Uranium and Other Elements in Colorado Rocky Mountain Wetlands—A Reconnaissance Study

U.S. GEOLOGICAL SURVEY BULLETIN 1992

Front cover: Photograph of a lake-fill subalpine wetland in northern Colorado. Note prominent spring pool in the center. Photograph taken in 1988 by Douglass Owen.

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By DOUGLASS E. OWEN, JAMES K. OTTON,
F. ALLAN HILLS, and R. RANDALL SCHUMANN

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By Douglass E. Owen, James K. Otton, F. Allan Hills, *and* R. Randall Schumann

Abstract

Wetlands have a well-documented capacity for extracting metals, particularly uranium, from ground and surface waters containing only very dilute concentrations of the metals. The plutonic and volcanic rocks of the Colorado Rockies contain uranium concentrations high enough to serve as a uranium source to waters that feed wetlands. Reconnaissance sampling was conducted in 145 montane and subalpine wetlands in Colorado to determine how many of them are uraniferous. Forty-six percent of the wetlands showed the presence of moderate or high concentrations of uranium, but unless the price of uranium substantially increases none of the deposits is of economic value. Many of the processes responsible for concentrating uranium and other metals in organic-rich sediments of wetlands are reversible, however, and serious environmental consequences may occur if anthropogenic or natural disturbances change the chemical conditions in a wetland sufficiently to release uranium or other metals.

INTRODUCTION

Granitic terrains in many areas of Canada and the United States contain significant accumulations of uranium in late Pleistocene- to Holocene-age, organic-rich surficial wetland sediments. These surficial uranium occurrences were first described for a few sites in the Sierra Nevada of California in reports of uranium exploration activities in the 1950's (Bowes and others, 1957; Swanson and Vine, 1958). More recently, such occurrences have been found to be widespread in many areas of the United States and Canada (R.R. Culbert, Beaty Geological Ltd., written commun., 1983; Radiation Control Section, 1983; Culbert and others, 1984; Otton, 1984).

We began reconnaissance sampling of wetlands in the State of Colorado in 1982 after examination of analytical data from stream sediment samples collected during the U.S. Department of Energy National Uranium Resource Evaluation (NURE) program suggested that wetlands in granitic terrains were likely sites of uranium accumulation. Sampling of mountain wetlands by Leventhal and others (1978) and stream sediment sampling by a few mineral exploration companies also suggested that uranium might be present in such environments.

The uranium in these wetlands has accumulated so recently (late Pleistocene to Holocene) that it is in gross disequilibrium (excess) compared with its more radioactive daughter products. As a result of this disequilibrium, uraniferous wetlands have low radioactivity and generally cannot be detected using airborne or handheld gamma-ray spectrometers or scintillometers. Previous exploration for uranium mostly employed these techniques and thus failed to detect uraniferous wetlands. In addition, geologists exploring for uranium were principally interested in bedrock sources because surficial accumulations were thought to be too small to be economically important.

In spite of past perceptions, uraniferous wetlands constitute a potential uranium resource for the future. To date, however, only one wetland in the United States has been mined for its uranium. In the fall of 1983, a small uranium deposit in organic-rich alluvium on the north fork of Flodelle Creek in Stevens County, Washington, went into production. Sediments along the 4.1-km (2.5 mi)-long stream drainage are estimated to contain about 450,000 kg (990,000 lbs) of uranium having an average grade of about 0.08 percent (800 ppm) U and a maximum grade of about 1.0 percent (10,000 ppm) U (by dry weight) (Robert E. Miller, Joy Mining Company, written commun., 1985). Only about 500 kg (1,100 lbs) of uranium was produced from the deposit before mining activities ceased, mainly because of processing difficulties associated with the low price of uranium. Other exploration and development work

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occurred in nearby stream valleys and in other areas throughout northeastern Washington and northern Idaho, but no other mines were brought into production. (Further information on this region can be found in Finch and others, 1990.) With the spot price of uranium at about $9 per pound in the beginning of 1990, it is unlikely that further attempts at producing uranium from wetlands will be made until the market improves significantly.

Surficial accumulations of uranium, if disturbed sufficiently to release the held uranium, are potential contamination sources of community water supplies. Concerns about the environmental impact of mining a small uraniferous wetland in southern British Columbia were, in part, responsible for a moratorium placed on uranium exploration and mining in British Columbia in 1977 (R.R. Culbert, Beaty Geological Ltd., written commun., 1982). Local, small public water supplies in the Carson Range of Nevada contain moderate levels of uranium in an area where numerous surficial uranium deposits are present along the stream valley floors (Otton and others, 1989); two small wetlands along one stream drainage contain an estimated 24,000 kg (53,000 lbs) and 15,000 kg (33,000 lbs) of uranium, respectively. Thus, in areas where surficial uranium deposits are present, local water supplies are likely to have elevated levels of uranium and other radionuclides and precautions should be taken to avoid disturbing the wetland system. In addition to being sources themselves of contamination, uraniferous wetlands are direct evidence that large amounts of uranium are being leached by water from nearby bedrock sources, and such water may pose hazards even where environmental disturbances to wetlands are not present. Natural seasonal variations of the water table in uraniferous wetlands can also impact domestic water supplies by influencing whether uranium is being stored or released by the organic-rich sediments (Zielinski and Otton, 1989).

