		107	46	46.65	35	24	38.68		13S	247540	3922149		13S	247589.8	3921945.25		247543		3922145		
26	C1	24	-107.7796097	35.4102783		107	46	46.59	35	24	37		13S	247540	3922097		13S	247589.8	3921893.25		247542		3922094		
27	C0	25	-107.7795944	35.4098167		107	46	46.54	35	24	35.34		13S	247540	3922046		13S	247589.8	3921842.25		247540		3922045		
28	D0	26	-107.7790451	35.4098206		107	46	44.56	35	24	35.35		13S	247590	3922045		13S	247639.8	3921841.25		247541		3922043		
29	D1	27	-107.7790604	35.4102249		107	46	44.62	35	24	36.81		13S	247590	3922090		13S	247639.8	3921886.25		247592				
30	D2	28	-107.7791824	35.410675		107	46	45.06	35	24	38.43		13S	247580	3922140		13S	247629.8	3921936.25		247595		3922142		
31	D3	29	-107.7790909	35.4111366		107	46	44.73	35	24	40.09		13S	247590	3922191		13S	247639.8	3921987.25		247597				
32	D5	30	-107.7790146	35.412056		107	46	44.45	35	24	43.4		13S	247600	3922293		13S	247649.8	3922089.25		247602				
33	E5	31	-107.7784576	35.4120712		107	46	42.45	35	24	43.46		13S	247650	3922293		13S	247699.8	3922089.25		247653				
34	E4	32	-107.7784424	35.4115944		107	46	42.39	35	24	41.74		13S	247650	3922240		13S	247699.8	3922036.25		247650				
35	E3	33	-107.7785416	35.4111404		107	46	42.75	35	24	40.11		13S	247640	3922190		13S	247689.8	3921986.25		247648				
36	E2	34	-107.7785263	35.4106789		107	46	42.69	35	24	38.44		13S	247640	3922139		13S	247689.8	3921935.25		247645				
37	E1	35	-107.778511	35.4102402		107	46	42.64	35	24	36.86		13S	247640	3922090		13S	247689.8	3921886.25		247644				
38	E0	36	-107.7784958	35.4097977		107	46	42.58	35	24	35.27		13S	247640	3922041		13S	247689.8	3921837.25		247640				
39	F0	37	-107.7780533	35.40979		107	46	40.99	35	24	35.24		13S	247680	3922039		13S	247729.8	3921835.25		247689				
40	F1	38	-107.7779541	35.410244		107	46	40.63	35	24	36.88		13S	247690	3922089		13S	247739.8	3921885.25		247693				
41	F2	39	-107.777977	35.4106941		107	46	40.72	35	24	38.5		13S	247690	3922139		13S	247739.8	3921935.25		247698				
42	F3	40	-107.7778778	35.4111557		107	46	40.36	35	24	40.16		13S	247700	3922190		13S	247749.8	3921986.25		247701				
43	F4	41	-107.7778931	35.4116135		107	46	40.42	35	24	41.81		13S	247700	3922241		13S	247749.8	3922037.25		247702				
44	F5	42	-107.7779083	35.4120827		107	46	40.47	35	24	43.5		13S	247700	3922293		13S	247749.8	3922089.25		247705				
45	G0	43	-107.777504	35.4098129		107	46	39.01	35	24	35.33		13S	247730	3922040		13S	247779.8	3921836.25		247739				
46	G1	44	-107.7774048	35.4102554		107	46	38.66	35	24	36.92		13S	247740	3922089		13S	247789.8	3921885.25		247742				
47	G2	45	-107.77742	35.4107056		107	46	38.71	35	24	38.54		13S	247740	3922139		13S	247789.8	3921935.25		247746				
48	G3	46	-107.7774353	35.4111557		107	46	38.77	35	24	40.16		13S	247740	3922189		13S	247789.8	3921985.25		247748				
49	G4	47	-107.7773438	35.4116173		107	46	38.44	35	24	41.82		13S	247750	3922240		13S	247799.8	3922036.25		247751				
50	G5	48	-107.777359	35.4120522		107	46	38.49	35	24	43.39		13S	247750	3922288		13S	247799.8	3922084.25		247754				13
51	H5	49	-107.7768097	35.4119911		107	46	36.51	35	24	43.17		13S	247800	3922280		13S	247849.8	3922076.25		247804				
52	H4	50	-107.7769012	35.4115295		107	46	36.84	35	24	41.51		13S	247790	3922229		13S	247839.8	3922025.25		247797				12
53	H3	51	-107.776886	35.4111862		107	46	36.79	35	24	40.27		13S	247790	3922191		13S	247839.8	3921987.25		247796				
54	H2	52	-107.7768707	35.4107285		107	46	36.73	35	24	38.62		13S	247790	3922140		13S	247839.8	3921936.25		247791				
55	H1	53	-107.7768555	35.4102325		107	46	36.68	35	24	36.84		13S	247790	3922085		13S	247839.8	3921881.25		247791				
56	H0	54	-107.776947	35.409771		107	46	37.01	35	24	35.18		13S	247780	3922034		13S	247829.8	3921830.25		247789				
57	A1-	55	-107.7806778	35.4093323		107	46	50.44	35	24	33.6		13S	247440	3921995		13S	247489.8	3921791.25		247440				12
58	Z1-	56	-107.7813416	35.4093437		107	46	52.83	35	24	33.64		13S	247380	3921998		13S	247429.78	3921794.25		247388				11
59	B1-	57	-107.7802353	35.4093361		107	46	48.85	35	24	33.61		13S	247480	3921994		13S	247529.8	3921790.25		247485				11
60	C1-	58	-107.779686	35.4093475		107	46	46.87	35	24	33.65		13S	247530	3921994		13S	247579.8	3921790.25		247537				
61	D1-	59	-107.7791367	35.4093513		107	46	44.89	35	24	33.66		13S	247580	3921993		13S	247629.8	3921789.25		247586				10
62	E1-	60	-107.7785873	35.4093437		107	46	42.91	35	24	33.64		13S	247630	3921991		13S	247679.8	3921787.25		247635				10
63	F1-	61	-107.778038	35.4093323		107	46	40.94	35	24	33.6		13S	247680	3921988		13S	247729.8	3921784.25		247685				12
64	G1-	62	-107.7774887	35.4093246		107	46	38.96	35	24	33.57		13S	247730	3921986		13S	247779.8	3921782.25		247735				11
65	H1-	63	-107.7769394	35.4093285		107	46	36.98	35	24	33.58		13S	247780	3921985		13S	247829.8	3921781.25		247786				

APPENDIX D

Laboratory Soil Analyses Data

	A	B	C	D	E	F	G	H
1			Sec 27 samples analyzed by 400 oven, 120 min					
2								
3		**sample #**	**% OC**	**stdev**		sample #	**% OC**	stdev
4		1- 0	**3.89**			-A1	**2.31**	
5		1- 5				A1	**1.99**	0.15
6		1- 10	**3.95**			A3	**2.97**	
7		1- 15	**3.68**			A5		
8		1- 20				-C1	**2.20**	
9		1- 25				C1	**1.12**	0.00
10		1- 30	**3.41**			C3	**5.23**	
11		2- 0	**0.73**			C5	**3.06**	
12		2- 5	**0.69**			-E1	**3.58**	
13		2- 10	**0.59**	0.18		E1	**0.46**	
14		2- 15	**0.71**			E3	**1.12**	
15		2- 20	**0.86**			E5	**1.98**	
16		2- 25	**0.66**			-G1	**1.79**	
17		2- 30	**0.72**	0.24		G1	**0.55**	
18		3- 0	**0.59**			G3	**0.90**	0.18
19		3- 5				G5	**1.81**	
20		3- 10	**0.70**	0.12		B2	**2.80**	
21		3- 15				D2	**1.47**	0.05
22		3- 20	**0.69**			F2	**0.37**	0.03
23		3- 25	**0.77**			H2	**0.39**	
24		3- 30	**0.37**	0.52		B4	**2.67**	
25						C4	**0.77**	
26						D4	**0.24**	
27						F4	**2.72**	
28						H4	**1.69**	

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
3			% OC loss				% OC loss					% OC					%OC
4			**after 400**		**locn**	**Point**	**after 400**		**locn**	**Pit #**	**Depth**	**fter 400**		**locn**	**Pit #**	**Depth**	**after 400**
5	36	E1	2.16		36	A1	2.79		36	2	20	1.75		27?	1	20	5.47
6	36	E2	2.81		36	A2	3.54		36	2	30	1.25		36	1	0	1.89
7	36	E3	4.56		36	A3	2.45		36	2	40	1.08		36	1	7	1.65
8	36	F1	2.27		36	B1	1.58		36	2	40	1.18		36	1	21	1.65
9	36	F2	2.51		36	B2	3.94		36	2	50	1.16		36	1	35	1.52
10	36	F3	2.46		36	B3	2.51		36	2	60	1.52		36	1	35	1.46
11	36	G1	1.98		36	C1	2.31		36	3	10	7.48		36	1	49	0.57
12	36	G2	3.00		36	C2	3.90		36	3	20	5.25		36	1	60	2.80
13	36	G3	2.34		36	C3	2.92		36	3	30	4.35		36	1	70	3.12
14	36	H1	3.02		36	D1	2.24		36	3	40	4.50		36	2	0	2.10
15	36	H2	1.38		36	D2	5.18		36	3	50	4.34		36	2	10	2.17
16	36	H3	5.47		36	D3	3.09		36	3	60	4.30		blank			0.17
17	36	H3 dup	6.68		36	C1 dup	2.22		36	3	70	3.77					
18	BLANK		0.00		blank		0.08		blank			0.10					
19	27	A5	1.52														
20																	

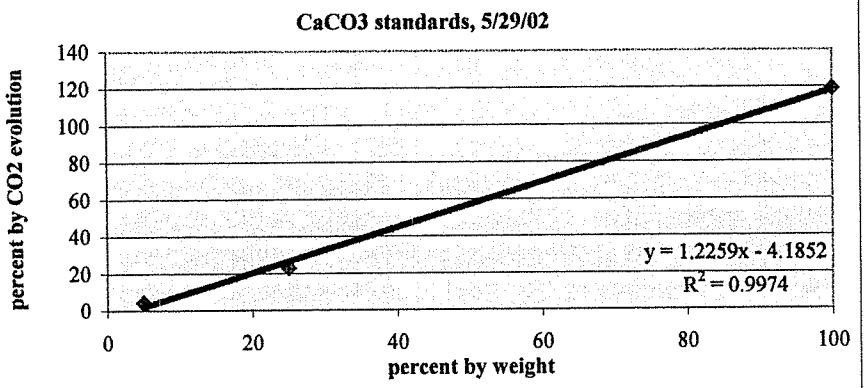
	K	L	M	N
28	**400 for 120 min**			
29	**5.47**	27	1	20
30	**1.52**	27	A5	
31	**1.89**	36	1	0
32	**1.65**	36	1	7
33	**1.65**	36	1	21
34	**1.52**	36	1	35
35	**1.46**	36	1	35 dup
36	**0.57**	36	1	49
37	**2.80**	36	1	60
38	**3.12**	36	1	70
39	**2.10**	36	2	0
40	**2.17**	36	2	10
41	**1.75**	36	2	20
42	**1.25**	36	2	30
43	**1.08**	36	2	40
44	**1.18**	36	2	40 dup
45	**1.16**	36	2	50
46	**1.52**	36	2	60
47	**7.48**	36	3	10
48	**5.25**	36	3	20
49	**4.35**	36	3	30
50	**4.50**	36	3	40
51	**4.34**	36	3	50
52	**4.30**	36	3	60
53	**3.77**	36	3	70
54	**2.79**	36	A1	
55	**3.54**	36	A2	
56	**2.45**	36	A3	
57	**1.58**	36	B1	
58	**3.94**	36	B2	
59	**2.51**	36	B3	
60	**2.31**	36	C1	
61	**2.22**	36	C1 dup	
62	**3.90**	36	C2	
63	**2.92**	36	C3	
64	**2.24**	36	D1	
65	**5.18**	36	D2	
66	**3.09**	36	D3	
67	**2.16**	36	E1	
68	**2.81**	36	E2	
69	**4.56**	36	E3	
70	**2.27**	36	F1	
71	**2.51**	36	F2	
72	**2.46**	36	F3	
73	**1.98**	36	G1	
74	**3.00**	36	G2	
75	**2.34**	36	G3	
76	**3.02**	36	H1	
77	**1.38**	36	H2	
78	**5.47**	36	H3	
79	**6.68**	36	H3	
80	**0.10**	blank		
81	**0.00**	blank		
82	**0.08**	BLANK		
83	**0.17**	blank		

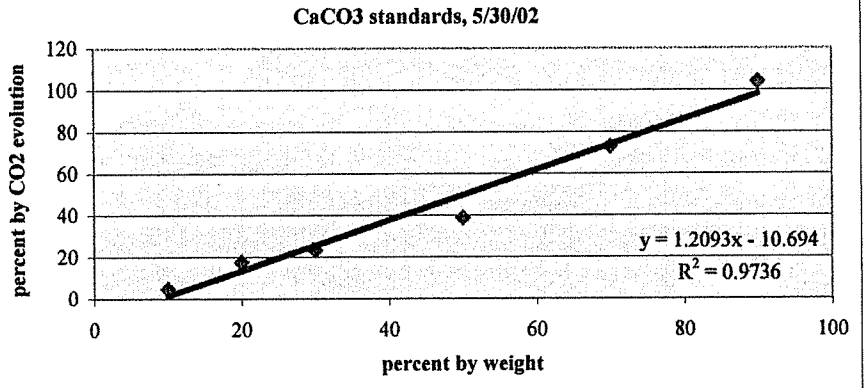
	A	B	C	D	E	F	G	H	I	J	K	L
1		Chittick Measurement of Section 27 Surface Soil Carbonate										
2				Sample	CO2			Correction		w/barometric		
3			Dish	Wt.	Evolved	Temp.	Pressure	Factor	CaCO3	pressure		
4	Date	Label	#	(g)	(ml)	(C)	(inches)		(%)	adjustment		
5									=((0.3866*H5*E5)/D5)	=((I5)-1.7381)/0.8797	Point	Average
6	29-May-02	A1-	33k	5.5609	30	25.5	30.08	1.0288	2.15	0.46		
7	30-May-02	A1-		5.5028	33	27	30	1.01741	2.36	0.71		
8	30-May-02	A1		7.5656	63	28	30	1.01741	3.28	1.75		
9	29-May-02	A1	681	7.1368	52	27	30.08	1.02018	2.87	1.29		
10	29-May-02	A3	608	6.2483	19	25.5	29.97	1.02323	1.20	-0.61		
11	30-May-02	A3		6.6105	30	27	30	1.01741	1.79	0.05	A1-	0.706
12	29-May-02	B2	619	5.4061	32	25.5	30.08	1.0288	2.35	0.70	A1	1.747
13	30-May-02	B2		5.5893	35	25.5	30	1.026	2.48	0.85	A3	0.533
14	29-May-02	B4	634	5.4803	33	26	30.08	1.02594	2.39	0.74	B2	0.848
15	30-May-02	B4		5.4827	40	25.5	30	1.026	2.89	1.31	B4	1.314
16	29-May-02	C1	640	6.1190	31	25	29.97	1.02626	2.01	0.31	-c1	1.24
17	27-Jun-02	C1	616	19.001	100	27.5	30	1.0145	2.06	0.37	c1	0.37
18	29-May-02	C1-	635	4.5803	22	25	30.08	1.02594	1.91	0.19	c3	0.00
19	27-Jun-02	C1-	215	15.1004	109	27.5	30	1.01450	2.83	1.24	c4	1.09
20	29-May-02	C3	653	6.0849	24	25.5	29.97	1.02323	1.56	-0.20	c5	2.63
21	27-Jun-02	c3	624	5.7578	23	25.5	30	1.026	1.58	-0.17	d2	0.00
22	29-May-02	C4	616	8.4059	46	26	30.08	1.02594	2.17	0.49	d4	0.40
23	27-Jun-02	c4	620	8.6412	59	26.5	30.08	1.02306	2.70	1.09	E1-	1.601
24	29-May-02	C5	620	3.5653	24	26	30.08	1.02594	2.67	1.06	E1-	0.368
25	27-Jun-02	c5	640	3.5344	36	25.5	30.08	1.0288	4.05	2.63	E3	1.606
26	29-May-02	D2	624	7.1938	23	26	30.08	1.02594	1.27	-0.53	E5	3.49
27	27-Jun-02	d2	33k	7.1427	25	25.5	30	1.02318	1.38	-0.40	F2	1.605
28	29-May-02	D4	621	4.4022	27	25.5	29.97	1.02323	2.43	0.78	F4	1.864
29	27-Jun-02	d4	634	13.4246	71	26.5	30.08	1.02306	2.09	0.40	G1-	-0.1302
30	30-May-02	E1-		6.3995	48	26	30	1.02318	2.97	1.4	G1	1.285
31	30-May-02	E1-		6.0641	51	27	30	1.02318	3.33	1.81	G3	1.915
32	30-May-02	E1		8.2937	42	26	30	1.02318	2	0.3	G5	3.779
33	30-May-02	E1		8.3917	45	26	30	1.02318	2.12	0.44	H2	0.56
34	30-May-02	E3		8.9569	72	27	30	1.02318	3.18	1.64	H4	1.79
35	30-May-02	E3		8.8693	70	27	30	1.02318	3.12	1.57		
36	30-May-02	E5		6.2975	68	27	30	1.02318	4.27	2.88		
37	30-May-02	E5		6.2949	85	27	30	1.02318	5.34	4.1		
38	7-Feb-03	E5		4.8383	57	25.5	29.86	1.02047				
39	30-May-02	F2		10.1845	81	27	30	1.02318	3.15	1.6		
40	30-May-02	F2		9.908	79	27	30	1.02318	3.15	1.61		
41	30-May-02	F4		6.2324	56	27	30	1.02318	3.55	2.06		
42	30-May-02	F4		5.561	45	26	30	1.02318	3.2	1.66		
43	30-May-02	G1-		6.6714	21	26	30	1.02318	1.25	-0.56		
44	30-May-02	G1-		6.7179	34	26	30	1.02318	2	0.3		
45	30-May-02	G1		8.5257	59	27	30	1.02318	2.74	1.14		
46	30-May-02	G1		8.0456	61	27	30	1.02318	3	1.43		
47	30-May-02	G3		7.7863	69	27	30	1.02318	3.51	2.01		
48	30-May-02	G3		7.3443	62	27	30	1.02318	3.34	1.82		
49	30-May-02	G5		6.8245	86	26.5	30	1.026	5	3.71		
50	30-May-02	G5		7.1182	92	26.5	30	1.026	5.13	3.85		
51	7-Feb-03	G5		7.1602	98	27	29.86	1.01188				
52	30-May-02	H2		7.8883	44	25.5	30	1.026	2.21	0.54		
53	30-May-02	H2		8.1128	46	25.5	30	1.026	2.25	0.58		
54	30-May-02	H4		6.8541	58	26.5	30	1.026	3.36	1.84		
55	30-May-02	H4		6.7966	56	26.5	30	1.026	3.27	1.74		