In the Colorado Rockies, some wetlands contain accumulations of peat that are mined for agricultural purposes. Disturbing wetlands to mine peat may release metals from the peat to the environment. Moreover, the use of uranium-bearing or metal-bearing peat for agricultural purposes may cause foodstuffs to accumulate elevated levels of uranium or other metals.

The purpose of this paper is to (1) provide background information about wetlands and their metal accumulation; (2) describe methods of identifying and studying wetlands for uranium accumulation; (3) identify source rocks in the Colorado Rocky Mountains that may be supplying uranium for accumulation in wetlands; (4) report the results of five years of sampling (1982–1987) of 145 wetlands in the Colorado Rockies; and (5) describe the economic, environmental, and health implications of uraniferous wetlands. Because the Colorado Rockies probably contain thousands of isolated wetlands, our sampling is by no means comprehensive, but it does provide some indication of the extent of uranium accumulations in wetlands in various areas of Colorado.

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DEFINITIONS AND CHARACTERIZATIONS

Wetland is a general term that includes marshes, swamps, bogs, fens, wet meadows, and so forth (Windell and others, 1986). Because of a plethora of legal cases involving wetlands, the U.S. Government developed the "Federal Manual for Identifying and Delineating Jurisdictional Wetlands" (U.S. Fish and Wildlife Service and others, 1989); this manual goes into far more detail than is required for this paper and was unavailable at the start of the project. Prior to this manual, the U.S. Fish and Wildlife Service used the following definition and set of qualifying attributes for classification purposes (Cowardin and others, 1979):

> Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes [vegetation adapted to wet conditions]; (2) the substrate is predominantly undrained hydric soil [soil that is saturated, flooded, or ponded long enough during the growing season to develop anoxic conditions in the upper part]; and (3) the substrate is nonsoil [rock] and is saturated with water or covered by shallow water at some time during the growing season of each year.

With the general attributes of wetlands in mind, specific types of wetlands can be discussed. Funk and Wagnalls (1984) defines a bog as "wet and spongy ground," and traditionally geologists have used similar definitions of bog to refer to areas described above as wetlands. Geologists have also used the term fen in a general sense; that is "fen: waterlogged, spongy ground containing alkaline decaying vegetation, characterized by reeds, that may develop into peat" (Bates and Jackson, 1980). Wetland scientists, however, use more restricted definitions for the terms bog, fen, marsh, swamp, and so forth, and, in this paper, we use these restricted definitions (defined following) and we use "wetland" as the general term.

True bogs are rain formed and rain fed (ombrogenous and ombrotrophic). They derive their water from rainfall rather than from the ground-water system of the immediately surrounding terrain (Cooper, 1988). Bogs generally have a moss layer dominated by *Sphagnum* species. Bogs can develop from fens when the germination surface of the peat becomes elevated enough to be kept

Figure 1. Montane fen (outlined area) northwest of Central City, Colorado, along Chase Gulch. Sampling site A19 (plate 1). This fen has had its peat mined for agricultural purposes upvalley from this location.

leached by rainfall (Windell and others, 1986). Because of the low humidity and low rainfall in our study areas in Colorado, no true bogs are present.

Fens are sedge-, grass-, or reed-dominated minerotrophic peatlands (Windell and others, 1986). Minerotrophic means that the fen receives nutrient-bearing water that has passed through mineral soil (Mitsch and Gosselink, 1986). Fens are classified as being poor or rich, based on the pH of the fen water. They range from extremely poor, having a pH of 3.7–5.2, to extremely rich, having a pH of 7.0–8.5; in contrast, true bogs generally have a pH of 3.5–4.3 (Windell and others, 1986). Most peatlands in the Southern Rocky Mountains, including those in Colorado, are fens, and nutrients are dominantly provided by ground-water and surface-water flow (Cooper, 1988). Figures 1 and 2 show typical Colorado mountain fens.

Marshes are open grassy wetlands that developed on mineral soils but differ from fens in that they stand under shallow water at least part of the year and, because they are well aerated, store little or no peat (Crum, 1988). Swamps are forested mineral-rich wetlands that are flooded during part of the year and are similar to marshes in that they are well aerated and store little or no peat (Crum, 1988). At least parts of some wetlands investigated in this study are marshes.

Carrs, another type of wetland, are also abundant in the Colorado Rockies. A carr is a wetland that has more than 25 percent shrub cover and occurs on organic soil composed of minerotrophic peat. In other words, a carr is a shrub-dominated fen. Figure 3 shows a typical carr in the Colorado Rockies that formed behind an old beaver dam. *Salix* or willow is one of the most common shrubs in Rocky Mountain carrs; the shrubs may form thickets or they may be scattered more uniformly throughout the wetland (Windell and others, 1986).

Many of the wetlands in the study area are complexes of fen and carr environments. The drier parts of fens are frequently invaded by shrubs, whereas the wetter parts remain open. The cover photo shows such a carr-fen complex in the upper part of the Laramie River Valley in northern Colorado. All of the wetlands investigated for uranium and other elements in this study are fens, carrs, or carr-fen complexes. Many of them began as lakes or beaver ponds that gradually filled with sediment and became fens. As shrubs invaded, the fens changed to carr-fen complexes, and eventually to carrs. Hydrophytic plants commonly become established along stream drainages in Colorado, giving rise to the ubiquitous willow carrs of riparian zones.