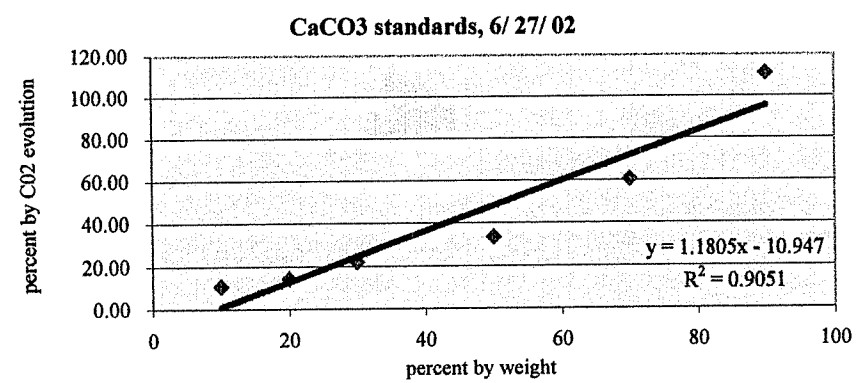
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1			**Chittick Measurement of Section 27 Soil Profile Carbonate**											
2										CO3				
3		Label	Dish	Sample	CO2			Correction		w/barometric		***barom. pres adjustment values		
4	Date		#	Wt.	Evolved	Temp.	Pressure	Factor	CaCO3	pressure				
5				(g)	(ml)	(C)	(inches)		(%)	adjustment				
6									=((0.3866*H6*E6)/D6)	=((I6)-1.7381)/0.8797				
7	27-Jun-02	1-0	32k	6.2332	17	25.5	29.95	1.026	1.08	-0.75		Point	Average	STDEV
8	27-Jun-02	1-0	621	6.2050	17	26	29.95	1.02318	1.08	-0.74				
9	7-Feb-03	1- 05		6.9703	22	24	29.86	1.02888	1.26			1-0	0	
10	27-Jun-02	1-10	38f	5.3994	11	24.5	30.05	1.03444	0.81	-1.05		1-5		
11	27-Jun-02	1-10	8k	5.4380	11	24.5	30.05	1.03444	0.81	-1.06		1-10	0	
12	27-Jun-02	1-15	2a	5.9818	14	24	30.05	1.03723	0.94	-0.91		1-15	0	
13	27-Jun-02	1-15	ca	5.9394	15	24.5	30.05	1.03444	1.01	-0.83		1-20		
14	7-Feb-03	1-25		7.1157	21	24.5	29.86	1.02608	1.17			1-25		
15	27-Jun-02	1-30	13a	11.9381	26	24.5	30.05	1.03444	0.87	-0.99		1-30	0	
16	7-Feb-03	1-30	47	5.5101	18	24	29.86	1.02888	1.30					
17	27-Jun-02	2-0	113	16.4868	160	28	30.05	1.01435	3.81	2.35		2-0	2.35	
18	27-Jun-02	2-5	112	17.8414	189	28	30.05	1.01435	4.15	2.75		2-5	2.75	
19	27-Jun-02	2-10	9k	14.6893	88	26	30.05	1.02594	2.38	0.73		2-10	0.73	
20	27-Jun-02	2-15	600	13.5630	65	26	30.05	1.02594	1.90	0.18		2-15	0.18	
21	27-Jun-02	2-20	24f	6.7888	35	25	30.05	1.03165	2.06	0.36		2-20	0.36	
22	27-Jun-02	2-20	9a	7.3968	35	25	30.05	1.03165	1.89	0.17		2-25	0	
23	27-Jun-02	2-25	666	7.1184	30	25	30.05	1.03165	1.68	-0.07		2-30	0.25	0.36
24	27-Jun-02	2-25	672	7.6222	29	25	30.05	1.03165	1.52	-0.25				
25	27-Jun-02	2-30	78	7.5891	33	25	30.05	1.03165	1.73	0.00		3-0	1.1	0.15
26	27-Jun-02	2-30	80	7.4962	41	25	30.05	1.03165	2.18	0.50		3-5		
27	27-Jun-02	3-0	676	9.1759	60	26	30.05	1.02594	2.59	0.97				
28	27-Jun-02	3-0	643	9.5666	67	26	30.05	1.02594	2.78	1.18		3-10	0.75	0.11
29	7-Feb-03	3-5		8.7048	68	25	29.86	1.02329	3.09			3-15		
30	27-Jun-02	3-10	700	8.3193	52	26	30.05	1.02594	2.48	0.84				
31	27-Jun-02	3-10	693	8.1581	48	25	30.05	1.03165	2.35	0.69		3-20	1.54	0.21
32	7-Feb-03	3-15		7.9191	58	25	29.86	1.02329	2.90			3-25	0.4143	0.33
33	27-Jun-02	3-20	614	7.7716	58	26	30.05	1.02594	2.96	1.39		3-30	0.88	
34	27-Jun-02	3-20	688	7.9676	65	26.5	30.05	1.02306	3.23	1.69				
35	27-Jun-02	3-25	626	7.9181	46	25.5	30.05	1.02880	2.31	0.65				
36	27-Jun-02	3-25	296	7.9778	38	25.5	30.05	1.02880	1.89	0.18				
37	27-Jun-02	3-30	he	16.1435	103	27.5	30.05	1.01727	2.51	0.88				

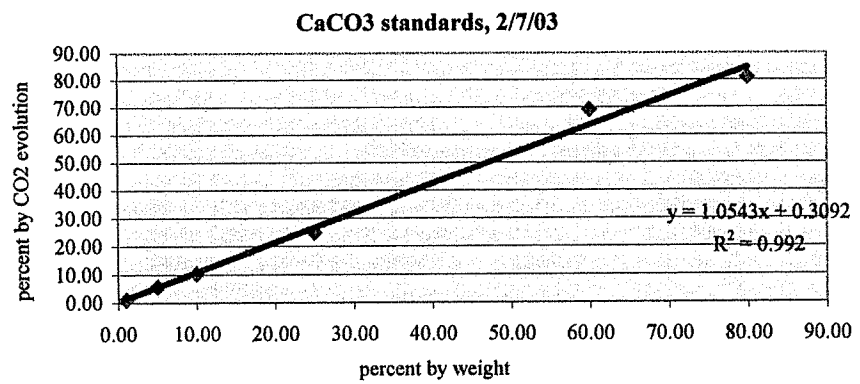
	A	B	C	D	E	F	G	H	I	J	K	L	M
1		**Chittick Measurement of Section 36 Surface Carbonate**											
2													
3					sample								CO3
4		Sample	dish wt	tub wt	and dish	Sample		CO2			Correction		w/barometric
5	Date	Number			wt	Wt.	acid level	Evolved	Temp.	Pressure	Factor	CaCO3	pressure
6			(g)		(g)	(g)		(ml)	(C)	(inches)		(%)	adjustment
7												=(0.3866*K7*H7)/F7	=((L7))/1.1708
8	2-Nov-02	101	A1	1.7888	11.215	9.4262	10	42	21.5	30.05	1.05103	1.81	1.55
9	2-Nov-02	102	A2	1.8127	8.5472	6.7345	10	84	22	30.05	1.04829	5.05	4.32
10	7-Feb-03		A2	1.8076	9.1435	7.3359	10	59	26	29.86	1.98429	6.17	
11	2-Nov-02	103	A3	1.7974	11.257	9.4596	10	75	22	30.05	1.04829	3.21	2.74
12	7-Feb-03		A3	1.798	13.7094	11.9114	10	100	27	29.86	1.01188	3.28	
13	2-Nov-02	104	B1	1.832	13.9299	12.0979	10	54	22.5	30.05	1.04556	1.80	1.54
14	7-Feb-03		B1	1.7771	8.2766	6.4995	10	37	25	29.86	1.02329	2.25	
15	2-Nov-02	105	B2	1.7931	11.4862	9.6931	10	82	22.5	30.05	1.04556	3.42	2.92
16													
17	2-Nov-02	106	B3	1.7886	12.4449	10.6563	10	56	22.5	30.05	1.04556	2.12	1.81
18	2-Nov-02	107	C1	1.8354	12.0895	10.2541	10	175	24.5	30.05	1.03444	6.83	5.83
19	2-Nov-02	dup	C1	1.7913	12.6957	10.9044	10.5	190	26	30.05	1.02594	6.91	5.90
20	7-Feb-03		C1	1.8176	6.0691	4.2515	10	75	25	29.86	1.02329	6.98	
21	2-Nov-02	108	C2	1.8413	14.7729	12.9316	10	165	24.5	30.05	1.03444	5.10	4.36
22	2-Nov-02	109	C3	1.779	9.3197	7.5407	14	15	21.5	30.05	1.05103	0.81	0.69
23	2-Nov-02	110	D1	1.8535	12.4175	10.564	10	170	24.5	30.05	1.03444	6.44	5.50
24													
25	2-Nov-02	111	D2	1.7947	13.5521	11.7574	10.5	70	22.5	30.05	1.04556	2.41	2.06
26	2-Nov-02	112	D3	1.7944	10.8153	9.0209	10	135	23.5	30.05	1.04003	6.02	5.14
27	2-Nov-02	113	E1	1.8089	12.1646	10.3557	10	70	22.5	30.05	1.04556	2.73	2.33
28	2-Nov-02	dup	E1	1.789	12.4118	10.6228	10	85	23	30.05	1.04282	3.23	2.76
29	2-Nov-02	114	E2	1.7779	10.49	8.7121	10	30	21.5	30.05	1.05103	1.40	1.20
30	2-Nov-02	115	E3	1.8036	12.8683	11.0647	10.5	39	21.5	30.05	1.05103	1.43	1.22
31													
32	2-Nov-02	116	F1	1.8026	10.5803	8.7777	10	10	21.5	30.05	1.05103	0.46	0.40
33	2-Nov-02	117	F2	1.7732	12.2234	10.4502	10.8	103	24	30.05	1.03723	3.95	3.38
34	2-Nov-02	118	F3	1.8051	11.8262	10.0211	10	14	22	30.05	1.04829	0.57	0.48
35	2-Nov-02	119	G1	1.7828	14.4207	12.6379	8.5	200	26	30.05	1.02594	6.28	5.36
36	2-Nov-02	120	G2	1.763	11.659	9.896	10.5	11	22	30.05	1.04829	0.45	0.38
37													
38	2-Nov-02	121	G3	1.7764	11.6967	9.9203	10	43	22	30.05	1.04829	1.76	1.50
39	2-Nov-02	122	H1	1.7937	12.0036	10.2099	10	10	22	30.05	1.04829	0.40	0.34
40	2-Nov-02	123	H2	1.7885	11.2095	9.421	10	157	25	30.05	1.03165	6.65	5.68
41	2-Nov-02	124	H3	1.7711	9.6262	7.8551	11	30	22	30.05	1.04829	1.55	1.32
42	2-Nov-02	dup	H3	1.7973	10.1566	8.3593	10	26	22	30.05	1.04829	1.26	1.08

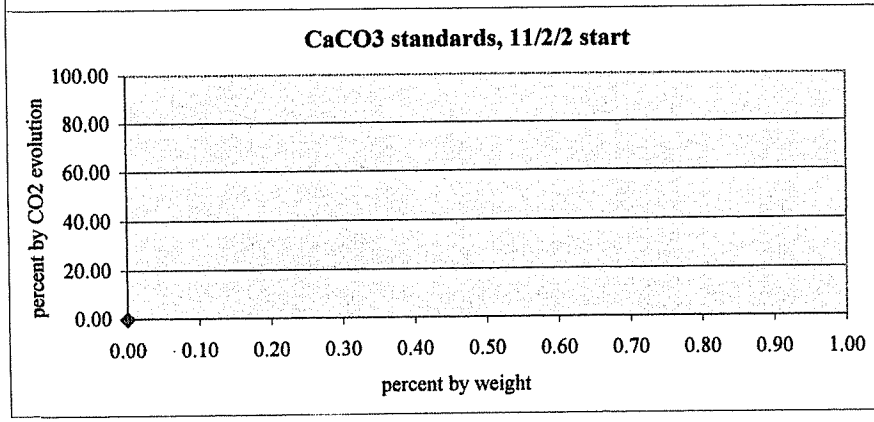
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		**Chittick Measurement of Section 36 Soil Profile Carbonate**												
2						sample								CO3
3		Sample		Locn	tub wt	and dish	Sample		CO2			Correction		w/barometric
4	Date	Number	36-soil pit	depth		wt	Wt.	acid level	Evolved	Temp.	Pressure	Factor	CaCO3	pressure
5					(g)	(g)	(g)		(ml)	(C)	(inches)		(%)	adjustment
6							=F6-E6						=(0.3866*L6*I6)/G6	=((M6))/1.1708
7	2-Nov-02	80	1	0	1.8624	21.2027	19.3403	11	48	22	30.06	1.04829	1.01	0.86
8	2-Nov-02	81	1	7	1.8302	19.6309	17.8007	10	37	22	30.06	1.04829	0.84	0.72
9	2-Nov-02	82	1	21	1.8234	20.6272	18.8038	10	4	21	30.06	1.05376	0.09	0.07
10	2-Nov-02	83	1	35	1.8499	22.0074	20.1575	10	3	21	30.06	1.05376	0.06	0.05
11	2-Nov-02	84	1	49	1.8869	19.9672	18.0803	10	4	21.5	30.06	1.05103	0.09	0.08
12	2-Nov-02	85	1	60	1.781	19.0081	17.2271	10.5	24	21.5	30.06	1.05103	0.57	0.48
13	2-Nov-02	86	1	70	1.7925	22.5156	20.7231	5	200	25.5	30.06	1.0288	3.84	3.28
14	7-Feb-03		1	70	1.805	6.905	5.1	6.5	240	29	29.86	1.00024	18.20	15.54
15														
16	2-Nov-02	87	2	0	1.843	21.982	20.139	10.5	6	21.5	30.06	1.05103	0.12	0.10
17	2-Nov-02	88	2	10	1.8685	23.0362	21.1677	10.5	8	21.5	30.06	1.05103	0.15	0.13
18	2-Nov-02	89	2	20	1.9309	23.8179	21.887	10	4	21	30.06	1.05376	0.07	0.06
19	2-Nov-02	90	2	30	1.9112	24.3303	22.4191	10	117	23	30.06	1.04282	2.10	1.80
20	2-Nov-02	91	2	40	1.8952	27.6668	25.7716	10	250	26	30.06	1.02594	3.85	3.29
21	7-Feb-03		2	40	1.7683	7.0219	5.2536	10	59	25.5	29.86	1.02047	4.43	3.78
22	2-Nov-02	92	2	50	1.8714	26.0663	24.1949	10	200	25	30.06	1.03165	3.30	2.82
23	7-Feb-03		2	50	1.7684	7.399	5.6306	10	81	26	29.86	1.01765	5.66	4.83
24	2-Nov-02	93	2	60	1.9098	23.6894	21.7796	10	200	25	30.06	1.03165	3.66	3.13
25	7-Feb-03		2	60	1.8182	7.2967	5.4785	10	148	28	29.86	1.00612	10.51	8.97
26														
27	2-Nov-02	94	3	10	1.8342	19.6269	17.7927	10	81	21	30.06	1.05376	1.85	1.58
28	2-Nov-02	95	3	20	1.8887	20.3667	18.478	10	15	21	30.06	1.05376	0.33	0.28
29	2-Nov-02	96	3	30	1.8669	24.0131	22.1462	10	15	21	30.06	1.05376	0.28	0.24
30	2-Nov-02	97	3	40	1.8662	21.499	19.6328	10	29	21	30.06	1.05376	0.60	0.51
31	2-Nov-02	98	3	50	1.8538	22.8849	21.0311	12	48	21	30.06	1.05376	0.93	0.79
32	2-Nov-02	99	3	60	1.7714	22.2978	20.5264	10	88	22.5	30.06	1.04556	1.73	1.48
33	2-Nov-02	100	3	70	1.8584	21.3806	19.5222	10	111	23	30.06	1.04282	2.29	1.96

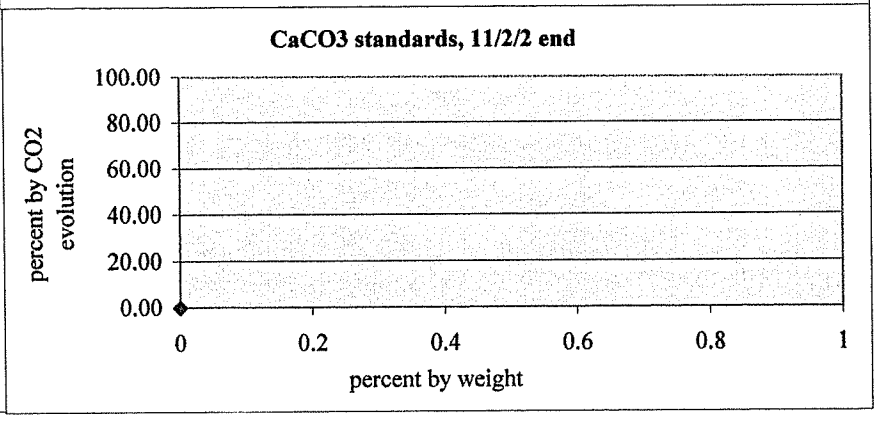

CaCO3 standards, 5/29/02
percent by CO2 evolution
140
120
100
80
60
40
20
0
0
20
40
60
80
100
percent by weight
y = 1.2259x - 4.1852
R2 = 0.9974


CaCO3 standards, 5/30/02
percent by CO2 evolution
120
100
80
60
40
20
0
0
20
40
60
80
100
percent by weight
y = 1.2093x - 10.694
R2 = 0.9736


CaCO3 standards, 6/ 27/ 02
percent by C02 evolution
120.00
100.00
80.00
60.00
40.00
20.00
0.00
0
20
40
60
80
100
percent by weight
y = 1.1805x - 10.947
R2 = 0.9051


CaCO3 standards, 2/7/03
percent by CO2 evolution
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
percent by weight
y = 1.0543x + 0.3092
R2 = 0.992


CaCO3 standards, 11/2/2 start
percent by CO2 evolution
100.00
80.00
60.00
40.00
20.00
0.00
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
percent by weight


CaCO3 standards, 11/2/2 end
percent by CO2 evolution
100.00
80.00
60.00
40.00
20.00
0.00
0
0.2
0.4
0.6
0.8
1
percent by weight

	A	B	C	D
1	27	1	0	7.75
2	27	1	5	8
3	27	1	10	7.97
4	27	1	15	7.76
5	27	1	20	7.88
6	27	1	20	8.06
7	27	1	25	7.84
8	27	1	30	8.02
9				
10	27	2	0	7.64
11	27	2	5	7.75
12	27	2	15	7.75
13	27	2	25	7.67
14				
15	27	3	0	7.53
16	27	3	5	7.36
17	27	3	10	7.74
18	27	3	15	7.53
19	27	3	20	7.65
20	27	3	25	7.43
21	27	3	30	7.5
22				
23				
24	36	1	0	7.73
25	36	1	14	7.85
26	36	1	28	4.95
27	36	1	42	4.51
28	36	1	55	4.74
29	36	1	65	7.77
30				
31	36	2	0	7.7
32	36	2	5	7.72
33	36	2	20	8.12
34	36	2	40	8.32
35	36	2	55	8.35
36	36	2	55	8.39
37	36	2	65	8.4
38				
39	36	3	40	8
40	36	3	50	8.05
41	36	3	60	8.03
42	36	3	a	7.67
43	36	3	Bk	7.99
44				

pH

	A	B	C
1	36	A1	7.63
2	36	A3	7.44
3	36	B1	7.58
4	36	B2	7.65
5	36	B3	7.42
6	36	C1	7.73
7	36	C2	7.72
8	36	C3	7.02
9	36	D1	7.96
10	36	D3	7.33
11	36	E1	7.68
12	36	E2	7.47
13	36	E3	7.37
14	36	F1	7.37
15	36	F2	7.46
16	36	F3	7.65
17	36	G1	7.73
18	36	G2	7.35
19	36	G3	7.6
20	36	H1	7.2
21	36	H2	7.78
22	36	H3	7.24
23			
24	27	-A1	7.7
25	27	-C1	7.96
26	27	-E1	7.78
27	27	-G1	8.19
28	27	A1	7.93
29	27	A3	7.8
30	27	A5	8.1
31	27	B4	7.99
32	27	C3	7.71
33	27	C4	7.62
34	27	C5	7.77
35	27	D2	7.72
36	27	D2	7.76
37	27	D4	7.88
38	27	E1	7.75
39	27	E3	7.87
40	27	E5	8.04
41	27	F2	8.06
42	27	F4	7.2
43	27	G1	7.88
44	27	G3	7.57
45	27	G5	7.79
46	27	H2	7.73
47	27	H4	8.37

	A	B	C	D	E	F	G
48	**Section 27 Surface Soils**						
49	Locn	sand % of total		silt % of total		clay % of total	
50	-A1						
51	A1	70.44		15.18		14.39	
52	A3						
53	A5						
54	B2						
55	B4						
56	-C1	50.77		35.29		13.94	
57	C1	76.61		14.80		8.59	
58	C3	11.10		52.19		36.72	
59	C4	85.69		8.42		5.89	
60	D2	61.46		21.41		17.14	
61	D4	83.77		9.86		6.37	
62	-E1	24.85		63.45		11.70	
63	E1	81.25		11.34		7.41	
64	E3 dup	52.34		38.74	0.23	8.92	0.23
65	E3 dup	52.34	13.14	38.42	13.07	9.24	0.07
66	E3	70.91		19.94		9.14	
67	E5	50.50		27.87		21.63	
68	F2	78.94		14.50		6.56	
69	F4	57.04		23.72		19.25	
70	-G1	55.38		32.89		11.73	
71	G1	104.61	19.13	-12.66	19.20	8.06	0.06
72	G1 dup	77.55		14.49		7.96	
73	G3	80.48		12.32		7.19	
74	G5	62.46		22.23		15.31	
75	H2	82.79		10.67		6.54	
76	H4	56.88		33.24		9.88	
77							
78							
79	**Section 36 Surface Soils**						
80	Locn	sand % of total		silt % of total		clay % of total	
81	A1	65.62		22.81		11.57	
82	A2	42.31		46.19		11.49	
83	A3	30.01		60.00		9.99	
84	B1	75.86		22.64		1.50	
85	B2	49.85		39.30		10.85	
86	B3	47.66		41.37		10.96	
87	F1	31.78	0.92	55.37	0.99	12.85	0.07
88	F1 dup	30.47		56.77		12.76	
89	C1	39.05	1.14	59.41	6.74	1.54	7.87
90	C1 dup	37.44		49.88		12.67	
91	C2	32.01		59.03		8.96	
92	C3	62.97					
93	D1	30.25		53.42		16.33	
94	D1			53.77		15.99	
95	D2	34.88		39.92	0.25	25.20	0.25
96	D2 dup			40.27		24.85	
97	D3	65.72		21.75		12.53	
98	E1	34.40		50.18		15.42	
99	E2	17.39		58.22		24.39	
100	E3	25.39		53.78		20.83	
101	F2	20.03		64.24	0.61	15.74	0.61
102	F2 dup			65.10		14.88	
103	D2	34.50		45.25		20.25	
104	F3	59.44		30.23	0.50	10.32	0.50
105	F3 dup			30.94		9.61	
106	G1	40.10		59.90		0.00	
107	G2	43.96		44.39		11.65	
108	G3	51.23		34.08	4.61	14.69	4.61
109	G3 dup			40.60		8.16	
110	H1	28.12	0.16	63.60	0.23	8.28	0.07
111	H1 dup	27.89		63.92		8.19	
112	H2	26.18		61.85		11.97	
113	H3	46.89		42.82		10.28	

	A	B	C	D	E	F	G
1	**Section 27 Soil Profiles**						
2	**Locn**	**sand % of total**	**std dev sand**	**silt % of total**	**std dev silt**	**clay % of total**	**std dev clay**
3	1-0	15.84		39.63		44.53	
4	1-10	12.75		38.31		48.94	
5	1-20	12.95		39.75		47.30	
6	1-30	10.83					
7							
8	2-0	76.57		10.78		12.65	
9	2-10	80.49		11.80		7.71	
10	2-20	65.90		10.27		23.84	
11	2-30	79.62		10.10		10.28	
12							
13	3-0D	79.65	0.25	11.21	0.56	9.14	0.31
14	3-0	79.29		12.00		8.71	
15	3-10	82.30		10.61		7.09	
16	3-20	75.45		13.36		11.19	
17	3-30	78.13	0.11	12.49	0.11	9.38	0.22
18	3-30D	77.98		12.33		9.68	
19							
20							
21	**Section 36 Soil Profiles**						
22	**Locn**	**sand % of total**		**silt % of total**		**clay % of total**	
23	1 - 0	78.20		13.63		8.17	
24	1 - 7	74.53		15.62		9.85	
25	1 - 21	74.00		15.65		10.35	
26	1 - 35	75.85		14.68		9.47	
27	1 - 49	87.13		7.92		4.95	
28	1 - 60	49.41		37.68		12.91	
29	1- 70	33.49		46.83		19.68	
30							
31	2 - 0	63.57		21.33		15.10	
32	2 - 10	69.95		16.55		13.51	
33	2 - 20	72.00		14.78		13.22	
34	2 - 30	71.95		15.47		12.58	
35	2 - 40	76.44		11.04		12.52	
36	2 - 50	71.76		14.09		14.14	
37	2 - 60	54.59		29.74		15.67	
38							
39	3-10	34.06		47.79		18.15	
40	3-20	21.92		46.19		31.89	
41	3- 30						
42	3 - 40	17.95		57.85		24.20	
43	3 - 50	16.96		79.18		3.86	
44	3 - 60	15.37		49.40		35.23	
45	3 - 70	16.81		33.21		49.98	
46							
47							

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1																											
2				F1A	F1A	F1A	F1A	*F1B*	F1B	F1B	F1B	F1B	*F2A*	F2A	F2A	F2A	F2A	*F2B*	F2B	F2B	F2B	F2B	*F3A*	F3A	F3A	F3A	F3A
3	*Sample:*	mass	*Sample:*	U / 238	Total DF	RSD (%)	U ppm	*Sample:*	U / 238	Total DF	RSD (%)	U ppm	*Sample:*	U / 238	Total DF	RSD (%)	U ppm	*Sample:*	U / 238	Total DF	RSD (%)	U ppm	*Sample:*	U / 238	Total DF	RSD (%)	U ppm
4	*27-2-0*	2.09	*27-2-0*	895	50	6.2	21.41	*27-2-0*	438.1	50	5.85	10.48	*27-2-0*	33450	50	9.83	800.24	*27-2-0*	3345	50	12.89	80.02	*27-2-0*	1263	5	0.68	30.22
5	*27-2-0*	2.09	*27-2-0*	748.6	1032.43	2.94	17.91	*27-2-0*	360.7	1032.43	4.01	8.63	*27-2-0*	28800	1032.43	4.14	689.00	*27-2-0*	2458	1032.43	5.22	58.80	*27-2-0*	1108	50.7	3	26.51
6	*27-2-0b*	2.68	*27-2-0b*	1261	50	8.87	23.53	*27-2-0b*	575.7	50	4.83	10.74	*27-2-0b*	45510	50	8.22	849.07	*27-2-0b*	5106	50	16.57	95.26	*27-2-0b*	1343	5	0.69	25.06
7	*27-2-0b*	2.68	*27-2-0b*	1060	1032.43	2.09	19.78	*27-2-0b*	497.6	1032.43	0.89	9.28	*27-2-0b*	40420	1032.43	3.28	754.10	*27-2-0b*	3802	1032.43	2.56	70.93	*27-2-0b*	1169	50.7	0.86	21.81
8	*27-2-0b*	2.68																*27-2-0b DUP*	5999	50	12.37	111.92					
9	*27-2-0b*	2.68																*27-2-0b DUP*	4436	1032.43	0.94	82.76					
10	*27-2-10*	2.41	*27-2-10*	1252	50	7.93	25.98	*27-2-10*	629.1	50	3.04	13.05	*27-2-10*	23100	50	12.32	479.25	*27-2-10*	3578	50	16.14	74.23	*27-2-10*	1364	5	0.76	28.30
11	*27-2-10*	2.41	*27-2-10*	1071	1032.43	2.12	22.22	*27-2-10*	557.8	1032.43	2.6	11.57	*27-2-10*	19460	1032.43	4.45	403.73	*27-2-10*	2675	1032.43	1.51	55.50	*27-2-10*	1202	50.7	1.36	24.94
12	*27-2-20*	2.66	*27-2-20*	2592	50	8.05	48.72	*27-2-20*	1293	50	3.3	24.30	*27-2-20*	7567	50	14.33	142.24	*27-2-20*	1244	50	17.74	23.38	*27-2-20*	1006	5	1.52	18.91
13	*27-2-20*	2.66	*27-2-20*	2247	1032.43	0.14	42.24	*27-2-20*	1142	1032.43	2.78	21.47	*27-2-20*	5783	1032.43	3.63	108.70	*27-2-20*	964.6	1032.43	10.21	18.13	*27-2-20*	871.6	50.7	2.17	16.38
14	*27-2-20*	2.66						*27-2-20*	1156	1032.43	1.74	21.73															
15	*27-2-30*	2.5	*27-2-30*	1280	50	8.63	25.60	*27-2-30*	791.9	50	2.15	15.84	*27-2-30*	5370	50	15.07	107.40	*27-2-30*	941.8	50	16.94	18.84	*27-2-30*	954.3	5	3.44	19.09
16	*27-2-30*	2.5	*27-2-30*	1080	1032.43	1.19	21.60	*27-2-30*	680.9	1032.43	0.9	13.62	*27-2-30*	4059	1032.43	0.88	81.18	*27-2-30*	731.8	1032.43	14.55	14.64	*27-2-30*	837.2	50.7	2.05	16.74
17	*27-2-30*	2.5						*27-2-30*	696.8	1032.43	0.39	13.94															
18	*36-1-0*	2.56	*36-1-0*	229.9	50	12.79	4.49	*36-1-0*	62.98	50	1.89	1.23	*36-1-0*	3181	50	15.37	62.13	*36-1-0*	1052	50	16.93	20.55	*36-1-0*	1201	5	0.99	23.46
19	*36-1-0*	2.56	*36-1-0*	196	1032.43	4.14	3.83	*36-1-0*	82.56	1032.43	12.56	1.61	*36-1-0*	2309	1032.43	0.54	45.10	*36-1-0*	823.6	1032.43	13.79	16.09	*36-1-0*	1055	50.7	1.16	20.61
20	*36-1-0*	2.56						*36-1-0*	148.5	1032.43	6.46	2.90															
21	*36-1-21*	2.4	*36-1-21*	304.5	50	12.92	6.34	*36-1-21*	134.6	50	3.92	2.80	*36-1-21*	3707	50	16.08	77.23	*36-1-21*	715.6	50	17.36	14.91	*36-1-21*	666.9	5	0.62	13.89
22	*36-1-21*	2.4	*36-1-21*	259	1032.43	2.3	5.40	*36-1-21*	112.4	1032.43	1.58	2.34	*36-1-21*	2856	1032.43	2.94	59.50	*36-1-21*	658.5	1032.43	19.57	13.72	*36-1-21*	581.2	50.7	0.8	12.11
23	*36-1-42*	2.73	*36-1-42*	687.7	50	8.08	12.60	*36-1-42*	219.3	50	4.84	4.02	*36-1-42*	1221	50	15.21	22.36	*36-1-42*	210.2	50	16.95	3.85	*36-1-42*	180.2	5	1.76	3.30
24	*36-1-42*	2.73	*36-1-42*	596.7	1032.43	0.39	10.93	*36-1-42*	173.6	1032.43	3.92	3.18	*36-1-42*	909.7	1032.43	1.85	16.66	*36-1-42*	214.4	1032.43	26.74	3.93	*36-1-42*	182	50.7	0.94	3.33
25	*36-1-42*	2.73						*36-1-42*	178.8	1032.43	1.37	3.27															
26	*36-1-60*	2.43	*36-1-60*	9370	50	3.49	192.80	*36-1-60*	3719	50	3.85	76.52	*36-1-60*	8349	50	13.58	171.79	*36-1-60*	1442	50	16.13	29.67	*36-1-60*	1062	5	0.68	21.85
27	*36-1-60*	2.43	*36-1-60*	9171	1032.43	2.31	188.70	*36-1-60*	3416	1032.43	0.77	70.29	*36-1-60*	6094	1032.43	2.29	125.39	*36-1-60*	1086	1032.43	6.36	22.35	*36-1-60*	921.3	50.7	1.81	18.96
28	*27+C1*	2.58	*27+C1*	1214	50	4.95	23.53	*27+C1*	587.1	50	4.84	11.38	*27+C1*	6666	50	13.38	129.19	*27+C1*	1553	50	19.13	30.10	*27+C1*	1423	5	0.67	27.58
29	*27+C1*	2.58	*27+C1*	1059	1032.43	1.33	20.52	*27+C1*	487.1	1032.43	2.86	9.44	*27+C1*	4910	1032.43	3.03	95.16	*27+C1*	1752	1032.43	4.73	33.95	*27+C1*	1251	50.7	1.2	24.24
30	*27+C1*	2.58						*27+C1*	533.9	1032.43	5.97	10.35															
31	*27+D2*	2.53	*27+D2*	4390	50	5.21	86.76	*27+D2*	2403	50	0.75	47.49	*27+D2*	19900	50	11.72	393.28	*27+D2*	4689	50	14.71	92.67	*27-D2*	5038	5	0.37	99.57
32	*27+D2*	2.53	*27+D2*	3811	1032.43	3.34	75.32	*27+D2*	2091	1032.43	2.43	41.32	*27+D2*	16140	1032.43	4.21	318.97	*27+D2*	7219	1032.43	19.84	142.67	*27-D2*	5092	50.7	1	100.63
33	*27+D2*	2.53	*27+D2*	3867	1032.43	0.87	76.42						*27+D2 DUP*	19900	50	11.72	393.28										
34	*27+D2*	2.53											*27+D2 DUP*	17020	1032.43	5.16	336.36										
35	*27+G1*	2.5	*27+G1*	243.8	50	6.49	4.88	*27+G1*	168.9	50	8.36	3.38	*27+G1*	7261	50	14.32	145.22	*27+G1*	1195	50	15.77	23.90	*27-G1*	468.2	5	1.61	9.36
36	*27+G1*	2.5	*27+G1*	230.7	1032.43	8.04	4.61	*27+G1*	137.1	1032.43	7.75	2.74	*27+G1*	5211	1032.43	1.65	104.22	*27+G1*	918.5	1032.43	11.57	18.37	*27-G1*	398.5	50.7	1.52	7.97
37	*27+G1*	2.5						*27+G1*	148.1	1032.43	5.39	2.96															
38	*27-D2b*	2.43	*27-D2b*	4148	50	4.53	85.35	*27-D2b*	2472	50	2.87	50.86	*27+D2b*	20700	50	11	425.93	*27+D2b*	5190	50	14.58	106.79	*27-D2b*	3930	5	1.08	80.86
39	*27-D2b*	2.43	*27-D2b*	3577	1032.43	1.46	73.60	*27-D2b*	2180	1032.43	0.79	44.86	*27+D2b*	17150	1032.43	4.36	352.88	*27+D2b*	4116	1032.43	3.04	84.69	*27-D2b*	4019	50.7	1.55	82.70
40	*27-D2b*	2.43						*27-D2b*	2190	1032.43	0.63	45.06															
41																											
42																											
43	=final total volume			(volume of liquids added and carryover not important for concentration)																							
44		Volume	Volume	Volume	Volume	Volume	Volume	Volume																			
45		F1A	F1B	F2A	F2B	F3A	F3B	F4																			
46		50	50	50	50	50	50	50																			