In the Rocky Mountains, most fens are in areas where ground-water discharge is occurring (Cooper, 1988). The

Figure 2. Subalpine fen (outlined area) west of Apex, Colorado, at an elevation of 3,170 m (10,400 ft). Sampling site A16 (plate 1). This fen covers approximately 40 acres (16.1 hectares); in its central part the peat is thicker than 4 m (13 ft).

primary source of both surface water and groundwater that feed montane and subalpine wetlands is snowmelt (Dougherty and others, 1987). Snow is the dominant form of precipitation from October to May in the montane and subalpine zones, and the greatest amount of water from snowmelt is available in late spring and early summer. During the late summer, the principal source of precipitation is rain produced by afternoon mountain thunderstorms. Snowmelt and rainwater are routed into wetlands from stream flow, direct snowmelt and rainfall, ground-water movement through fractures and upland soils, and overland flow (Dougherty and others, 1987).

Figure 4 shows the physical settings of alpine, subalpine, and montane wetlands. All of the wetlands investigated in this study are in the subalpine and montane zones, generally between 2,000 and 3,000 m (7,000–10,000 ft). The mountain wetlands in this study commonly formed along spring lines in valley floors or adjacent to seeps and springs. Stratigraphic data from some of the holes we augered show that groundwater enters some wetlands from unconsolidated aquifers (sand lenses) that interfinger with the peat at the wetland margins. Other wetlands formed where drainage was restricted by glacial moraines, debris slides, and beaver dams. The effect of the American beaver, *Castor canadensis*, in altering running waters and thereby creating wetlands is generally not fully appreciated (Windell and others, 1986). About 20 percent of the wetlands in this study were created or enlarged by beaver activity.

The wetlands investigated in this study contain from 30 cm to more than 4 m of peat (1 to >13 ft) and organic-rich sediment. They are late Pleistocene to Holocene in age. None of the wetlands investigated can be older than late Pleistocene, when the Pinedale-age valley glaciers began to recede (between 14,600 and 13,000 years ago according to Madole, 1976). Some of the wetlands cannot be older than 7,000 years, the time of the last major glacial recession in the Front Range (Pennak, 1963).

Sediment accumulation rates of 0.19–0.45 mm (0.007–0.018 in.) per year are reported for montane and subalpine wetlands in the Colorado Front Range (Pennak, 1963). A fen now being studied in detail by the U.S. Geological Survey (USGS) in Northern Colorado has a carbon-14 age of 3,165±105 years B.P. for peat at a depth of 2.3 m (90 in.); this age yields an accumulation rate of 0.7 mm (0.027 in.) of peat per year. According to D.J. Cooper (Colorado School of Mines, oral commun., 1989), this rate is near the high end of peat accumulation rates for the region.

Figure 3. Carr formed behind an old beaver dam on Upper Lottis Creek, Colorado, between sampling site B7 and B11 (plate 1). Arrow points to old beaver dam. Carr is between beaver dam and the pines in background.

METHODS

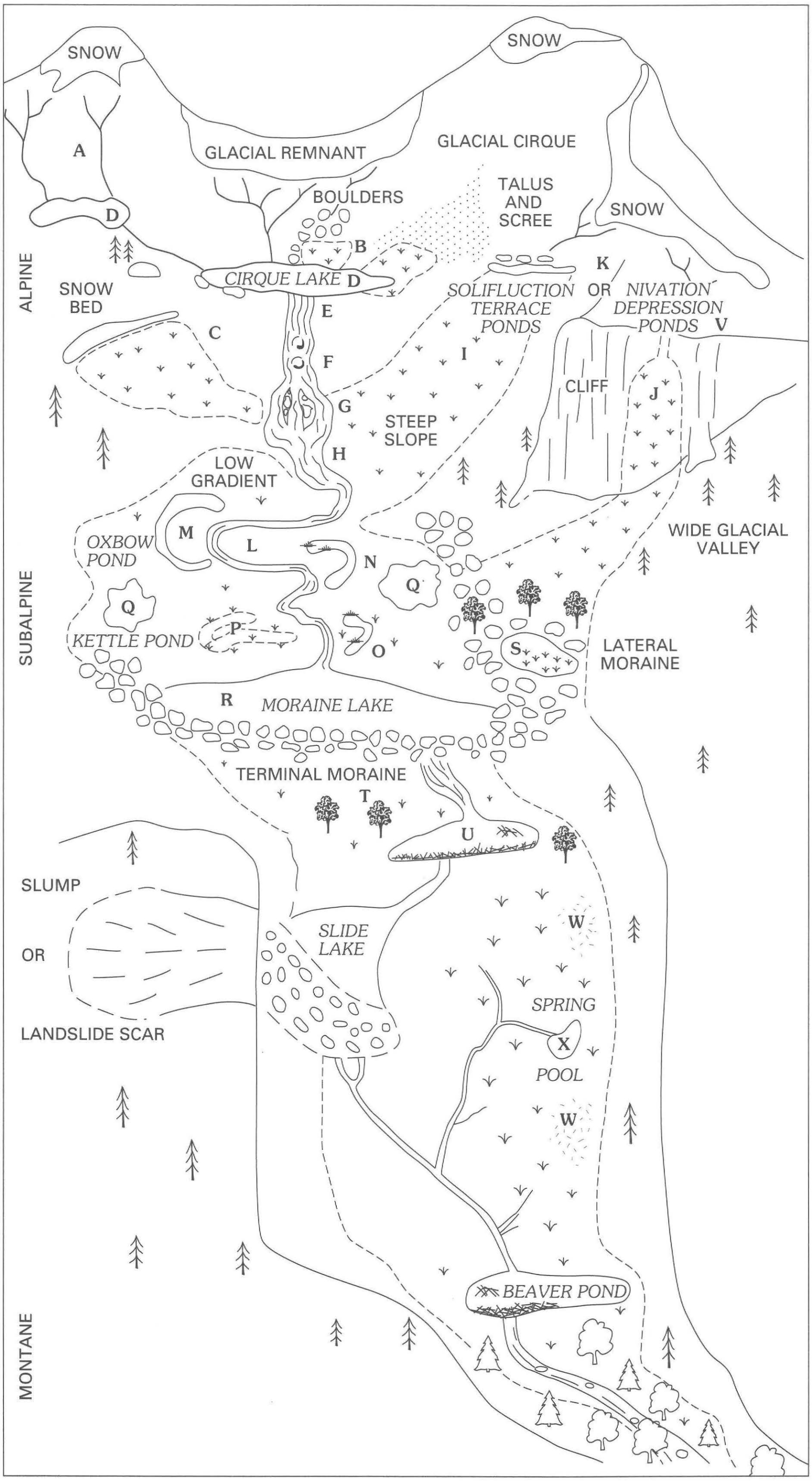
Recognizing Favorable Areas

Recognition of areas favorable for the occurrence of uranium in wetlands requires an indication that (1) uranium is present in, and may be leaching from, potential source rocks (granites, silicic volcanic rocks, or other uranium-enriched rocks), (2) uranium is moving in shallow groundwater or surface waters, and (3) uranium is being trapped and is accumulating in sediments. Geochemical data showing elevated concentrations of uranium in rocks, spring and surface waters, and stream sediments are the most direct evidence of favorable areas. The most readily available data are uranium analyses of stream sediments, stream or spring waters, and soils contained in the Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) reports of the NURE program. HSSR reports were utilized for the following 1°×2° quadrangle areas in the study area: Craig (Bolivar and Hill, 1979; Craig and others, 1982); Denver (Bolivar, and others, 1978; Hills and others, 1982a); Durango (Dawson and Weaver, 1979; Theis and others, 1981); Leadville (Planner, 1981; Collins, and others, 1982); and Montrose (Broxton and others, 1979; Goodnight and Ludlam, 1981).

Other data examined include compilations of uranium analyses of granitic and metamorphic rocks in the Colorado Rockies, NURE aeroradioactivity maps, NURE uranium occurrence reports, and unpublished stream sediment data from company sources (R.S. Zech, USGS, written commun., 1983). These data show that (1) uraniferous organic-rich soils and stream sediments are common near bedrock occurrences and deposits of uranium, (2) some stream sediments in the Colorado Rocky Mountains contain as much as 600 ppm U, and (3) many granites are anomalously enriched in uranium.

Identifying Wetlands

Within the potentially favorable areas identified using NURE and other geologic and geochemical data, we identified possible wetlands for investigation by studying standard topographic maps. Marsh and wooded marsh



EXPLANATION

A Tributary streams
B Seep and spring wetlands at the base of boulder, talus, and scree fields
C Snowbed wetlands
D Cirque or tarn lakes
E Waterfall
F Cascade
G Riffles in braided stream
H Pool
I Sloping willow-shrub wetland
J "Hanging garden" or cliff wetland
K Nivation depression or solifluction terrace pools
L Meandering stream in wide glacial valley
M Newly formed oxbow lake
N Early seral stage (emergent sedge/rush) in oxbow lake
O Later seral stage (sedge/willow) in oxbow lake
P Climax seral stage (willow/carr) in oxbow lake
Q Kettle lakes
R Moraine lake (pond) created by terminal moraine
S Moraine lake (pond) (semidrainage lake) in lateral moraine
T Seeps and spring wetlands at foot of moraine
U Beaver pond wetlands
V Narrow canyon riparian wetland
W Seeps } Spring- and seep-fed valley wetland
X Spring pool

Figure 4. Physical settings of alpine, subalpine, and montane wetlands. Modified from S.Q. Foster (*in* Windell and others, 1986, p. 25).