	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW
1												U										
2	*F3B*	F3B	F3B	F3B	F3B	*F4*	F4	F4	F4	F4		Sum of	U from				= F1A + F1B	= F2A + F2B	= F3A + F3B			
3	*Sample:*	U / 238	Total DF	RSD (%)	U ppm	*Sample:*	U / 238	Total DF	RSD (%)	U ppm	*Sample:*	extn values	MW digest		Sample:	=(((H1/1000)*50)/F1)	F1 U ppm	F2 U ppm	F3 U ppm	F4 U ppm	F5 U ppm	SUM
4	*27-2-0*	529.5	5	0.5	12.67	*27-2-0*	7117	5	1.2	170.26	*27-2-0*	1125.30	527.35	F5	27-2-0	7.58	31.89	880.26	42.88	170.26	7.58	1132.88
5	*27-2-0*	456.3	50.7	1.74	10.92	*27-2-0*	7060	50.7	0.63	168.90	*27-2-0*	980.66		F5	27-2-0	4.74	26.54	747.80	37.42	168.90	4.74	985.40
6	*27-2-0b*	453.3	5	2.35	8.46	*27-2-0b*	5496	5	1.73	102.54	*27-2-0b*	1114.65		F5	27-2-0b	6.35	34.27	944.33	33.51	102.54	6.35	1120.99
7	*27-2-0b*	389.2	50.7	1.88	7.26	*27-2-0b*	5477	50.7	1.4	102.18	*27-2-0b*	985.35		F5	27-2-0b	4.62	29.06	825.04	29.07	102.18	4.62	989.97
8											*27-2-0b*							111.92				
9											*27-2-0b*							82.76				
10	*27-2-10*	714	5	1.01	14.81	*27-2-10*	4436	5	4.88	92.03	*27-2-10*	727.66	344.9	F5	27-2-10	4.20	39.03	553.49	43.11	92.03	4.20	731.86
11	*27-2-10*	629.6	50.7	1.8	13.06	*27-2-10*	4458	50.7	0.65	92.49	*27-2-10*	623.51		F5	27-2-10	3.96	33.79	459.23	38.00	92.49	3.96	627.47
12	*27-2-20*	454	5	1.78	8.53	*27-2-20*	3178	5	1.73	59.74	*27-2-20*	325.83	187.7	F5	27-2-20	3.46	73.03	165.62	27.44	59.74	3.46	329.28
13	*27-2-20*	390.4	50.7	2.44	7.34	*27-2-20*	3256	50.7	1.38	61.20	*27-2-20*	275.46		F5	27-2-20	3.34	63.70	126.83	23.72	61.20	3.34	278.80
14											*27-2-20*						21.73					
15	*27-2-30*	477.9	5	1.22	9.56	*27-2-30*	4129	5	0.63	82.58	*27-2-30*	278.90	218.8	F5	27-2-30	3.94	41.44	126.24	28.64	82.58	3.94	282.83
16	*27-2-30*	405.7	50.7	1.45	8.11	*27-2-30*	4161	50.7	0.92	83.22	*27-2-30*	239.11		F5	27-2-30	3.90	35.22	95.82	24.86	83.22	3.90	243.01
17											*27-2-30*											
18	*36-1-0*	364.2	5	0.87	7.11	*36-1-0*	1643	5	1.69	32.09	*36-1-0*	151.06	7	F5	36-1-0	0.97	5.72	82.68	30.57	32.09	0.97	152.03
19	*36-1-0*	314.4	50.7	1.68	6.14	*36-1-0*	1407	50.7	1.07	27.48	*36-1-0*	120.85		F5	36-1-0	0.86	5.44	61.18	26.75	27.48	0.86	121.71
20											*36-1-0*						2.90					
21	*36-1-21*	321	5	1.69	6.69	*36-1-21*	766.8	5	1.56	15.98	*36-1-21*	137.84	3.39	F5	36-1-21	1.68	9.15	92.14	20.58	15.98	1.68	139.52
22	*36-1-21*	273.1	50.7	2.01	5.69	*36-1-21*	656.9	50.7	0.62	13.69	*36-1-21*	112.44		F5	36-1-21	1.44	7.74	73.22	17.80	13.69	1.44	113.88
23	*36-1-42*	139	5	0.86	2.55	*36-1-42*	385.7	5	1.95	7.06	*36-1-42*	55.73		F5	36-1-42	0.73	16.61	26.21	5.85	7.06	0.73	56.46
24	*36-1-42*	141.7	50.7	1.47	2.60	*36-1-42*	325.4	50.7	1.42	5.96	*36-1-42*	46.58		F5	36-1-42	0.42	14.11	20.59	5.93	5.96	0.42	47.01
25											*36-1-42*						3.27					
26	*36-1-60*	268.2	5	1.4	5.52	*F4-36-1-60*	1206	5	2	24.81	*36-1-60*	522.97	6.21	F5	36-1-60	1.47	269.32	201.46	27.37	24.81	1.47	524.44
27	*36-1-60*	228.3	50.7	0.49	4.70	*F4-36-1-60*	1036	50.7	1.56	21.32	*36-1-60*	451.70		F5	36-1-60	0.89	258.99	147.74	23.65	21.32	0.89	452.59
28	*27+C1*	597.5	5	1.16	11.58	*F4-27+C1*	4771	5	2.44	92.46	*27+C1*	325.81		F5	27 + C1	3.99	34.91	159.28	39.16	92.46	3.99	329.80
29	*27+C1*	514.2	50.7	2.25	9.97	*F4-27+C1*	4832	50.7	0.5	93.64	*27+C1*	286.92	174.4	F5	27 + C1	3.93	29.96	129.11	34.21	93.64	3.93	290.86
30											*27+C1*						10.35					
31	*27+D2*	1649	5	0.8	32.59	*F4-27+D2*	8092	5	0.7	159.92	*27+D2*	912.27	621.9	F5	27 + D2	31.46	134.25	485.95	132.15	159.92	31.46	943.74
32	*27+D2*	1463	50.7	2.1	28.91	*F4-27+D2*	8169	50.7	0.63	161.44	*27+D2*	869.27		F5	27 + D2	11.42	116.64	461.64	129.55	161.44	11.42	880.69
33											*27+D2*						76.42	393.28				
34											*27+D2*							336.36				
35	*27+G1*	196.1	5	10.7	3.92	*F4-27+G1*	2275	5	0.74	45.50	*27+G1*	236.16	139.5	F5	27 + G1	3.90	8.25	169.12	13.29	45.50	3.90	240.06
36	*27+G1*	185	50.7	1.86	3.70	*F4-27+G1*	2346	50.7	1.02	46.92	*27+G1*	188.54		F5	27 + G1	2.73	7.36	122.59	11.67	46.92	2.73	191.26
37											*27+G1*						2.96					
38	*27-D2b*	1721	5	0.7	35.41	*F4-27-D2b*	10370	5	1.68	213.37	*27-D2b*	998.58	621.9	F5	27 + D2b	31.23	136.21	532.72	116.28	213.37	31.23	1029.81
39	*27-D2b*	1524	50.7	1.39	31.36	*F4-27-D2b*	10550	50.7	1.29	217.08	*27-D2b*	887.16		F5	27 + D2b	14.14	118.46	437.57	114.05	217.08	14.14	901.30
40											*27-D2b*											
41																						
42																						
43																						
44																						
45																						
46																						

	AX	AY	AZ	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ
1																				
2	U from			Exchangeable	Carbonate	Oxide	Organic	Residual								average	average	average	average	average
3	MW digest	% diff		F1 %	F2 %	F3 %	F4 %	F5 %								Exchangeable	Carbonate	Oxide	Organic	Residual
4	527.35	-36.47	27-2-0	2.82	77.70	3.79	15.03	0.67		2.75	76.79	3.79	16.08	0.57	**27-2-0**	F1 %	F2 %	F3 %	F4 %	F5 %
5			27-2-0	2.69	75.89	3.80	17.14	0.48	27-2-0							2.88	80.29	3.38	12.91	0.55
6			27-2-0b	3.06	84.24	2.99	9.15	0.57	27-2-0b	3.00	83.79	2.96	9.73	0.52	**27-2-10**	*0.17*	*4.95*	*0.59*	*4.49*	*0.04*
7			27-2-0b	2.94	83.34	2.94	10.32	0.47	27-2-0b						**27-2-20**	5.36	74.41	5.97	13.66	0.60
8			27-2-0b						27-2-0b						**27-2-30**	22.51	47.90	8.42	20.05	1.12
9			27-2-0b						27-2-0b							14.57	42.03	10.18	31.72	1.50
10	344.9	-35.94	27-2-10	5.33	75.63	5.89	12.58	0.57	27-2-10	5.36	74.41	5.97	13.66	0.60						
11			27-2-10	5.39	73.19	6.06	14.74	0.63	27-2-10						**36-1-0**	4.12	52.33	21.04	21.84	0.67
12	187.7	-27.39	27-2-20	22.18	50.30	8.33	18.14	1.05	27-2-20	22.51	47.90	8.42	20.05	1.12	**36-1-21**	6.68	65.17	15.19	11.73	1.23
13			27-2-20	22.85	45.49	8.51	21.95	1.20	27-2-20						**36-1-42**	29.72	45.11	11.48	12.60	1.09
14			27-2-20						27-2-20						**36-1-60**	54.29	35.53	5.22	4.72	0.24
15	218.8	-12.77	27-2-30	14.65	44.63	10.13	29.20	1.39	27-2-30	14.57	42.03	10.18	31.72	1.50						
16			27-2-30	14.49	39.43	10.23	34.25	1.60	27-2-30											
17			27-2-30						27-2-30						**27+C1**	10.44	46.34	11.82	30.12	1.28
18	7	-91.20	36-1-0	3.76	54.38	20.11	21.11	0.64	36-1-0	4.12	52.33	21.04	21.84	0.67	**27 + D2**	13.46	51.05	13.16	20.02	2.31
19			36-1-0	4.47	50.27	21.98	22.58	0.70	36-1-0							*0.39*	*1.28*	*1.69*	*3.37*	*0.01*
20			36-1-0						36-1-0						**27+G1**	3.64	67.27	5.82	21.74	1.53
21	3.39	-95.26	36-1-21	6.56	66.04	14.75	11.45	1.20	36-1-21	6.68	65.17	15.19	11.73	1.23						
22			36-1-21	6.79	64.30	15.63	12.02	1.26	36-1-21											
23			36-1-42	29.42	46.43	10.35	12.51	1.29	36-1-42	29.72	45.11	11.48	12.60	1.09						
24			36-1-42	30.01	43.80	12.61	12.68	0.90	36-1-42											
25			36-1-42						36-1-42											
26	6.21	-97.66	36-1-60	51.35	38.41	5.22	4.73	0.28	36-1-60	54.29	35.53	5.22	4.72	0.24						
27			36-1-60	57.22	32.64	5.23	4.71	0.20	36-1-60											
28			27+C1	10.58	48.30	11.87	28.04	1.21	27+C1	10.44	46.34	11.82	30.12	1.28						
29	174.4	-25.03	27+C1	10.30	44.39	11.76	32.20	1.35	27+C1											
30			27+C1						27+C1											
31	621.9	-20.56	27+D2	14.23	51.49	14.00	16.95	3.33	27+D2	13.73	51.96	14.36	17.64	2.32						
32			27+D2	13.24	52.42	14.71	18.33	1.30	27+D2											
33			27+D2						27+D2											
34			27+D2						27+D2											
35	139.5	-26.49	27+G1	3.44	70.45	5.53	18.95	1.62	27+G1	3.64	67.27	5.82	21.74	1.53						
36			27+G1	3.85	64.09	6.10	24.53	1.43	27+G1											
37			27+G1						27+G1											
38	621.9	-24.70	27-D2b	13.23	51.73	11.29	20.72	3.03	27-D2b	13.18	50.14	11.97	22.40	2.30						
39			27-D2b	13.14	48.55	12.65	24.09	1.57	27-D2b											
40			27-D2b						27-D2b											
41																				
42																				
43																				
44																				
45																				
46																				

APPENDIX E

Vegetation Transect Data

	B	C	D	E	F	G	H	I	J	K	L	M	N
81		**Land type**	**Locn**	**bare ground**	**litter**	**herbs**	**grasses**	**bushes**	**total**	**# herb specie**	**grass specie**	**e grass patch size**	
82	27	Disturbed Plain	F1-F2	92.42	0.48	1.66	6.94	--	101.5	4	3	13	
83													
84			**Summary Statistics for F1-F2 Sec 27**										
85					**# patches**	**sum length**	**avg size**	**std dev**	**% of total**				
86				artemesia	1	17	17	--	0.340	13.984			
87				bare ground	47	4546	98.83	139.86	90.920				
88				Blue Grama grass	2	14	7	2.83	0.280				
89				Snakeweed	3	38	12.67	2.52	0.760				
90				Kochia weed	7	22	3.14	3.02	0.440				
91				Soil litter	6	24	4	3.94	0.480				
92				Lope?	8	10	1.25	0.71	0.200				
93				Indian Rice Grass	18	323	17.94	14.76	6.460				
94				Tumbleweed	3	6	2	1.732051	0.120				
95						**5000**			**100.000**				

	B	C	D	E	F	G	H	I	J	K	L	M	N
55		**Land type**	**Locn**	**bare ground**	**litter**	**herbs**	**grasses**	**bushes**	**total**	**# herb specie**	**grass specie**	**e grass patch size**	
56	27	Former Pond	G1-F1	65.96	4.98	1.38	21.62	4.74	98.68	3	8	12.58	
57													
58			**Summary Statistics for G1-F1 Section 27**										
59				**Name**	**# patches**	**sum length**	**avg size**	**std dev**	**% of total**				
60				ag sp	60	217	3.62	4.06	4.34				
61				bare ground	136	3298	24.25	29.76	65.96				
62				Blue grama grass	3	28	9.33	3.21	0.56				
63				galleta	2	33	16.5	21.92	0.66				
64				grass	1	1	1		0.02				
65				Snakeweed	3	16	5.33	6.67	0.32				
66				Kochia weed	11	66	6	6.87	1.32				
67				ground litter	28	249	8.89	12.6	4.98				
68				losc	1	1	1		0.02				
69				muhly	1	11	11		0.22				
70				Indian Rice grass	30	510	17	14.42	10.20				
71				rock	1	50	50		1.00				
72				Tumbleweed	1	2	2		0.04				
73				Sand dropseed grass	20	273	13.65	13.11	5.46				
74				stco	1	8	8		0.16				
75				tamarisk	1	237	237		4.74				
76						**5000**			**100.000**				

	B	C	D	E	F	G	H	I	J	K	L	M	N
24	**Land type**	**Locn**	**bare ground**	**litter**	**herbs**	**grasses**	**bushes**	**total**	**# herb specie**	**#grass specie**	**e grass patch size**		
25	Undisturbed	A2-A3	44.02	41.4	0.44	11.66	0	97.52	3	2	7.8		
26		A3-A4	43.2	38.02	2	12.6	5.04	100.86	4	1	9.13		
27													
28		**Summary statistics A3-A4 Sec 27 01**											
29				**# patches**	**sum length**	**avg size**	**std dev**	**% of total**					
30			Fourwing saltbush	7	192	27.43	20.32	3.84	9.13				
31			bare ground	91	2160	23.74	25.86	43.2					
32			Blue Grama grass	69	630	9.13	9.09	12.6					
33			Depi	5	28	5.60	5.86	0.56					
34			Gasp	2	30	15.00	14.14	0.6					
35			Snakeweed	4	41	10.25	2.87	0.82					
36			Herb	1	1	1.00	--	0.02					
37			ground litter	106	1901	17.93	16.62	38.02					
38			poop	1	17	17.00	--	0.34					
39					**5000**			**100**					
40													
41													
42		**Summary Statistics for A2-A3 Sec 27 01**											
43			Name	**# patches**	**sum length**	**avg size**	**std dev**	**% of total**					
44			atrb	1	2	2.00	--	0.04	7.87837838				
45			bare ground	63	2301	36.52	42.27	46.02					
46			Blue grama grass	58	523	9.02	7.49	10.46					
47			depi	10	14	1.40	0.52	0.28					
48			eltr	16	60	3.75	4.63	1.2					
49			ground litter	91	2070	22.75	18.03	41.4					
50			mustard	2	6	3.00	2.83	0.12					
51			poop	2	24	12.00	2.83	0.48					
52					**5000**			**100**					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		**Land type**	**Locn**	**bare ground**	**litter**	**herbs**	**grasses**	**bushes**	**total**	**# herb specie**	**#grass specie**	**e grass patch size**		
2	27	Waste Piles		95.3	0.48	0.02	3.98	0	99.78	1	1	24.86		
3	27		C4-D4	98.88	0.25	0.81	0.08	0	100.02	3	1	n/a		
4	36													
5														
6		**Summary for H2-G2 Sec 27 01**												
7			**Name**	**# patches**	**sum length**	**avg size**	**std dev**	**% of total**						
8			bare ground	17	4765	317.67	463.11	95.300	24.86					
9			scrap iron	1	2	2	--	0.040						
10			ground litter	4	24	6	5.83	0.480						
11			Loasaceae	1	10	10	--	0.200						
12			Indian Rice grass	8	199	24.86	25.72	3.980						
13					**5000**			**100.000**						
14														
15		**Summary Statistics C4-D4 Sec 27 01**												
16			**name**	**# patches**	**sum length**	**avg size**	**std dev**	**% of total**						
17			bare ground	15	3955	263.67	230.82	98.875	3					
18			buckwheat	1	3	3		0.075						
19			mustard	1	2	2		0.050						
20			ground litter	3	10	3.33	4.04	0.250						
21			aster	1	3	3		0.075						
22			Tumbleweed	8	27	3.38	1.41	0.675						
23					**4000**			**100.000**						

APPENDIX F

Soil ICP-MS Uranium Data

	A	B	C	D	E	F	G	H	I	J	K	L	M
18	**Total DF**	**Sample:**	**sample point**	**Date/Time:**	**mass (g)**	**vol (ml)**	**Na / 23**	**Mg / 24**	**K / 39**	**Ca / 43**	**Ca / 44**	**U / 238**	***u/ rsd***
19	91.11	866	c5	10/1/2002 0:00	0.222	50	0.0	0.0	0.0	0.0	0.0	7.1	*7.9*
20	5	875	f2	10/2/2002 0:18	0.2489	50	1376.7	2099.2	2961.0	12645.6	13252.3	923.1	*4.4*
21	5	867	f2	10/1/2002 23:30	0.2486	50	1639.8	2174.2	3069.2	13640.4	14227.7	961.4	*4.2*
22	91.11	868	f4	10/1/2002 0:00	0.1950	50	0.0	0.0	0.0	0.0	0.0	33.6	*9.6*
23	5	869	-g1	10/1/2002 23:49	0.2246	50	1408.5	5420.7	6600.6	10253.8	10937.2	4.7	*6.6*
24													
25	91.11	873	h2	10/2/2002 0:04	0.2789	50	854.4		2527.8	9458.6	9051.6	86.1	*5.9*
26	91.11	874	h4	10/2/2002 0:14	0.2129	50			3633.2	11040.4	10784.4	104.4	*6.5*
27													
28													
29	5	876	brs sed	10/2/2002 0:28	0.2116	50	2289.0	14477.8	20052.0	32018.0	33459.4	2.0	*4.9*
30	5	877	blank	10/2/2002 0:38	1.0000	50	255.5	4.4	14.3	56.4	57.1	0.0	*13.0*
31		CCV 50/5000/0.5		10/1/2002 23:11	1	50	274.8	275.4	278.4	265.9	286.3	2.5	*6.7*