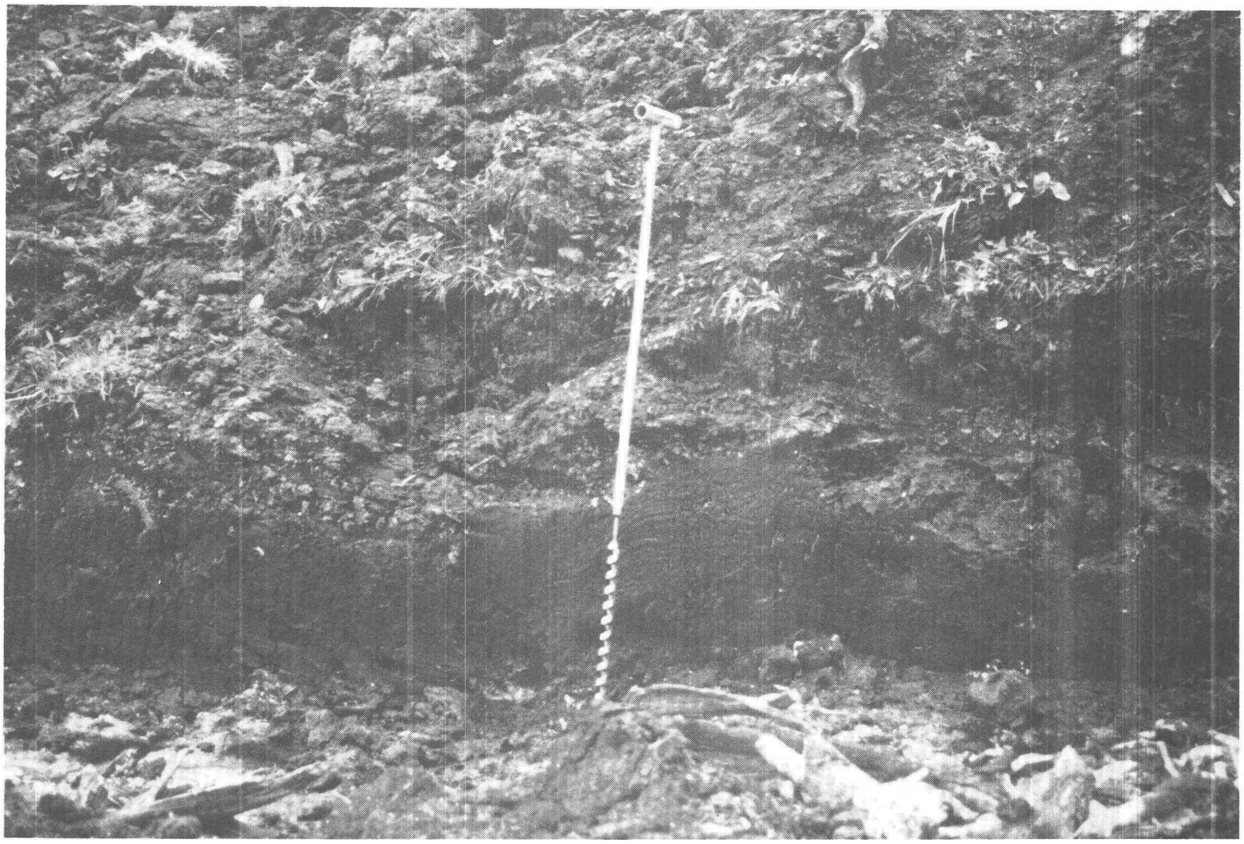


Figure 5. Auger used to acquire samples. Auger is leaning against an approximately 5-ft-high wall of peat exposed during peat mining.

symbols on topographic maps identify some wetlands; however, probably more than 80 percent of the montane and subalpine wetlands were *not* recognized as water-logged areas during topographic mapping and lack a marsh symbol. Generally only wetlands in riparian zones were properly identified as wetlands, and other criteria had to be employed to identify wetland areas in other settings.

Spring symbols shown on topographic maps are indicators of possible wetlands because fens commonly form in areas adjacent to seeps and springs or along seep or spring lines associated with fracture systems or other geologic phenomena. Unfortunately, many seeps and springs were not recognized during topographic mapping. Nonforested areas (uncolored areas on topographic maps) along valley floors that have broadly spaced contours (gentle slope) are characteristic settings for fens and therefore good targets for investigation. If a stream, intermittent stream, or spring(s) is also shown in the valley, the probability that a wetland is present is even greater. A final feature to look for on topographic maps is a series of closely spaced small ponds along a drainage that may indicate beaver activity and the presence of wetlands that result from such activity. Ultimately, only actual site visits can confirm the presence of wetlands, but the criteria just described are remarkably indicative of montane and subalpine wetlands.

Sampling Procedures

Subsurface sampling of wetlands was accomplished using a 1.25-in. (3.2 cm)-diameter auger constructed from ship's auger bits. A drill-rod coupling was welded to the top of the bit so that 3-ft (0.9 m)-long sections of lightweight aluminum drill rod (commercially available) could be screwed on. A T-handle fabricated from welded pipe sections permitted easy turning of the auger. Figure 5 shows this apparatus with a 3-ft section of drill rod attached. The auger was twisted into the ground in 1-ft (0.31 m) drives and then pulled straight up out of the hole. The sample recovered on the bit was examined carefully, and any slough above the sample was discarded. As the sample was removed from the bit, examined, and bagged, a preliminary sample description was made. Successive 1-ft drives were made and additional 3-ft sections of drill rod were added until the desired depth was reached. Figure 6 shows the drill stem broken into two sections after a drive to a depth of greater than 30 ft. The practical depth limit of this technique is 30–40 ft, though a maximum depth of 60 ft may be possible. This sampling technique allows rapid documentation of subsurface stratigraphy and provides reconnaissance samples for analysis of trace-element and organic contents.

Figure 6. Geologists holding auger. Drill stem was separated into two sections as it was pulled from the hole to prevent it from bending. Crouching geologist is removing a sample collected from a depth greater than 30 ft (9.3 m) from the auger bit.

Preliminary classification of the auger samples was made in the field based on color, visual and tactile texture, and presence of minerals, rock fragments, plant fibers, or other biologic remains. On return from the field, samples were oven dried and an aliquot was ashed. The percent ash was used to reclassify the sample where necessary. The percent ash and the sample description based on the percent ash are given for each sample in the appendix. If no percent ash is listed for the sample, then the sample description listed is the field description.

The classification system adopted in this report is that of the Louisiana Geological Survey (Kearns and Davison, 1983). Based on the percent ash content each sample was designated as follows: (1) 0–25 percent ash, peat; (2) 25–45 percent ash, peaty muck; (3) 45–65 percent ash, muck; (4) 65–85 percent ash, inorganic texture muck; (5) 85–95 percent ash, mucky inorganic texture (sediment); and (6) greater than 95 percent ash, inorganic texture (sediment). This classification system was chosen for three reasons: (1) the range for peat (0–25 percent ash or 75–100 percent organic matter) is in agreement with the American Society for Testing Materials (ASTM) definition of peat (ASTM, 1969); (2) the terms of Kearns and Davison for the categories (peat, peaty muck, muck, and so forth) were almost identical to the descriptive terms we were already using; and (3) the classification system was proposed as a "standardized system that will help scientists to describe organic and inorganic constituents of sediments in a consistent, quantitative fashion so that workers can more effectively compare data from other sources" (Kearns and Davison, 1983).

Uranium and thorium concentrations of splits of the auger samples were determined using the delayed neutron activation counting technique described by Millard and Keaten (1982) and McKowan and Millard (1987). Samples were analyzed at the USGS-TRIGA reactor facility, Denver, Colorado, and at reactor facilities used by Nuclear Activation Services, Inc., in Ann Arbor, Michigan. The detection limits are 0.1 ppm U and 1 ppm Th. Uranium concentrations were determined for all 587 samples taken during the study, and thorium concentrations were determined for 517 of the samples (appendix). About one-third (178) of the samples (representing 9 of the 25 7½-minute quadrangles investigated) were analyzed for 36 other elements using inductively coupled plasma-atomic emission spectrometry (ICP) Lichte and others (1987) (appendix).

SOURCE ROCKS AND POTENTIAL SOURCE ROCKS

Mobility of Uranium During Weathering and Source-Rock Characteristics

Uranium oxides dissolve readily in the oxidizing, carbonate-bearing waters characteristic of most surface waters and near-surface groundwaters, and they precipitate only when these waters encounter appropriate reductants in the subsurface. Because dissolved uranium may be transported far from its source and may be mixed with uranium from other sources, most commercially important uranium deposits have only a tenuous relationship to their source rocks. As a result, actual source rocks rarely have been identified and studied, and the nature of source rocks is poorly understood.

What is known or believed about source rocks commonly depends on a chain of circumstantial evidence. Volcanic rocks and especially volcanic ash have been shown to lose significant amounts of uranium during leaching and devitrification, probably in geologically short intervals of time (Zielinski, 1981). Where present near uranium deposits and in appropriate parts of the geologic section, they generally have been inferred to be the source of uranium for the deposits. Granitic rocks also lose uranium during weathering and may be the chief source of uranium in some deposits. For example, granitic rocks adjoining a mining district in Wyoming have lost many times the amount of uranium required to form the deposits in the district and are the most likely source rocks (Stuckless and Nkomo, 1978). However, volcanic rocks are also present in the region, and they introduce a degree of ambiguity. In other places, uranium deposits have been ascribed to hydrothermal solutions from unknown, buried sources.

Despite the high solubility of uranium oxides in near-surface groundwaters, most uranium apparently is not readily released by rocks during weathering. The uranium that is readily leached during weathering is called "labile" uranium. During crystallization or recrystallization of igneous or metamorphic rocks at high temperatures, uranium is bound in the crystal structures of resistate minerals, such as zircon, thorite, sphene, apatite, and monazite, from which only a small portion may be released by weathering. However, in certain igneous and metamorphic rocks, significant portions of the uranium may escape incorporation in the resistate minerals and be deposited instead in intergranular or intragranular microfractures, on cleavage planes, in iron oxide minerals, or even as uranium oxide minerals. Such rocks, which may give up significant portions of their uranium to groundwaters during weathering, are said to be "fertile," and their role in the formation of uranium deposits may be disproportionately greater than their abundance.

Even in the best circumstances, studies of uranium deposits formed in the geologic past are handicapped by incomplete information on paleogeography, paleogeology, paleoclimate, and paleohydrology. It is easy to find one or more possible source rocks for most uranium deposits but proving provenance is more difficult, and, in contrast with most other types of uranium deposits, geologically young surficial uranium deposits generated in small montane and subalpine fens provide unique opportunities to relate actual deposits to their conditions of formation, which for the most part still exist unchanged. Further, because these deposits are commonly found along first-order streams, their upstream drainage basins are small and well defined, and their source rocks may be unambiguously identified. Thus, although uraniferous wetlands in the Colorado Rockies have little potential for economic production of uranium and if left undisturbed most are presently not environmental hazards, some may be excellent modern analogs for understanding the genesis of ancient uranium deposits. Uranium deposits are not, however, the sole cause of environmental radiologic hazards. Anomalous uranium, radium, and radon concentrations are commonplace hazards associated with fertile granitic rocks. Thus, from the standpoint of both the uranium exploration geologist and the environmental geologist, these small fen-related deposits are important because they may indicate fertile source rocks for further study.

General Bedrock Geology

Fen deposits reported in this study are present above bedrock of Precambrian age or (in one instance) younger sedimentary rocks adjoining Precambrian terrane for which the source of uraniferous waters is mostly in the adjoining crystalline Precambrian highlands. For many fen deposits in the Precambrian highlands, intrusive and volcanic rocks of Cretaceous or Tertiary age are possible source rocks for uranium and have been proposed as source rocks for other types of uranium deposits in the region (Phair, 1958; Dickinson, 1987).