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Sample:**	**Date/Time:**	**ample poir**	**Total DF**	**Mass (g)**	**Vol. (ml)**	**Na / 23**	**Mg / 24**	**K / 39**	**Ca / 43**	**Ca / 44**	**U / 238**	**U / rsd**
2	878	7/17/02 4:01 PM	1-0		0.1902	50	0.00	0.00	0.00	0.00	0.00	5.93	
3	*946*	*9/6/02 4:54 PM*	*1-0 dup*	*5*	*0.2709*	*51.5*	*1303.18*	*6965.52*	*11971.04*	*9041.49*	*9452.12*	*5.01*	*1.44*
4	947	9/6/02 5:03 PM	1-5	5	0.2017	50	1472.73	6484.88	11056.02	7178.98	7578.09	4.94	6.93
5	879	7/17/02 4:07 PM	1-10		0.26	50						6.01	
6	880	7/17/02 4:13 PM	1-15		0.1736	50						3.77	
7	948	9/6/02 5:13 PM	1-20	5	0.2037	51	1546.02	6569.66	10758.32	10134.90	10643.15	2.70	7
8	*954*	*9/6/02 6:20 PM*	*1-20 dup*	*5*	*0.2285*	*50*	*1557.11*	*7120.35*	*11369.80*	*7505.47*	*7862.14*	*2.91*	*6.3*
9	949	9/6/02 5:22 PM	1-25	5	0.2046	50	1478.01	7035.68	11436.95	8558.16	8944.28	2.46	6.12
10	881	7/17/02 4:19 PM	1-30		0.2319	50						2.07	
11													
12	882	7/17/02 4:25 PM	2-0		0.203	50						540.15	
13	*952*	*9/6/02 6:06 PM*	*2-0 dup*	*105.9*	*0.2248*	*50*	*1267.35*	*1825.85*	*3340.75*	*14830.96*	*13959.07*	*410.81*	*5.23*
14	883	7/17/02 4:31 PM	2-5		0.194	50	0.00	0.00	0.00	0.00	0.00	1467.27	
15	*953*	*9/6/02 6:16 PM*	*2-5 dup*	*105.9*	*0.2403*	*50*	*1419.48*	*1529.55*	*2630.05*	*16017.48*	*15201.83*	*869.95*	*2.93*
16	884	7/17/02 4:37 PM	2-10		0.186	50						344.89	
17	885	7/17/02 4:44 PM	2-15		0.1986	50						211.73	
18	*888*	*7/17/02 5:02 PM*	*2-15 dup*		*0.24*	*50*						*284.79*	
19	886	7/17/02 4:50 PM	2-20		0.2316	50						187.72	
20	887	7/17/02 4:56 PM	2-25		0.2363	50						270.21	
21	890	7/17/02 5:14 PM	2-30		0.2263	50						218.80	
22													
23	891	7/17/02 5:20 PM	3-0		0.2608	50						81.98	
24	950	9/6/02 5:46 PM	3-5	105.9	0.2504	50	540.14	748.20	1464.46	8274.76	7653.75	32.31	5.66
25	892	7/17/02 5:26 PM	3-10		0.2451	50						50.86	
26	951	9/6/02 5:56 PM	3-15	105.9	0.2724	50	567.36	1748.53	2597.28	16360.13	15455.21	28.76	8.23
27	893	7/17/02 5:32 PM	3-20		0.2522	50						65.66	
28	894	7/17/02 5:51 PM	3-25		0.2425	50						61.90	
29	*900*	*7/17/02 6:40 PM*	*3-25 dup*		*0.2405*	*50*						*59.81*	
30	895	7/17/02 5:57 PM	3-30		0.2119	50						49.48	
31													
32	889	7/17/02 5:08 PM	std		0.2313	50						0.61	
33	901	7/17/02 6:46 PM	std		0.2471	50						0.73	
34	955	9/6/02 6:30 PM	std	5	0.2293	50	1592.02	10632.36	14478.85	22001.74	22655.91	1.56	7.23
35	956	9/6/02 6:40 PM	std	5	0.2195	50	1664.01	10867.88	14539.86	22464.69	23257.40	1.85	5.37
36	956	9/6/02 6:45 PM	std	105.9	0.2195	50	1468.11	10223.23	14086.56	22291.57	21118.45	2.39	10.64
37	957	9/6/02 6:49 PM	blank	5	1	50	150.60	3.34	7.22	81.95	76.85	0.02	3.8
38	100 ppb QC	7/17/02 5:38 PM	100 ppb		1	50						5.13	
39	2709	9/6/02 7:04 PM	std	1	1	50	101.70	710.50	347.95	706.00	730.00	0.08	7.36
40	2709	9/6/02 7:09 PM	std	21.18	1	50	87.95	638.00	337.15	694.50	643.50	0.08	4.81
41	2709	7/17/02 6:21 PM	std		1	50							
42	CCV 50/5000/0.5	9/6/02 5:32 PM	std	1	1	50	322.85	324.15	341.40	330.70	347.50	2.37	8.22
43	CCV 50/5000/0.5	9/6/02 7:13 PM	std	1	1	50	320.45	316.75	341.70	329.80	350.30	2.40	5.89
44	MOJO 1-10	9/6/02 6:54 PM	std	1	1	50	4.83	0.05	1.50			0.26	5.78