Precambrian rocks exposed in the cores of mountain ranges in Colorado are varied in both age and lithology. The oldest rocks exposed in Colorado are gneisses and schists of Late Archean age (about 2,750–2,500 Ma) in an area of only about a square kilometer in the Uinta Mountains (fig. 7), near the northwestern corner of Colorado (Tweto, 1987). Rocks of equivalent age and perhaps equivalent stratigraphic position may be important sources for uranium in Wyoming (Karlstrom and others, 1981). An Early Proterozoic gneiss complex, Early Proterozoic granitic to granodioritic rocks (Routt Plutonic Suite), and Middle

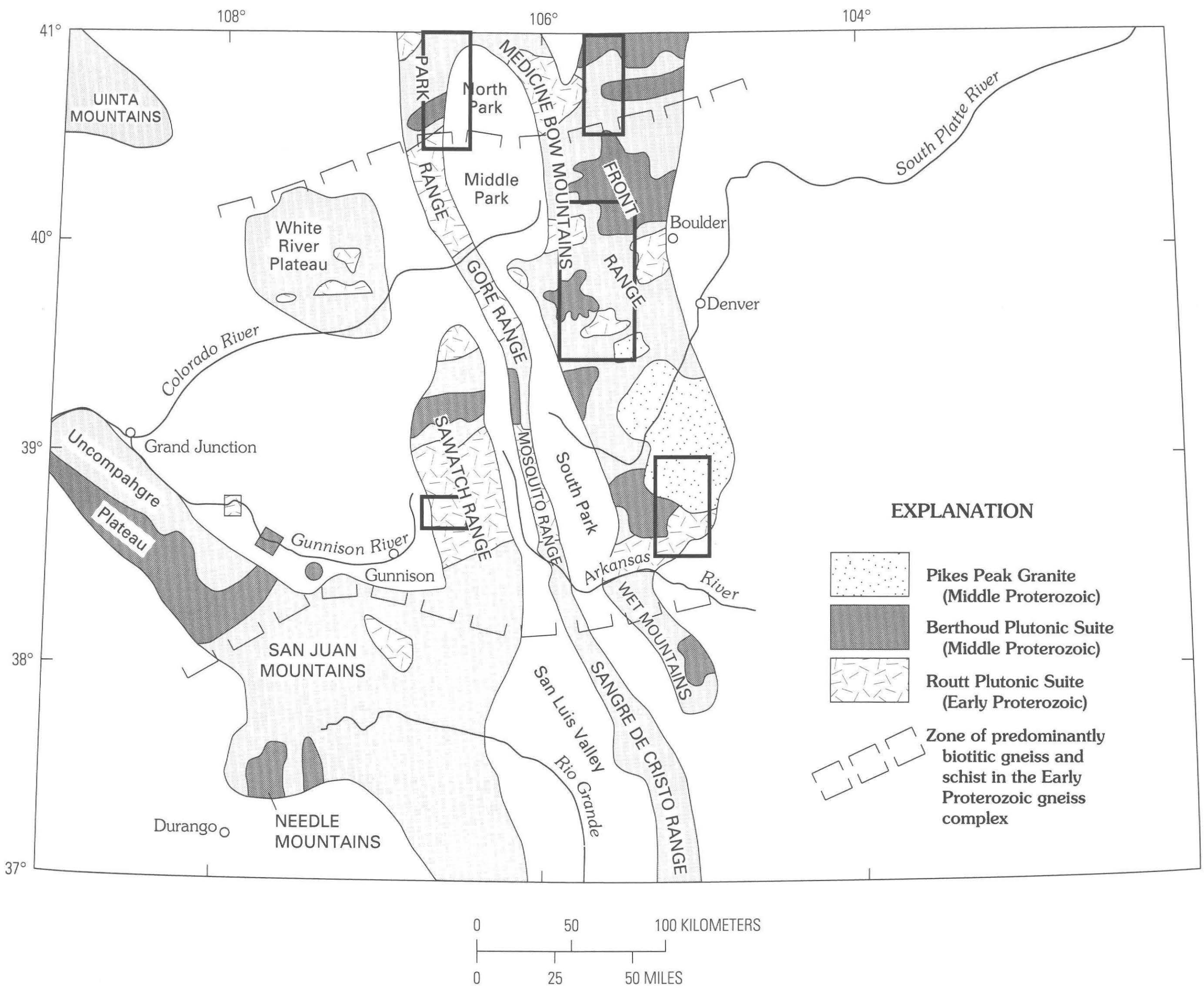


Figure 7. Simplified map showing areas of mountainous uplifts (patterned areas) in Colorado and locations of principal Precambrian plutons. Study areas are outlined by heavy lines. Modified from Tweto (1987).

Proterozoic granites (Berthoud Plutonic Suite) underlie most of Colorado's Precambrian highlands. These rocks are volumetrically dominant in the areas where surficial uranium deposits are found and thus are the most probable source rocks for uranium in the deposits. Early and Middle Proterozoic sedimentary and metasedimentary rocks (Early Proterozoic Vallecito Conglomerate, Early and Middle Proterozoic Uncompahgre Formation, and Middle Proterozoic Uinta Mountain Group) crop out only in limited areas of western Colorado, and, because they are outside the area of our study, they are not described.