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Total DF**	**Sample:**	**sample point**	**Date/Time:**	**mass (g)**	**vol (ml)**	**Na / 23**	**Mg / 24**	**Si / 29**	**K / 39**	**Ca / 43**	**Ca / 44**	**U / 238**	**U rsd%**	**U stdev**
2	105.9	1054	A1	9/6/2002	0.2448	55.25	861.93	4662.85		5005.90	8012.15	7456.94	**16.50**	*3.24*	
3	*105.9*	*1064*	*A1 Dup*	*9/6/2002*	*0.1519*	*50*	*1026.66*	*4558.92*		*5069.12*	*6339.70*	*5816.33*	***19.44***	*8.56*	*2.08*
4	5	1055	A2	9/6/2002	0.2571	50	1081.29	9105.41		5830.42	20458.97	20847.92	**2.16**	*5.81*	
5	5	1056	A3	9/6/2002	0.2291	50	1158.66	11082.50		5401.57	15128.76	15403.75	**1.46**	*6.32*	
6	5	1057	B1	9/6/2002	0.2495	54.5	1017.26	3152.04		3045.01	6963.77	7284.87	**1.23**	*6.51*	
7	105.9	1058	B2	9/6/2002	0.2171	52.75	1198.11	6249.33		5498.54	13298.05	12542.40	**5.54**	*5.85*	
8	*5*	*1081*	*B2 dup*	*10/2/2002 3:13*	*0.0665*	*50*	*3297.74*	*7699.25*	*0.00*	*7235.34*	*15593.98*	*17180.45*	***3.83***	*4.5*	*1.21*
9	5	1062	B3	9/6/2002	0.2157	50	942.05	7044.51		4601.30	11761.71	12167.36	**3.15**	*7.49*	
10															
11	5	1059	C1	9/6/2002	0.2343	50	932.99	11329.49		4711.91	26568.50	27230.05	**2.13**	*7.43*	
12	105.9	1060	C2	9/6/2002	0.2226	58	1169.90	10133.06		7053.28	20818.51	19575.65	**5.57**	*3.72*	
13	*91.11*	*1082*	*C2 dup*	*10/2/2002 3:28*	*0.0215*	*51.5*	*11526.42*	*9962.26*	*0.00*	*12506.12*	*24169.07*	*24720.00*	***5.89***	*5.34*	*0.23*
14	105.9	1061	C3	9/6/2002	0.2351	50	747.98	3145.47		4134.41	2235.22	2070.61	**8.55**	*6.26*	
15	5	1063	D1	9/6/2002	0.212	50	911.32	14941.04		5719.34	27122.64	27783.02	**1.95**	*6.56*	
16	91.11	1067	D2	10/2/2002 0:57	0.2614	54.5	1269.51	8560.71	0.00	7449.45	17709.37	17250.69	**11.56**	*9.22*	
17	5	1068	D3	10/2/2002 1:11	0.2591	50	1396.37	4258.97	0.00	4376.69	25935.93	27016.60	**1.45**	*3.65*	
18															
19	91.11	1066	E1	10/2/2002 0:48	0.2283	50	1353.26	9691.20	0.00	5989.93	17393.78	16579.06	**5.56**	*8.36*	
20	5	1069	E2	10/2/2002 1:21	0.2117	50	1659.90	12132.74	0.00	13167.22	12298.06	12881.44	**11.45**	*5.25*	
21	91.11	1070	E3	10/2/2002 1:36	0.1765	50	1266.86	6838.53	0.00	9535.41	8671.39	8220.96	**11.75**	*7.26*	
22	5	1071	F1	10/2/2002 1:41	0.2343	50	1415.49	8408.02	0.00	9974.39	7458.39	7859.58	**5.41**	*9.1*	
23	*5*	*1076*	*F1 dup*	*10/2/2002 2:30*	*0.2033*	*50*	*1274.23*	*7385.64*	*0.00*	*8470.24*	*3735.86*	*4082.64*	***5.07***	*4.42*	*0.24*
24	91.11	1072	F2	10/2/2002 1:56	0.2182	52.1	1012.63	10286.29	0.00	6377.59	17544.95	16799.98	**2.71**	*6.06*	
25	5	1073	F3	10/2/2002 2:00	0.2037	50	1286.70	4374.08	0.00	5638.19	4788.91	5225.82	**6.07**	*3.77*	
26															
27	5	1074	G1	10/2/2002 2:10	0.2073	50	1396.29	13663.77	0.00	7952.24	45224.31	46767.97	**3.49**	*4.39*	
28	91.11	1075	G2	10/2/2002 2:25	0.2134	54.1	1263.77	6705.46	0.00	6396.17	4276.79	4213.41	**17.84**	*7.57*	
29	5	1083	G3	10/2/2002 3:33	0.2409	50	1129.31	7015.36	0.00	8096.72	10695.31	11436.28	**2.23**	*4.6*	
30	50.7	1093	H1	2/3/03 8:57 PM	0.2599	50.00	1405.35	7651.02	919.78	8003.08	4399.77	2745.29	**17.31**	*2.25*	
31	5.0	1094	H2	2/3/03 8:41 PM	0.2292	50.50	1505.75	13938.18	6233.18	7610.25	28599.04	28753.27	**3.07**	*3.44*	
32	50.7	1095	H3	2/3/03 8:37 PM	0.2909	50.00	1526.81	6230.66	5149.54	7318.67	10309.38	9284.98	**16.72**	*3.18*	
33															
34	50.7	1096	I1	2/3/03 10:32 PM	0.1700	50.00	1700.59	8305.88	7061.76	7847.06	5591.18	1914.41	**15.64**	*3.19*	
35	50.7	1097	I2	2/3/03 10:22 PM	0.2622	50.00	1240.27	11325.32	4153.32	9692.98	8747.14	6395.88	**4.23**	*4.03*	
36	50.7	1098	I3	2/3/03 10:02 PM	0.1866	50.00	1837.08	11122.72	5988.75	13140.41	14957.13	11446.95	**17.19**	*3.43*	
37	5.0	1099	J1	2/3/03 9:47 PM	0.1608	50.00	1935.32	16620.02	6741.29	9123.13	24365.67	24070.27	**4.58**	*1.88*	
38	5.0	1102	J2	2/3/03 11:27 PM	0.1848	57.00	1825.67	11106.98	6579.06	10055.19	11042.21	11116.23	**3.96**	*2.25*	
39	5.0	1103	J3	2/3/03 11:17 PM	0.1426	55.00	2259.78	9923.91	8732.12	10174.61	8573.98	8454.42	**7.03**	*1.45*	
40															
41	50.7	1104	K1	2/3/03 11:12 PM	0.1658	54.00	1790.99	15353.20	8308.44	12884.44	71196.62	70512.67	**18.57**	*1.43*	
42	50.7	1105	K2	2/3/03 11:02 PM	0.1518	50.00	1655.14	9868.25	8122.53	9575.10	8274.04	4291.83	**7.57**	*1.46*	
43	50.7	1106	K3	2/3/03 10:52 PM	0.2109	50.00	1401.61	11017.07	1581.32	10149.36	16472.26	13259.84	**5.91**	*3.86*	
44	50.7	1107	L1	2/3/03 10:42 PM	0.3154	55.00	1134.18	7697.21	3201.65	6373.65	15012.52	13920.89	**6.95**	*2.92*	
45	50.7	1108	L2	2/4/03 12:43 AM	0.2286	52.00	1206.28	6885.56	5163.60	6719.51	6594.40	3748.73	**9.98**	*2.34*	
46	5.0	1109	L3	2/4/03 12:28 AM	0.3070	56.00	1074.76	5184.10	4064.10	5353.75	3936.42	3921.82	**2.62**	*1.61*	
47	*5.0*	*1113*	*L3 dup*	*2/3/03 11:37 PM*	*0.3063*	*50.00*	*477.96*	*5169.77*	*4513.55*	*5527.26*	*3586.35*	*3576.56*	***2.38***	*0.9*	*0.17*
48															
49	50.7	1110	M1	2/4/03 12:23 AM	0.2724	58.00	1167.45	7203.16	2081.10	6724.08	5108.00	2499.71	**4.28**	*3.65*	
50	5.0	1111	M2	2/4/03 12:07 AM	0.2393	50.00	814.67	4059.76	6318.43	4987.46	2927.29	2887.59	**2.07**	*1.75*	
51	50.7	1112	M3	2/3/03 11:53 PM	0.2802	55.00	1106.67	7818.17	5132.94	7221.45	3694.15	1353.02	**5.54**	*2.51*	
52															
53	5	1077	blank	10/2/2002 2:39	1	50	192.05	3.85	0.00	14.22	59.15	60.80	**0.05**	*4.42*	
54	5	1089	blank	10/2/2002 3:53	1	50	167.40	3.06	0.00	17.14	62.20	64.70	**0.01**	*3.01*	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
55	5.0	1100	blank	2/3/03 9:42 PM	1.0000	50.00	234.20	3.36		7.51	68.80	17.62	**0.01**	*10.42*	
56	5.0	1101	BRS std	2/3/03 9:32 PM	0.2149	55.50	2134.52	12677.97	6735.41	18104.00	25629.69	25779.48	**1.83**	*3.13*	
57	5	1065	Buf Riv Sed	9/6/2002	0.2489	53.9	1396.77	10364.22		13725.12	22326.60	23127.84	**1.36**	*6.11*	
58															
59	1.00	ICP internal check	BLANK	2/3/03 8:27 PM	1.00	50.00	7.28	0.02			1044.00	433.10	**0.00**	*34.55*	
60	1	ICP internal check	Blank Rinse	10/2/02 1:07 AM	1	50	0.15	0.14	0.00	0.77		0.00	**0.00**	*11.11*	
61	1	ICP internal check	Blank Rinse	10/2/02 2:58 AM	1	50						0.00	**0.00**	*18.06*	
62	1.00	ICP internal check	Blank Rinse	2/3/03 8:22 PM	0.20	50.00	55.58	1.76			1.77		**0.06**	*33.63*	
63	1.00	ICP internal check	Blank Rinse	2/3/03 10:12 PM	0.20	50.00	8.32	1.43			1.25		**0.01**	*31.65*	
64	1.00	ICP internal check	Blank Rinse	2/4/03 12:02 AM	0.20	50.00	1.36	1.22		0.90	1.01		**0.01**	*39.01*	
65	1.00	ICP internal check	Blank Rinse	2/4/03 1:03 AM	0.20	50.00	1.40	1.26		1.14	1.36		**0.01**	*38.74*	
66	1	ICP internal check	CCV 50/5000/0.5	10/2/02 1:02 AM	1	50	273.65	277.6	0	282.75	266.1	290.9	**2.5135**	*5.07*	
67	1	ICP internal check	CCV 50/5000/0.5	10/2/02 2:54 AM	1	50	271.35	272.75	0	289.65	271.05	292.5	**2.468**	*6.83*	*0.03*
68	1.00	ICP internal check	CCV 50/5000/5	2/3/03 8:17 PM	0.20	50.00	1303.00	1249.50	279.50	1284.00	1196.25	1237.00	**13.28**	*0.85*	
69	1.00	ICP internal check	CCV 50/5000/5	2/3/03 10:07 PM	0.20	50.00	1346.25	1327.25	205.23	1352.00	1240.25	1222.50	**13.36**	*2.04*	
70	1.00	ICP internal check	CCV 50/5000/5	2/3/03 11:58 PM	0.20	50.00	1398.25	1386.25	226.35	1400.50	1261.75	1260.75	**13.23**	*0.97*	
71	1.00	ICP internal check	CCV 50/5000/5	2/4/03 12:58 AM	0.20	50.00	1460.50	1456.00	259.00	1449.00	1286.75	1290.75	**13.34**	*0.73*	*0.06*
72	1.00	ICP internal check	ECS 5 ppb	2/4/03 12:48 AM	0.20	50.00	150.60	152.15		156.08	128.48	72.05	**1.03**	*2.8*	
73	10.14	ICP internal check	ECS 5 ppb	2/4/03 12:53 AM	0.20	50.00	141.65	133.08		136.18	103.48		**1.03**	*0.41*	*0.00*
74	1.00	ICP internal check	ICV 50/5000/5	2/4/03 1:07 AM	0.20	50.00	1375.00	1388.75	255.75	1440.75	1246.25	1263.75	**13.25**	*0.19*	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Total DF	Sample:	sample point	Date/Time:	mass (g)	vol (ml)	V / 51	Mn / 55	Fe / 56	Cu / 63	Zn / 66	As / 75	Se / 82	Pb / 208	Th / 232	U / 238	*w/ rsd*	stdev
2		829	a1	6/6/2002 21:12	##########	50	124.4	282.3	0.0	13.9	28.2	10.8	27.0	12.8	7.1	**163.9**		
3		830	a3	6/7/2002 13:00	0.1952	50	52.8	148.2	0.0	11.0	28.8	3.9	2.9	17.1	11.3	**7.3**		
4																		
5		831	b2	6/7/2002 13:05	0.2113	50	70.5	121.8	0.0	7.4	20.5	3.8	6.1	14.0	8.2	**50.7**		
6		832	b4	6/7/2002 13:11	0.1784	50	77.7	151.4	0.0	12.8	36.1	4.1	3.2	20.0	13.9	**11.2**		
7		833	-c1	6/7/2002 13:16	0.2605	50	27.9	114.5	0.0	5.4	16.9	2.2	1.3	10.3	8.1	**4.6**		
8		834	c1	6/7/2002 13:22	0.3202	50	71.1	120.0	0.0	3.8	8.7	4.0	5.9	8.9	4.3	**174.4**		
9		835	c3	6/7/2002 13:28	0.1640	50	81.4	139.5	0.0	14.2	38.8	3.8	2.7	20.0	14.8	**13.8**		
10		836	c4	6/7/2002 13:33	0.2014	50	86.0	155.1	0.0	6.1	181.4	3.9	6.5	7.3	4.2	**113.1**		
11		*836*	*c4*	*6/7/2002 14:42*	*0.2014*	*50*	*97.9*	*178.0*	*0.0*	*6.9*	*198.5*	*4.1*	*6.5*	*7.3*	*4.2*	***113.8***		0.49
12		866	c5	7/23/2002 15:43	0.2220	50	62.7	172.4	0.0	13.5	63.4	4.8	3.4	234.5	12.9	**10.7**		
13	*91.11*	*866*	*c5*	*10/1/2002 0:00*	*0.222*	*50*	*82.4*	*247.3*	*28536.0*	*23.1*	*165.2*	*10.1*	*10.5*	*186.3*	*9.6*	***7.1***	*7.88*	
14																		
15		837	d2	6/7/2002 13:39	0.1883	50	59.9	205.5	0.0	29.3	22.9	2.3	6.8	23.0	6.8	**621.9**		
16		838	d4	6/7/2002 13:45	0.2385	50	48.2	162.1	0.0	3.6	10.2	4.1	3.9	7.7	5.2	**96.2**		
17		*839*	*d4*	*6/7/2002 13:51*	*0.2288*	*50*	*37.7*	*194.3*	*0.0*	*3.5*	*8.5*	*3.0*	*3.1*	*6.1*	*16.3*	***62.6***		23.74
18		896	-e1	7/17/2002 18:03	0.1889	50	53.5	187.5	0.0	9.6	33.0	3.8	2.0	61.2	8.7	**8.1**		
19		897	e1	7/17/2002 18:09	0.2326	50	50.5	115.6	0.0	2.1	16.3	4.7	2.5	10.9	3.9	**71.6**		
20		898	e3	7/17/2002 18:15	0.2055	50	56.4	126.5	0.0	4.0	14.8	4.0	3.1	11.5	3.0	**26.3**		
21		899	e5	7/17/2002 18:33	0.2263	50	56.6	170.3	0.0	10.3	34.5	4.4	1.2	19.5	10.9	**9.9**		
22																		
23		875	f2	7/23/2002 16:29	0.2489	50	158.2	149.0	0.0	5.1	24.0	7.8	27.9	51.7	5.7	**963.0**		
24	*5*	*875*	*f2*	*10/2/2002 0:18*	*0.2489*	*50*	*241.5*	*239.5*	*9674.6*	*7.9*	*52.2*	*15.0*	*63.7*	*45.9*	*3.5*	***923.1***	*4.35*	86.35
25		*867*	*f2*	*7/23/2002 15:48*	*0.2486*	*50*	*201.0*	*162.2*	*0.0*	*5.4*	*23.5*	*7.4*	*18.8*	*60.3*	*5.9*	***1117.9***		
26	*5*	*867*	*f2*	*10/1/2002 23:30*	*0.2486*	*50*	*288.2*	*249.4*	*9288.0*	*8.3*	*48.5*	*13.5*	*40.4*	*48.1*	*3.3*	***961.4***	*4.19*	
27		868	f4	7/23/2002 15:54	0.1950	50	79.9	193.6	0.0	9.3	35.4	4.8	6.0	39.4	8.6	**50.2**		
28	*91.11*	*868*	*f4*	*10/1/2002 0:00*	*0.1950*	*50*	*77.5*	*206.7*	*18559.0*	*11.7*	*70.3*	*8.7*	*13.1*	*29.5*	*5.7*	***33.6***	*9.55*	11.73
29		869	-g1	7/23/2002 16:11	0.2240	50	39.4	164.1	0.0	7.8	33.4	3.4	1.8	51.5	10.1	**6.8**		
30	*5*	*869*	*-g1*	*10/1/2002 23:49*	*0.2246*	*50*	*57.9*	*246.2*	*17003.6*	*11.8*	*69.2*	*6.3*	*2.2*	*41.4*	*6.9*	***4.7***	*6.61*	1.49
31		870	g1	6/7/2002 13:56	0.2460	50	103.3	273.6	0.0	2.8	12.2	4.1	6.3	17.0	5.0	**139.5**		
32		871	g3	6/7/2002 14:14	0.2133	50	80.1	210.0	0.0	4.0	15.8	7.0	9.8	19.0	4.9	**58.9**		
33		*871*	*g3*	*6/10/2002 12:26*	*0.2133*	*50*	62.3	169.8	0.0	4.9	16.7	7.7	9.0	19.2	4.6	**56.5**		
34		872	g5	6/7/2002 14:19	0.2474	50	124.5	164.4	0.0	6.2	22.6	4.6	7.3	29.9	7.4	**63.5**		
35																		
36		873	h2	7/23/2002 16:17	0.2789	50	144.5	153.8	0.0	3.6	17.9	4.7	16.7	16.3	5.1	**129.2**		
37	*91.11*	*873*	*h2*	*10/2/2002 0:04*	*0.2789*	*50*	*140.4*	*163.1*	*8277.2*	*5.9*	*35.0*	*8.2*	*36.6*	*11.8*	*2.5*	***86.1***	*5.9*	30.51
38		874	h4	7/23/2002 16:23	0.2129	50	111.3	164.1	0.0	4.8	24.4	5.5	9.9	21.0	6.4	**150.2**		
39	*91.11*	*874*	*h4*	*10/2/2002 0:14*	*0.2129*	*50*	*110.9*	*177.1*	*9375.3*	*6.4*	*46.7*	*10.3*	*22.4*	*15.8*	*3.1*	***104.4***	*6.48*	32.40
40																		
41																		
42																		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
43																		
44																		
45		827	blank	6/6/2002 21:06	1.0000	50	0.7	0.3	0.0	1.1	1.9	0.2	0.4	0.2	0.2	**0.1**		
46		876		7/23/2002 16:34	0.2116	50	51.4	313.1	0.0	43.6	127.6	6.3	1.3	166.1	10.3	**2.5**		
47		876		7/23/2002 21:36	0.2116	50	62.5	334.6	0.0	45.1	125.3	6.6	1.4	172.7	10.4	**2.6**		
48		876		7/23/2002 16:34	0.2116	50	51.4	313.1	0.0	43.6	127.6	6.3	1.3	166.1	10.3	**2.5**		
49	5	876	brs sed	10/2/2002 0:28	0.2116	50	115.8	669.7	49456.5	94.7	390.1	17.1	1.5	173.0	8.3	**2.0**	*4.92*	
50		877		7/23/2002 16:40	1.0000	50	0.4	0.1	0.0	0.4	2.2	0.0	0.2	0.1	0.5	**0.1**		
51	5	877	blank	10/2/2002 0:38	1.0000	50		0.1	15.6	0.4	3.0		0.0	0.1		**0.0**	*12.96*	
52		901	brs sed	7/17/2002 18:46	0.2471	50	44.7	289.4	0.0	41.8	131.5	6.1	0.3	159.6	6.7	**0.7**		
53		2709		6/6/2002 17:02	0.5003	500	84.7	413.1	0.0	45.8	94.0	16.3	5.7	15.7	13.0	**2.9**		
54		2709		6/6/2002 21:23	0.5003	500	115.5	573.5	0.0	62.6	122.2	18.5	6.5	15.7	12.6	**2.8**		
55		2709		6/7/2002 12:19	0.5003	500	83.5	410.0	0.0	44.1	93.9	14.1	5.4	15.6	14.6	**6.5**		
56		2709		6/7/2002 14:31	0.5003	500	98.9	462.8	0.0	43.2	87.1	12.7	5.3	15.2	14.6	**6.5**		
57		2709		6/10/2002 12:21	0.5006	500	75.4	342.4	0.0	50.0	75.5	13.4	4.9	14.9	12.1	**4.2**		
58		2709		6/10/2002 14:59	0.5006	500	74.7	343.1	0.0	49.6	74.2	13.4	4.9	14.7	12.1	**4.2**		
59		2709		7/23/2002 17:09	0.5006	50	10.7	49.4	0.0	6.6	9.5	1.6	0.4	1.5	2.0	**0.4**		
60		100 ppb		6/7/2002 12:08	1	1	0.0	0.0	0.0		0.0	0.0	0.0	0.1	0.0	**0.1**		
61		100 ppb		6/10/2002 12:09	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	**0.1**		
62		100 ppb check		7/23/2002 17:15	1	1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.0	**0.1**		
63		100 ppb QC		7/17/2002 17:38	1	1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	**0.1**		
64		100 ppb QC		7/23/2002 16:00	1	1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	**0.1**		
65		20 ppb QC		6/7/2002 14:02	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**		
66		20 ppb QC		6/10/2002 14:06	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**		
67		Blank Rinse		6/7/2002 14:08	1	1	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	**0.0**		
68		Blank Rinse		6/10/2002 14:12	1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**		
69		Blank Rinse		7/23/2002 16:05	1	1	0.0	0.0	0.0			0.0	0.0	0.0	0.0	**0.0**		
70		CCV 50/5000/0.5		10/1/2002 23:11	1	50	2.7	2.7	271.4	2.4	2.6	2.5	2.6	2.2	2.0	**2.5**	*6.68*	
71		mojo 1/10		6/7/2002 12:14	1	1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	**0.0**		
72		mojo 1/10		6/7/2002 14:25	1	1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	**0.0**		
73		mojo 1/10		6/10/2002 12:15	1	1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	**0.0**		
74		mojo 1/10		6/10/2002 14:53	1	1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	**0.0**		
75		mojo 1/10		7/23/2002 17:03	1	1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	**0.0**		
76																		
77																		
78																		
79																		
80																		
81																		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	**Sample:**	**Date/Time:**	**sample point**	**Total DF**	**Mass (g)**	**Vol. (ml)**	**V / 51**	**Mn / 55**	**Fe / 56**	**Cu / 63**	**Zn / 66**	**As / 75**	**Se / 82**	**Pb / 208**	**Th / 232**	**U / 238**	**U / rsd**		**S27 point**	**depth**	**U / 238**	**stdev**
2	878	7/17/02 4:01 PM	1-0		0.1902	50	71.56	177.97	0.00	12.05	39.14	3.54	0.85	23.41	12.48	5.93			1-0	0	5.47	*0.65*
3	*946*	*9/6/02 4:54 PM*	*1-0 dup*	*5*	*0.2709*	*51.5*	*102.68*	*318.05*	*31348.65*	*19.56*	*82.64*	*8.44*		*18.99*	*11.51*	*5.01*	*1.44*		1-5	5	4.94	
4	947	9/6/02 5:03 PM	1-5	5	0.2017	50	95.79	222.86	29647.99	17.65	74.91	7.67	2.81	15.97	11.11	4.94	6.93		1-10	10	6.01	
5	879	7/17/02 4:07 PM	1-10		0.26	50	65.06	146.06	0.00	11.14	34.65	3.63	0.68	23.19	12.60	6.01			1-15	15	3.77	
6	880	7/17/02 4:13 PM	1-15		0.1736	50	68.15	198.04	0.00	12.16	38.77	4.36	0.54	20.64	11.54	3.77			1-20	20	2.80	*0.14*
7	948	9/6/02 5:13 PM	1-20	5	0.2037	51	95.99	304.20	31120.77	18.14	78.72	7.92	1.37	15.61	11.09	2.70	7		1-25	25	2.46	
8	*954*	*9/6/02 6:20 PM*	*1-20 dup*	*5*	*0.2285*	*50*	*97.99*	*239.39*	*31247.26*	*17.64*	*77.96*	*8.11*	*1.38*	*16.02*	*11.54*	*2.91*	*6.3*		1-30	30	2.07	
9	949	9/6/02 5:22 PM	1-25	5	0.2046	50	99.63	229.96	31573.80	18.39	79.30	7.98	1.32	17.04	11.95	2.46	6.12					
10	881	7/17/02 4:19 PM	1-30		0.2319	50	64.25	140.15	0.00	10.88	34.58	4.15	0.59	24.58	12.37	2.07			2-0	0	475.48	*91.46*
11																			2-5	5	1168.61	*422.36*
12	882	7/17/02 4:25 PM	2-0		0.203	50	240.49	229.41	0.00	4.60	11.84	11.65	110.96	10.50	2.56	540.15			2-10	10	344.89	
13	*952*	*9/6/02 6:06 PM*	*2-0 dup*	*105.9*	*0.2248*	*50*	*226.87*	*262.68*	*8138.35*	*4.11*	*19.46*	*9.97*	*83.81*	*7.53*	*4.07*	*410.81*	*5.23*		2-15	15	248.26	*51.66*
14	883	7/17/02 4:31 PM	2-5		0.194	50	246.08	262.11	0.00	2.73	15.93	7.81	33.40	22.25	3.43	1467.27			2-20	20	187.72	
15	*953*	*9/6/02 6:16 PM*	*2-5 dup*	*105.9*	*0.2403*	*50*	*248.65*	*283.60*	*8707.87*	*4.07*	*23.35*	*15.87*	*145.59*	*8.84*	*3.37*	*869.95*	*2.93*		2-25	25	270.21	
16	884	7/17/02 4:37 PM	2-10		0.186	50	168.63	159.62	0.00	3.96	16.68	7.66	19.73	8.30	2.90	344.89			2-30	30	218.80	
17	885	7/17/02 4:44 PM	2-15		0.1986	50	121.35	200.63	0.00	3.65	20.40	6.01	8.33	10.05	4.04	211.73						
18	*888*	*7/17/02 5:02 PM*	*2-15 dup*		*0.24*	*50*	*141.75*	*164.71*	*0.00*	*3.21*	*15.90*	*7.12*	*8.23*	*11.85*	*3.97*	*284.79*			3-0	0	81.98	
19	886	7/17/02 4:50 PM	2-20		0.2316	50	119.17	231.00	0.00	4.04	14.69	4.96	5.28	12.38	5.05	187.72			3-5	5	32.31	
20	887	7/17/02 4:56 PM	2-25		0.2363	50	175.33	136.99	0.00	4.37	12.48	10.85	28.29	15.52	3.40	270.21			3-10	10	50.86	
21	890	7/17/02 5:14 PM	2-30		0.2263	50	138.58	156.19	0.00	2.73	14.80	6.50	40.50	10.45	2.98	218.80			3-15	15	28.76	
22																			3-20	20	65.66	
23	891	7/17/02 5:20 PM	3-0		0.2608	50	59.74	207.82	0.00	3.44	8.49	5.55	15.98	5.93	4.17	81.98			3-25	25	60.85	*1.47*
24	950	9/6/02 5:46 PM	3-5	105.9	0.2504	50	40.36	144.33	6070.29	4.47	18.60	0.43	15.74	2.34	2.33	32.31	5.66		3-30	30	49.48	
25	892	7/17/02 5:26 PM	3-10		0.2451	50	83.52	150.49	0.00	1.94	7.54	5.97	38.31	5.60	2.27	50.86						
26	951	9/6/02 5:56 PM	3-15	105.9	0.2724	50	46.77	266.52	8616.01	3.80	17.21	9.60	8.39	3.92	3.77	28.76	8.23		std		0.61	
27	893	7/17/02 5:32 PM	3-20		0.2522	50	261.70	238.30	0.00	2.08	15.85	7.45	7.09	8.67	3.94	65.66			std		0.73	
28	894	7/17/02 5:51 PM	3-25		0.2425	50	58.58	172.23	0.00	2.70	51.34	4.54	9.16	6.37	3.21	61.90			std		1.56	
29	*900*	*7/17/02 6:40 PM*	*3-25 dup*		*0.2405*	*50*	*78.73*	*142.62*	*0.00*	*2.19*	*11.82*	*4.19*	*7.13*	*6.43*	*22.04*	*59.81*			std		1.85	
30	895	7/17/02 5:57 PM	3-30		0.2119	50	42.54	199.46	0.00	3.95	9.08	6.80	6.14	7.09	2.65	49.48			std		2.39	
31																			blank		0.02	
32	889	7/17/02 5:08 PM	std		0.2313	50	44.96	303.07	0.00	44.12	144.73	6.66	0.47	146.37	6.46	0.61			100 ppb		5.13	
33	901	7/17/02 6:46 PM	std		0.2471	50	44.68	289.36	0.00	41.78	131.49	6.09	0.33	159.55	6.69	0.73			std		0.08	
34	955	9/6/02 6:30 PM	std	5	0.2293	50	79.76	471.65	34387.27	67.51	302.22	13.09	1.13	120.02	6.44	1.56	7.23		std		0.08	
35	956	9/6/02 6:40 PM	std	5	0.2195	50	80.91	485.88	35148.06	72.35	317.08	13.32		119.52	6.38	1.85	5.37		std			
36	956	9/6/02 6:45 PM	std	105.9	0.2195	50	63.10	453.99	37175.40	73.62	362.64	13.29		107.38	6.29	2.39	10.64		std		2.37	
37	957	9/6/02 6:49 PM	blank	5	1	50		0.05	13.84	0.33	0.52		0.01	0.05		0.02	3.8		std		2.40	
38	100 ppb QC	7/17/02 5:38 PM	100 ppb		1	50	5.35	5.36	0.00	4.98	4.36	5.45	5.01	5.21	5.41	5.13			std		0.26	
39	2709	9/6/02 7:04 PM	std	1	1	50	4.96	20.07	1507.00	1.35	3.97	0.68	0.05	0.56	0.43	0.08	7.36					
40	2709	9/6/02 7:09 PM	std	21.18	1	50	4.10		1575.00	1.25	4.11			0.48	0.42	0.08	4.81					
41	2709	7/17/02 6:21 PM	std		1	50	4.98	25.48	0.00	2.40	4.80	0.69		0.53	0.33							
42	CV 50/5000/0	9/6/02 5:32 PM	std	1	1	50	2.45	2.52	336.40	2.15	2.37	2.37	2.44	2.10	2.33	2.37	8.22					
43	CV 50/5000/0	9/6/02 7:13 PM	std	1	1	50	2.48	2.55	340.95	2.16	2.34	2.28	2.30	2.10	2.30	2.40	5.89					
44	MOJO 1-10	9/6/02 6:54 PM	std	1	1	50	1.63	1.72	6.05	0.93	3.43	2.77	0.54	0.76		0.26	5.78					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Total DF	Sample:	sample point	Date/Time:	mass (g)	vol (ml)	V / 51	Mn / 55	Fe / 56	Cu / 63	Zn / 66	As / 75	Se / 82	Pb / 208	Th / 232	U / 238	U rsd%	U stdev
2	105.9	1054	A1	9/6/2002	0.2448	55.25	227.05	156.11	10693.40	7.00	18.71	5.85	19.45	8.87	3.97	**16.50**	*3.24*	
3	*105.9*	*1064*	*A1 Dup*	*9/6/2002*	*0.1519*	*50*	*217.38*	*148.19*	*10780.12*	*7.32*	*20.51*	*7.86*	*15.02*	*7.68*	*3.95*	***19.44***	*8.56*	*2.08*
4	5	1055	A2	9/6/2002	0.2571	50	27.15	144.85	12024.50	6.13	33.99	3.44	0.78	7.38	5.48	**2.16**	*5.81*	
5	5	1056	A3	9/6/2002	0.2291	50	25.10	170.23	13077.26	22.98	33.48	3.32	0.60	9.11	5.93	**1.46**	*6.32*	
6	5	1057	B1	9/6/2002	0.2495	54.5	16.85	101.97	7097.01	5.16	17.88	2.01	1.55	4.46	2.64	**1.23**	*6.51*	
7	105.9	1058	B2	9/6/2002	0.2171	52.75	94.57	155.29	12328.58	8.09	21.53	5.24	1.11	5.88	4.32	**5.54**	*5.85*	
8	*5*	*1081*	*B2 dup*	*10/2/2002 3:13*	*0.0665*	*50*	*107.59*	*154.06*	*12676.69*	*11.69*	*53.66*	*5.52*		*7.51*	*4.12*	***3.83***	*4.5*	*1.21*
9	5	1062	B3	9/6/2002	0.2157	50	103.59	152.97	11961.06	7.05	31.34	4.91	2.14	7.40	4.93	**3.15**	*7.49*	
10																		
11	5	1059	C1	9/6/2002	0.2343	50	22.15	137.26	11124.63	6.04	31.84	3.05	0.61	7.34	5.05	**2.13**	*7.43*	
12	105.9	1060	C2	9/6/2002	0.2226	58	40.28	156.96	16032.08	5.59	33.95	2.55	2.04	8.28	6.35	**5.57**	*3.72*	
13	*91.11*	*1082*	*C2 dup*	*10/2/2002 3:28*	*0.0215*	*51.5*	*64.96*	*152.99*	*17833.37*	*32.03*	*207.60*			*12.46*		***5.89***	*5.34*	*0.23*
14	105.9	1061	C3	9/6/2002	0.2351	50	310.29	126.69	11144.19	6.33	29.09	4.69	7.38	5.60	3.92	**8.55**	*6.26*	
15	5	1063	D1	9/6/2002	0.212	50	22.88	133.28	13674.53	6.00	33.40	4.15	0.52	8.71	6.06	**1.95**	*6.56*	
16	91.11	1067	D2	10/2/2002 0:57	0.2614	54.5	33.21	128.95	15132.40	10.65	45.51	4.41	6.90	16.22	5.54	**11.56**	*9.22*	
17	5	1068	D3	10/2/2002 1:11	0.2591	50	23.37	186.80	10082.98	8.55	24.51	2.60		6.31	3.17	**1.45**	*3.65*	
18																		
19	91.11	1066	E1	10/2/2002 0:48	0.2283	50		155.32	13771.35	8.68	36.88	4.52	1.39	10.49	6.31	**5.56**	*8.36*	
20	5	1069	E2	10/2/2002 1:21	0.2117	50	60.46	373.64	24492.21	13.84	57.63	5.82	2.63	15.77	8.61	**11.45**	*5.25*	
21	91.11	1070	E3	10/2/2002 1:36	0.1765	50	38.13	212.29	16951.84	13.48	53.40	4.61	4.39	12.73	5.81	**11.75**	*7.26*	
22	5	1071	F1	10/2/2002 1:41	0.2343	50	25.44	308.37	19545.45	11.49	44.64	5.09	1.26	13.04	7.04	**5.41**	*9.1*	
23	*5*	*1076*	*F1 dup*	*10/2/2002 2:30*	*0.2033*	*50*	*32.64*	*257.26*	*17533.20*	*10.00*	*38.96*			*11.88*	*6.34*	***5.07***	*4.42*	*0.24*
24	91.11	1072	F2	10/2/2002 1:56	0.2182	52.1	29.85	148.71	12936.65	8.64	35.17	6.26	1.64	9.78		**2.71**	*6.06*	
25	5	1073	F3	10/2/2002 2:00	0.2037	50	24.45	204.76	12042.22	8.67	29.28	2.81	1.51	7.68	4.05	**6.07**	*3.77*	
26																		
27	5	1074	G1	10/2/2002 2:10	0.2073	50	35.79	173.37	19290.88	12.01	40.30	8.64	3.24	11.64	7.67	**3.49**	*4.39*	
28	91.11	1075	G2	10/2/2002 2:25	0.2134	54.1	37.11	217.72	15271.72	10.57	46.82	4.84	4.94	12.15	5.49	**17.84**	*7.57*	
29	5	1083	G3	10/2/2002 3:33	0.2409	50	26.88	205.50	13731.84	7.85	37.19	3.85	1.22	7.34	5.04	**2.23**	*4.6*	
30	50.7	1093	H1	2/3/03 8:57 PM	0.2599	50.00	34.82	262.02	15565.60	11.23	56.02	5.39	2.31	15.30	6.37	**17.31**	*2.25*	
31	5.0	1094	H2	2/3/03 8:41 PM	0.2292	50.50	35.16	194.00	16544.70	9.91	59.07	7.97	1.31	15.06	7.41	**3.07**	*3.44*	
32	50.7	1095	H3	2/3/03 8:37 PM	0.2909	50.00	28.89	234.96	12194.91	15.11	58.54	4.77	4.78	11.48	5.65	**16.72**	*3.18*	
33																		
34	50.7	1096	I1	2/3/03 10:32 PM	0.1700	50.00	38.09	269.74	15867.65	15.27	78.76	5.15	5.57	15.69	5.94	**15.64**	*3.19*	
35	50.7	1097	I2	2/3/03 10:22 PM	0.2622	50.00	38.31	246.57	18525.93	12.78	65.56	8.51	1.84	13.89	7.45	**4.23**	*4.03*	
36	50.7	1098	I3	2/3/03 10:02 PM	0.1866	50.00	48.26	534.57	22534.83	15.82	86.25	7.22	5.19	16.44	8.22	**17.19**	*3.43*	
37	5.0	1099	J1	2/3/03 9:47 PM	0.1608	50.00	45.52	227.02	17282.34	13.88	85.82	6.19	2.19	18.96	7.04	**4.58**	*1.88*	
38	5.0	1102	J2	2/3/03 11:27 PM	0.1848	57.00	45.09	253.14	18389.29	11.87	60.89	7.09	1.68	14.11	6.93	**3.96**	*2.25*	
39	5.0	1103	J3	2/3/03 11:17 PM	0.1426	55.00	36.61	222.58	16523.14	12.86	58.59	6.09	2.29	13.02	6.55	**7.03**	*1.45*	
40																		
41	50.7	1104	K1	2/3/03 11:12 PM	0.1658	54.00	60.25	337.09	19600.24	24.24	102.59	9.17	3.25	17.27	6.83	**18.57**	*1.43*	
42	50.7	1105	K2	2/3/03 11:02 PM	0.1518	50.00	39.62	295.16	19855.07	11.24	51.25	12.16	1.74	14.04	7.11	**7.57**	*1.46*	
43	50.7	1106	K3	2/3/03 10:52 PM	0.2109	50.00	35.23	219.35	17828.35	8.97	47.23	7.47	2.05	10.82	7.37	**5.91**	*3.86*	
44	50.7	1107	L1	2/3/03 10:42 PM	0.3154	55.00	29.68	295.23	13464.01	8.30	46.63	5.03	4.19	9.85	5.10	**6.95**	*2.92*	
45	50.7	1108	L2	2/4/03 12:43 AM	0.2286	52.00	26.09	215.12	12183.38	7.62	39.44	4.39	1.23	8.24	4.46	**9.98**	*2.34*	
46	5.0	1109	L3	2/4/03 12:28 AM	0.3070	56.00	24.46	136.22	9844.69	6.69	46.39	4.13	0.82	7.53	3.86	**2.62**	*1.61*	
47	*5.0*	*1113*	*L3 dup*	*2/3/03 11:37 PM*	*0.3063*	*50.00*	*19.75*	*135.18*	*9784.52*	*5.62*	*44.91*	*4.42*	*0.81*	*7.52*	*3.93*	***2.38***	*0.9*	*0.17*
48																		
49	50.7	1110	M1	2/4/03 12:23 AM	0.2724	58.00	25.27	192.29	12140.82	7.54	39.88	4.38	1.86	9.86	4.71	**4.28**	*3.65*	
50	5.0	1111	M2	2/4/03 12:07 AM	0.2393	50.00	22.46	167.26	10068.95	5.82	28.58	4.14	0.85	7.23	4.22	**2.07**	*1.75*	
51	50.7	1112	M3	2/3/03 11:53 PM	0.2802	55.00	30.15	198.05	15602.96	8.67	43.10	7.20	1.40	11.32	6.71	**5.54**	*2.51*	
52																		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
53	5	1077	blank	10/2/2002 2:39	1	50	0.23	0.10	16.92	0.72	0.69			0.05		**0.05**	*4.42*	
54	5	1089	blank	10/2/2002 3:53	1	50		0.08	12.48	0.49	2.76			0.04	0.01	**0.01**	*3.01*	
55	5.0	1100	blank	2/3/03 9:42 PM	1.0000	50.00	6.94	0.44		0.62	4.64			0.09		**0.01**	*10.42*	
56	5.0	1101	BRS std	2/3/03 9:32 PM	0.2149	55.50	87.55	546.74	37447.65	80.14	436.98	16.93	2.00	210.74	6.45	**1.83**	*3.13*	
57	5	1065	Buf Riv Sed	9/6/2002	0.2489	53.9	78.61	477.93	34865.01	82.27	316.60	13.68	1.18	119.88	6.05	**1.36**	*6.11*	
58																		
59	1.00	ICP internal check	BLANK	2/3/03 8:27 PM	1.00	50.00	6.27	0.06	-0.67	0.05	-0.03			0.00	0.00	**0.00**	*34.55*	
60	1	ICP internal check	Blank Rinse	10/2/02 1:07 AM	1	50		2.75	0.06	0.00	0.00			0.00	0.00	**0.00**	*11.11*	
61	1	ICP internal check	Blank Rinse	10/2/02 2:58 AM	1	50			0.21	0.00	0.00					**0.00**	*18.06*	
62	1.00	ICP internal check	Blank Rinse	2/3/03 8:22 PM	0.20	50.00	0.15	0.40	-1.81	0.32	0.06	0.02	-0.05	0.02	0.02	**0.06**	*33.63*	
63	1.00	ICP internal check	Blank Rinse	2/3/03 10:12 PM	0.20	50.00	0.11	0.28	-2.73	0.09	0.05	0.04	0.02	0.02	0.01	**0.01**	*31.65*	
64	1.00	ICP internal check	Blank Rinse	2/4/03 12:02 AM	0.20	50.00	0.13	0.28	-2.08	0.03	0.05	0.05	0.04	0.01	0.01	**0.01**	*39.01*	
65	1.00	ICP internal check	Blank Rinse	2/4/03 1:03 AM	0.20	50.00	0.14	0.29	-1.55	0.02	0.05	0.04	0.02	0.01	0.01	**0.01**	*38.74*	
66	1	ICP internal check	CCV 50/5000/0.5	10/2/02 1:02 AM	1	50	2.738	0	0	0	0	0	0	2.1675	2.019	**2.5135**	*5.07*	
67	1	ICP internal check	CCV 50/5000/0.5	10/2/02 2:54 AM	1	50	2.745	2.7435	271	2.36	2.522	2.502	2.5585	2.0775	1.919	**2.468**	*6.83*	*0.03*
68	1.00	ICP internal check	CCV 50/5000/5	2/3/03 8:17 PM	0.20	50.00	11.98	12.64	8.59	10.72	12.48	12.90	13.77	11.43	13.26	**13.28**	*0.85*	
69	1.00	ICP internal check	CCV 50/5000/5	2/3/03 10:07 PM	0.20	50.00	12.06	12.74	9.31	10.41	12.51	12.28	12.61	11.26	13.42	**13.36**	*2.04*	
70	1.00	ICP internal check	CCV 50/5000/5	2/3/03 11:58 PM	0.20	50.00	12.52	12.98	10.14	10.36	12.41	12.16	12.38	10.90	13.25	**13.23**	*0.97*	
71	1.00	ICP internal check	CCV 50/5000/5	2/4/03 12:58 AM	0.20	50.00	12.87	13.30	10.46	10.48	12.61	12.37	12.55	10.91	13.33	**13.34**	*0.73*	*0.06*
72	1.00	ICP internal check	ECS 5 ppb	2/4/03 12:48 AM	0.20	50.00	0.95	1.47	117.73	1.14	1.15	1.19	1.20	1.07	0.84	**1.03**	*2.8*	
73	10.14	ICP internal check	ECS 5 ppb	2/4/03 12:53 AM	0.20	50.00	1.50	3.89	96.68	0.96	0.07	1.48	1.23	1.03	0.83	**1.03**	*0.41*	*0.00*
74	1.00	ICP internal check	ICV 50/5000/5	2/4/03 1:07 AM	0.20	50.00	12.92	12.74	10.56	10.41	12.44	12.43	12.57	10.83	13.01	**13.25**	*0.19*	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	**Total DF**	**Sample**	**sample point**	**Date/Time**	**mass (g)**	**vol (ml)**	**V / 51**	**Mn / 55**	**Cu / 63**	**Zn / 66**	**As / 75**	**Se / 82**	**Pb**	**Th**	**U / 238**	***U rsd %***	**U stdev**
2	105.9	1030	1-0	9/6/2002	0.178	50	427.25	82.13	0.85	14.04	17.00	17.00	4.69	3.08	**48.60**	*5.76*	
3	105.9	1031	1-7	9/6/2002	0.1885	50	528.65	96.47	0.53	13.34	21.70	21.00	6.58	4.12	**71.86**	*3.6*	
4	105.9	1032	1-21	9/6/2002	0.2463	50	1146.98	40.86	1.76	24.81	21.27	45.41	8.52	3.30	**49.07**	*6.32*	
5	105.9	1033	1-35	9/6/2002	0.2259	50	662.24	39.95	0.82	11.84	24.60	41.80	9.61	3.53	**20.57**	*3.77*	
6	91.11	1078	1-49	10/2/2002 2:44	0.1878	55	88.85	36.00	4.13	19.35	16.39	5.66	3.13	3.20	**19.07**	*7.09*	
7	*91.11*	*1087*	*1-49*	*10/2/2002*	*0.1486*	*50*	*68.25*	*20.13*	*5.15*	*22.09*	*15.94*	*7.08*	*6.17*	*2.74*	***20.26***	*8.37*	0.84
8	105.9	1035	1-60	9/6/2002	0.2066	50	23.92	296.71	3.78	20.00	3.70	1.31	5.09	5.54	**248.55**	*5.79*	
9	105.9	1036	1-70	9/6/2002	0.2409	50	23.39	126.09	6.25	20.31	4.50		5.65	5.91	**9.88**	*5.1*	
10																	
11	5	1037	2-0	9/6/2002	0.2199	50	20.89	156.59	6.06	24.69	2.75		6.03	4.05	**2.08**	*5.37*	
12	5	1038	2-10	9/6/2002	0.2628	50	22.15	132.06	5.08	24.28	3.09		5.33	3.88	**0.53**	*6.1*	
13	5	1039	2-20	9/6/2002	0.2444	50	20.99	142.64	5.47	22.22	4.48		9.94	3.75	**0.53**	*7.39*	
14	5	1040	2-30	9/6/2002	0.2122	50	18.18	111.64	4.39	24.62	2.57		4.35	3.25	**0.48**	*6.67*	
15	5	1042	2-40	9/6/2002	0.2155	53	15.51	102.43	4.60	18.83	2.45		4.24	2.94	**0.47**	*4.89*	
16	5	1043	2-50	9/6/2002	0.2231	50	17.75	97.94	4.41	17.42	2.37		3.96	3.01	**0.50**	*4.6*	
17	5	1044	2-60	9/6/2002	0.237	55.5	18.64	117.46	6.59	22.99	2.75		5.72	3.80	**0.56**	*4.09*	
18	*5*	*1052*	*2-60*	*9/6/2002*	*0.2522*	*51.75*	*18.83*	*119.77*	*5.37*	*32.07*	*2.70*		*5.05*	*4.12*	***0.64***	*6.76*	0.06
19																	
20	105.9	1045	3-10	9/6/2002	0.1412	50	31.28	462.82	13.20	41.11	4.04	5.02	9.27	6.61	**15.88**	*6.98*	
21	105.9	1046	3-20	9/6/2002	0.2515	50	38.39	358.05	7.78	58.23	5.32		10.90	9.60	**13.52**	*3.63*	
22	105.9	1047	3-30	9/6/2002	0.2105	50	29.12	244.89	5.43	42.59	4.68	0.80	10.24	7.90	**9.02**	*8.65*	
23	*91.11*	*1080*	*3-30*	*10/2/2002 3:03*	*0.1277*	*50*	*29.85*	*238.35*	*8.64*	*42.30*	*3.95*	*0.73*	*11.41*	*8.65*	***10.40***	*8.23*	0.97
24	105.9	1048	3-40	9/6/2002	0.2496	61.5	36.54	331.65	7.84	60.19	5.43		11.28	10.02	**8.89**	*5.75*	
25	5	1049	3-50	9/6/2002	0.2462	58	31.03	248.30	5.51	53.67	7.45	1.47	17.41	12.76	**9.30**	*9.49*	
26	105.9	1050	3-60	9/6/2002	0.2338	56.5	35.28	312.71	7.96	56.33	5.77	0.68	12.11	12.07	**5.20**	*4.33*	
27	105.9	1051	3-70	9/6/2002	0.2228	50	35.79	254.94	13.18	55.39	5.17	0.88	10.56	9.24	**4.01**	*5.71*	
28																	
29	5	1053	Blank	9/6/2002	1	50	0.30	0.65	2.13	12.23	0.03	0.00	0.31	0.06	**0.05**	*8.14*	
30	5	1041	std BRS 8704	9/6/2002	0.23	50.1	74.58	456.13	68.70	313.67	12.86	1.02	124.81	6.12	**1.36**	*8.02*	
31																	
32																	
33																	

APPENDIX G

Vegetation ICP-MS Uranium Data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Location**	**sample point**	**leaves/stems**	**mass (g)**	**vol (ml)**	**U / 238**	**U / 238**	pt avg	pt stdev			Soil U	CR		
2	JR S27	-A1-3	-	0.2989	50	1.906	**0.32**	0.32	0.00			156.2			
3	JR S27	-A1-3	-	0.2636	50	1.717	**0.33**								
4															
5	JR S27	A1-3	leaves	0.3945	50	68.82	**8.72**	5.81	4.12			--			
6	JR S27	A1-3	stem	0.3783	50	21.88	**2.89**								
7															
8	JR S27	-E1-2	stem	0.3951	50	0.5576	**0.07**	0.19	0.17			8.1			
9	JR S27	-E1-2	leaves	0.3949	50	2.415	**0.31**								
10															
11	JR S27	B4-3	stem	0.3973	50	0.9304	**0.12**	0.17	0.08			11.2			
12	JR S27	B4-3	leaves	0.3867	50	1.765	**0.23**								
13															
14	JR S27	-C1-3	-	0.3852	50	0.2189	**0.03**	0.07	0.04			4.6			
15	JR S27	-C1-3	leaves	0.3852	50	0.8135	**0.11**								
16	JR S27	-C1-3	stem	0.3788	50	0.6489	**0.09**								
17									pt avg	pt stdev					
18	JR S27	C1-1	-	0.5003	50	151.5	**15.14**	1.78	1.21	0.17		174.4			
19	JR S27	C1-1	-	0.3986	50	3.462	**0.43**								
20	JR S27	C1-1	-	0.3979	50	3.493	**0.44**								
21	JR S27	C1-1	-	0.3957	50	3.655	**0.46**								
22	JR S27	C1-1	-	0.398	50	5.457	**0.69**								
23	JR S27	C1-1	-	0.3999	50	5.179	**0.65**								
24	JR S27	C1-1	-	0.3973	50	5.254	**0.66**								
25	JR S27	C1-1	-	0.393	50	6.139	**0.78**								
26	JR S27	C1-1	-	0.3962	50	5.915	**0.75**								
27	JR S27	C1-1	-	0.3977	50	8.907	**1.12**								
28	JR S27	C1-1	-	0.3982	50	5.983	**0.75**								
29	JR S27	C1-1	-	0.3966	50	6.577	**0.83**								
30	JR S27	C1-1	-	0.3998	50	3.187	**0.40**								
31	JR S27	C1-1	leaves	0.3948	50	8.336	**1.06**	1.11							
32	JR S27	C1-1	leaves	0.3888	50	8.37	**1.08**								
33	JR S27	C1-1	leaves	0.3952	50	10.15	**1.28**		1.09						
34	JR S27	C1-1	leaves	0.3899	50	8.131	**1.04**								
35	JR S27	C1-1	stem	0.3821	50	2.986	**0.39**	0.38							
36	JR S27	C1-1	stem	0.3821	50	2.82	**0.37**			**Location**	**sample pt**	**pt avg**	**Soil U**	**CR**	**pt stdev**
37	JR S27	C1-1	stem	0.397	50	3.479	**0.44**			JR S27	-C1	0.07	4.6	1.59	0.04
38	JR S27	C1-1	stem	0.391	50	3.308	**0.42**			JR S27	B4	0.17	11.2	1.54	0.08
39	JR S27	C1-1	stem	0.3944	50	2.285	**0.29**			JR S27	-E1	0.19	8.1	2.32	0.17
40	JR S27	C1-3	leaves	0.3925	50	15.15	**1.93**	1.93	1.33	JR S27	-A1	0.32	156.2	0.21	0.00
41	JR S27	C1-3	stem	0.3970	50	5.68	**0.72**	0.72		JR S27	C1	1.09	174.4	0.63	0.17
42							**stem**	**0.38**		JR S27	C1	1.33	174.4	0.76	
43							**leaves**	**1.11**		JR S27	A1	5.81	--		4.12
44							**plant**	**3.00**							
45								0.75							

	A	B	C	D	E	F	G	H	I	J
1	**Sample:**	**Location**	**sample point**	**plt/ sht**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	avg	stdev
2	232	JR S27	A5-3	bogr	0.3967	50	11.51	**1.45**	0.96	0.42
3	233	JR S27	A5-3	bogr	0.4	50	5.494	0.70		
4	233	JR S27	A5-3	bogr	0.4000	50	5.853	**0.73**		
5										

	A	B	C	D	E	F	G	H	I	J
1	**Sample:**	**Location**	**sample point**	**leaves/stems**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	**sample poin**	**leaves/stems**
2	279	JR S27	D4-3	stem	0.3841	50	58.51	**7.62**	D4-3	stem
3	280	JR S27	D4-3	leaves	0.3945	50	80.69	**10.23**	D4-3	leaves
4										

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Sample:**	**Location**	**sample poin**	**plt/ sht**	**leaves/stem**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**		**Location**	**sample pt**	avg Plant U	Soil U
2	180	JR S27	-G1-1	deob	stem	0.2966	50	1.576	**0.27**	0.35	JR S27	-G1-1	0.35	6.8
3	181	JR S27	-G1-1	deob	stem	0.1392	50	1.197	**0.43**		JR S27		2.16	63.5
4	189	JR S27	G5-3	deob	stem	0.0966	50	4.165	**2.16**	**2.16**	JR S27	G5-3	2.52	139.5
5	309	JR S27	XG1-1	deob	stem	0.3846	50	8.695	**1.13**	2.52	JR S27	XG1-1		
6	310	JR S27	XG1-1	deob	seed	0.3928	50	30.77	**3.92**		JR S27			
7														
8									1.68	1.16				

	A	B	C	D	E	F	G	H	I	J
1	**Sample:**	**Location**	**sample poin**	**plt/ sht**	**eaves/stems**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	
2	266	JR S27	C5-1	erlo	leaves	0.3929	50	3.729	**0.47**	0.71
3	267	JR S27	C5-1	erlo	stem	0.3645	50	6.843	**0.94**	
4	295	JR S27	E5-1	erlo	stem	0.3957	50	23.89	3.00	
5	295	JR S27	E5-1	erlo	stem	0.3957	50	19.54	**2.47**	1.89
6	296	JR S27	E5-1	erlo	leaves	0.3864	50	6.096	**0.79**	
7										
8										1.30
9										0.839897

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	**Sample:**	**Location**	**sample poin**	**plt/ sht**	**leaves/stem**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	**U / 238**							
2	213	JR S27	G5-2	gusa	-	0.3985	50	48.34	**6.07**	6.07	5.26	G5-2	-				avg Plant U
3	214	JR S27	G5-2	gusa	-	0.3905	50	34.76	**4.45**	4.45		G5-2	-			G5-2	5.26
4																A3-1	0.86
5	220	JR S27	A3-1	gusa	leaves	0.3908	50	8.108	**1.04**	1.04		A3-1	leaves			A3-2	0.95
6	220	JR S27	A3-1	gusa	leaves	0.3908	50	5.418	**0.69**	0.69	0.86	A3-1	leaves			A5-2	0.48
7	221	JR S27	A3-1	gusa	stem	0.3888	50	5.385	**0.69**	0.69		A3-1	stem			D4-1	7.77
8																D4-2	25.10
9	222	JR S27	A3-2	gusa	stem	0.3530	50	9.964	**1.41**	1.41		A3-2	stem			E1-2	9.30
10	223	JR S27	A3-2	gusa	leaves	0.3966	50	3.809	**0.48**	0.48	0.95	A3-2	leaves			E5-3	0.89
11																F4-3	4.6
12	230	JR S27	A5-2	gusa	leaves	0.3991	50	2.316	**0.29**	0.29	0.48	A5-2	leaves				
13	253	JR S27	A5-2	gusa	stem	0.3918	50	5.203	**0.66**	0.66		A5-2	stem				
14																	
15	276	JR S27	D4-1	gusa	stem	0.3979	50	44.02	**5.53**	5.53	7.77	D4-1	stem				
16	277	JR S27	D4-1	gusa	leaves	0.3926	50	78.62	**10.01**	10.01		D4-1	leaves				
17																	
18	278	JR S27	D4-2	gusa	-	0.3934	50	197.5	**25.10**	25.10	**25.10**	D4-2	-				
19																	
20	301	JR S27	E1-2	gusa	stem	0.3323	50	33.66	**5.06**			E1-2	stem				
21	289	JR S27	E1-2	gusa	leaves	0.3861	50	104.5	**13.53**	13.53	9.30	E1-2	leaves				
22																	
23	298	JR S27	E5-3	gusa	stem	0.3935	50	5.899	**0.75**	0.75		E5-3	stem				
24	299	JR S27	E5-3	gusa	leaves	0.3707	50	7.576	**1.02**	1.02	0.89	E5-3	leaves				
25																	
26	308	JR S27	F4-3	gusa	leaves	0.3946	50	36.3	**4.60**	4.60	4.6	F4-3	leaves				
27																	
28												6.13	7.824281				
29																	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	**Sample:**	**Location**	**sample point**	**plt/ sht**	**leaves/stems**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	**sample poin**	avg plant U	**Soil U**			sample point	avg plant U	Soil U
2	207	JR S27	-A1-2	hija	-	0.3612	50	1.959	**0.27**	-A1-2	0.29	156.2			-A1-2	0.29	156.20
3	208	JR S27	-A1-2	hija	-	0.3103	50	1.918	**0.31**	-A1-2					B4-1	0.95	11.20
4	216	JR S27	A1-2	hija	-	0.3974	50	502	**63.16**	A1-2	84.47	n/a			B4-2	0.66	11.20
5	217	JR S27	A1-2	hija	-	0.3940	50	833.6	**105.79**	A1-2					G5-1	4.65	63.50
6	240	JR S27	B4-1	hija	-	0.3864	50	7.376	**0.95**	B4-1	0.95	11.2			A3-3	0.85	73.30
7	241	JR S27	B4-2	hija	-	0.3924	50	4.602	**0.59**	B4-2	0.66	11.2			B2-2	3.44	50.70
8	254	JR S27	B4-2	hija	-	0.3927	50	5.755	**0.73**	B4-2					E5-2	0.72	9.90
9	168	JR S27	G5-1	himu	-	0.3935	50	32.2	4.10	G5-1	4.65	63.5			F4-1	5.46	50.80
10	169	JR S27	G5-1	himu	-	0.387	50	40.04	5.20	G5-1					F4-2	2.40	50.80
11	224	JR S27	A3-3	himu	-	0.3926	50	6.182	**0.79**	A3-3	0.85	73.3					
12	225	JR S27	A3-3	himu	-	0.3963	50	7.562	**0.95**	A3-3							
13	226	JR S27	A3-3	himu	-	0.3913	50	6.314	**0.81**	A3-3							
14	236	JR S27	B2-2	himu	-	0.3823	50	26.27	**3.44**	B2-2	3.44	50.7					
15	297	JR S27	E5-2	himu	-	0.3967	50	5.737	**0.72**	E5-2	0.72	9.9					
16	305	JR S27	F4-1	himu	-	0.3882	50	42.39	**5.46**	F4-1	5.46	50.8			A1-2	84.47	n/a
17	306	JR S27	F4-2	himu	-	0.3946	50	18.93	**2.40**	F4-2	2.40	50.8					
18																	
19								plant avg	**12.23**								
20								plant stdev	29.30659								

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Sample:	Location	sample poin	plt/ sht	leaves/stem	mass (g)	vol (ml)	U / 238	U / 238			sample poin	Plant U	Soil U
2	205	JR S27	-A1-1	kosc	-	0.2137	50	1.926	0.45			-A1-1	0.65	156.2
3	206	JR S27	-A1-1	kosc	-	0.1629	50	2.094	0.64	0.65		B2-1	3.00	50.7
4	206	JR S27	-A1-1	kosc	-	0.1629	50	2.831	0.87			C1-2	28.89	174.4
5	234	JR S27	B2-1	kosc	-	0.1491	50	8.951	3.00	3.00		C3-1	1.22	13.8
6	250	JR S27	C1-2	kosc	-	0.3975	50	229.7	28.89	28.89		D2-2	27.43	621.9
7	257	JR S27	C3-1	kosc	-	0.3922	50	9.559	1.22	1.22		-E1-1	0.44	8.1
8	273	JR S27	D2-2	kosc	-	0.3958	50	223.1	28.20	27.425		E3-1	16.42	26.3
9	273	JR S27	D2-2	kosc	-	0.3958	50	211	26.65			E3-2	6.38	26.3
10	281	JR S27	-E1-1	kosc	stem	0.2805	50	2.635	0.47	0.44		E3-3	5.87	26.3
11	282	JR S27	-E1-1	kosc	leaves	0.3725	50	2.998	0.40			F2-1	347.67	1040.45
12	292	JR S27	E3-1	kosc	-	0.2423	50	79.56	16.42	16.42		F2-2	323.55	1040.45
13	293	JR S27	E3-2	kosc	-	0.2819	50	35.96	6.38	6.38		F2-3	343.60	1040.45
14	294	JR S27	E3-3	kosc	-	0.1539	50	18.07	5.87	5.87		H4-1	5.44	150.2
15	302	JR S27	F2-1	kosc	-	0.3417	50	2376	347.67	347.67				
16	303	JR S27	F2-2	kosc	-	0.3100	50	2006	323.55	323.55				
17	304	JR S27	F2-3	kosc	-	0.0953	50	654.9	343.60	343.60	12.91413		5.94822	
18	741	JR S27	H4-1	kosc		0.2453	50	26.68	5.44	5.44				
19														
20									92.09	144.5457				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Sample:**	**Location**												
2	260	JR S27	C4-1	memu	stem	0.3909	50	101.1	12.93	27.70	11.31		27.70	11.31
3	261	JR S27	C4-1	memu	leaves	0.3899	50	331.1	42.46				26.76	11.31
4	262	JR S27	C4-2	memu	stem	0.3868	50	207	26.76	26.76	11.31		29.58	11.31
5	264	JR S27	C4-3	memu	leaves	0.3999	50	363.6	45.46	29.58	11.31			
6	265	JR S27	C4-3	memu	stem	0.3976	50	108.9	13.69					
7														
8														
9									28.26					
10									15.39					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Sample:	Location	sample poin	plt/ sht	eaves/stems	mass (g)	vol (ml)	U / 238	U (ppm)	U / 238	sample point	Avg Plant U	Soil U		Avg Plant U	Soil U
2	136	JR S27	H2-1	orhy	-	0.3978	50	35.69	4.50	4.5	H2-1	5.52	129.2	H2-1	5.52	129.20
3	137	JR S27	H2-1	orhy	-	0.3985	50	34.82	4.40	4.4	H2-1			G3-1	9.35	58.90
4	138	JR S27	H2-1	orhy	-	0.3998	50	54.97	6.90	6.9	H2-1			H2-2	25.98	129.20
5	139	JR S27	H2-1	orhy	-	0.3974	50	43.44	5.50	5.5	H2-1			G1-1	13.63	139.50
6	140	JR S27	H2-1	orhy	-	0.3999	50	37.24	4.70	4.7	H2-1			H2-2	12.62	129.20
7	141	JR S27	H2-1	orhy	-	0.3979	50	38.32	4.80	4.8	H2-1			H2-3	65.90	129.20
8	150	JR S27	H2-1	orhy	-	0.3959	50	40.39	5.10	5.1	H2-1					
9	151	JR S27	H2-1	orhy	-	0.3968	50	38.25	4.80	4.8	H2-1					
10	152	JR S27	H2-1	orhy	-	0.3948	50	50.89	6.40	6.4	H2-1					
11	153	JR S27	H2-1	orhy	-	0.398	50	54.72	6.90	6.9	H2-1					
12	154	JR S27	H2-1	orhy	-	0.3928	50	35.35	4.50	4.5	H2-1					
13	156	JR S27	H2-1	orhy	-	0.397	50	43.18	5.40	5.4	H2-1					
14	158	JR S27	H2-1	orhy	-	0.3866	50	51.14	**6.61**	6.614071	H2-1					
15	158	JR S27	H2-1	orhy	-	0.3866	50	52.58	6.80	6.8	H2-1					
16	170	JR S27	G3-1	orhy	-	0.3895	50	79.43	10.20	10.2	G3-1	9.35	58.9			
17	171	JR S27	G3-1	orhy	-	0.393	50	66.72	8.50	8.5	G3-1					
18	178	JR S27	H2-2	orhy	-	0.3970	50	211.9	**26.69**	26.68766	H2-2	25.98	129.2			
19	178	JR S27	H2-2	orhy	-	0.3970	50	200.7	**25.28**	25.27708	H2-2					
20	182	JR S27	G1-1	orhy	-	0.3950	50	102.5	**12.97**	12.97468	G1-1	13.63	139.5			
21	183	JR S27	G1-1	orhy	-	0.3886	50	111	**14.28**	14.28204	G1-1					
22	188	JR S27	H2-2	orhy	-	0.3942	50	99.48	**12.62**	12.61796	H2-2	12.62	129.2			
23	190	JR S27	H2-3	orhy	-	0.3947	50	459.4	**58.20**	58.1961	H2-3	65.90	129.2			
24	204	JR S27	H2-3	orhy	-	0.3989	50	587.2	**73.60**	73.60241	H2-3					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Sample:**	**Location**	**sample poin**	**plt/ sht**	**leaves/stems**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	Avg plant U	**sample point**		sample point	Avg plant U	soil U
2	174	JR S27	G3-3	spcr	-	0.3998	50	85.07	**10.64**	11.34	G3-3		G3-3	11.34	58.9
3	175	JR S27	G3-3	spcr	-	0.3991	50	96.13	**12.04**		G3-3		G1-2	41.09	139.5
4	184	JR S27	G1-2	spcr	-	0.2669	50	274.2	**51.37**	41.09	G1-2		B2-3	2.49	50.7
5	185	JR S27	G1-2	spcr	-	0.1511	50	93.11	**30.81**		G1-2				
6	228	JR S27	A5-1	spcr	-	0.3754	50	8.151	**1.09**	**1.09**	A5-1				
7	237	JR S27	B2-3	spcr	-	0.3910	50	15.1	**1.93**	2.49	B2-3		A5-1	1.09	
8	238	JR S27	B2-3	spcr	-	0.3896	50	23.81	**3.06**		B2-3				
9									15.85						
10									18.61865						
11															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Sample:**	**Location**	**sample poin**	**plt/ sht**	**leaves/stem**	**mass (g)**	**vol (ml)**	**U / 238**	**U (ppm)**	**sample point**				**sample poin**	avg plant U	Soil U
2	172	JR S27	G3-2	saka	-	0.3244	50	85.76	13.20	12.70	G3-2			G3-2	12.70	58.9
3	173	JR S27	G3-2	saka	-	0.108	50	26.42	12.20		G3-2			G1-3	40.42	139.5
4	186	JR S27	G1-3	saka	-	0.3226	50	192.8	**29.88**	40.42	G1-3			-C1-1	0.07	4.6
5	187	JR S27	G1-3	saka	-	0.3250	50	331.2	**50.95**		G1-3			-C1-2	0.085	4.6
6	244	JR S27	-C1-1	satr	stem	0.3615	50	0.5395	**0.07**	0.07	-C1-1			D2-1	21.54	621.9
7	246	JR S27	-C1-2	satr	stem	0.3890	50	0.5423	**0.07**	0.085	-C1-2			D2-3	33.49	621.9
8	247	JR S27	-C1-2	satr	leaves	0.3957	50	0.8258	**0.10**		-C1-2			-E1-3	0.53	8.1
9	271	JR S27	D2-1	satr	stem	0.2058	50	49.18	**11.95**	21.54	D2-1					
10	272	JR S27	D2-1	satr	leaves	0.3973	50	247.4	**31.14**		D2-1					
11	274	JR S27	D2-3	satr	-	0.3812	50	255.3	**33.49**	33.49	D2-3					
12	285	JR S27	-E1-3	satr	leaves	0.3963	50	5.49	**0.69**	0.53	-E1-3					
13	286	JR S27	-E1-3	satr	stem	0.3903	50	2.913	**0.37**		-E1-3					
14										15.55	16.77596					

	A	B	C	D
6	**plant**		**avg plant U**	**Soil U**
7	asbr	1	5.78	71.6
8	asfa	2	2.92	58.9
9	paob	3	1.54	8.09
10	scbr	4	4.24	13.8
11	sihy	5	0.78	8.09
12	chna	6	8.93	79.4
13	erlo	7	0.71	8.09
14	erlo	7	1.89	9.9
15		grsq	17.9	na