Early Proterozoic Gneiss Complex

The most extensive and lithologically variable map unit, comprising about half of exposed Precambrian rocks in Colorado, is the Early Proterozoic gneiss complex (Tweto, 1987). (Studies previous to Tweto used the names Idaho Springs Formation, Swandyke Hornblende Gneiss, and others for this unit.) This complex consists of a great variety of gneiss, schist, and amphibolitic rocks of metasedimentary and metaigneous origin; the predominant rock types were placed into two main lithologic groups by Tweto (1987). The more widespread of these two groups consists of felsic and hornblendic gneiss believed to be mainly metavolcanic in origin. The second group, which forms a broad and irregular zone about 150 km (100 mi) wide, trends northeast across Colorado (fig. 7) and consists chiefly of biotitic gneiss and schist thought to be mainly metasedimentary in origin. Almost nothing is known about the potential of any of these rock types to supply uranium to groundwaters, but, because of the great variety of rocks included in the gneiss complex, good source rocks are probably locally present. Phair and Gottfried (1964) reported an average uranium content of about 4.7 ppm for both lithologic groups and an average of 1.8 ppm for orthogneiss (part of Tweto's Early

Proterozoic gneiss complex), but these averages are based on small numbers of samples from a small part of the total unit and must be considered tentative.

Routt Plutonic Suite

The Routt Plutonic Suite (Early Proterozoic age) of Tweto (1987) consists of plutonic rocks that intruded the Early Proterozoic gneiss complex between about 1,750 and 1,670 Ma, during and immediately following the regional deformation and metamorphism of the gneiss complex (fig. 7). The suite consists of gabbro to granite, but granodiorite, much of it foliated, probably is the most characteristic lithology. The Routt Plutonic Suite typically forms large northeast-trending batholiths that crop out as isolated areas in the fault-bounded ranges of central and north-central Colorado but which are continuous in the subsurface (Tweto, 1987). Phair and Gottfried (1964) reported an average uranium content of approximately 2.7 ppm for rocks of this suite.

Berthoud Plutonic Suite

The Berthoud Plutonic Suite (Middle Proterozoic age) of Tweto (1987) consists of rocks that range in composition from gabbro and syenite to granite but are dominated by biotite monzogranite and syenogranite (fig. 7). Batholiths of this suite were intruded between approximately 1,430 and 1,380 Ma during a poorly understood, apparently anorogenic event. This suite was extensively sampled during the NURE program. Batholiths contain 5–7.4 ppm U and are the most consistently uraniferous rocks of any widespread unit in the Front Range (Hills and others, 1982a, b). Because batholiths of the Berthoud Plutonic Suite underlie some of the more densely inhabited parts of the Front Range, they have a high potential for environmental hazards.

Pikes Peak Granite

The Pikes Peak Granite (Middle Proterozoic age) was intruded into rocks of the southern Front Range, west and northwest of Colorado Springs, about 1,000 Ma (fig. 7). Similar to the plutons of the Berthoud Plutonic Suite, the Pikes Peak was emplaced during an anorogenic igneous event that apparently had little effect on basement rocks away from the immediate vicinity of the batholith (Barker and others, 1975; Tweto, 1987). It is composed of a variety of granitic and syenitic rocks, mostly pink to brown, massive, and coarse grained. Nash (1982, p. 77) reported that phases of the Pikes Peak Granite contain 4–19 ppm U.

Cretaceous to Tertiary Plutonic and Volcanic Rocks

Hypabyssal (subvolcanic) igneous rocks and volcanic rocks are present throughout the western half of Colorado. Tweto (1975) related these rocks to three periods of igneous activity and tectonism. Porphyritic stocks, sills, and dikes of the first period (about 70–50 Ma) are concentrated in a zone known as the Colorado Mineral Belt that crosses western Colorado from about Boulder to the southwestern part of the State. Gold, silver, tungsten, and some uranium mineralization is associated with these mainly Tertiary intrusive rocks (Carpenter and others, 1979). During a second period of igneous activity (about 40–25 Ma), volcanism was widespread throughout the western half of the State, particularly in the central, south-central, and southwestern parts. Gold, silver, and molybdenum mineralization from this period in part overlaps the earlier areas of mineralization. Some widely spread, uraniferous volcanic ash was also produced during this second period. The tuffaceous sediments of the White River Formation (Oligocene) may have supplied uranium for sandstone uranium deposits in Wyoming and possibly parts of northern Colorado (Zielinski, 1983), and various tuffs and other volcanic rocks may have been the source of uranium for sandstone uranium deposits and uraniferous lake deposits in South Park (Dickinson, 1987). In the third period (about 15–10 Ma), volcanic activity occurred in the north-central, south-central, and northwestern parts of the State.

This large and variable suite of rocks has a wide range of uranium contents. Phair and Gottfried (1964) reported an average uranium content of 7.6 ppm for Laramide stocks (probably Tweto's 70–50 Ma group), but some calcium-poor dikes average as much as 43.6 ppm U. The high-mountain areas underlain by Cretaceous and Tertiary igneous rocks are small relative to areas underlain by Proterozoic rocks. Nevertheless, many stocks and their associated veins and dikes occur at the high elevations appropriate for fen deposits and may be important source rocks. The fracturing and hydrothermal alteration of surrounding rocks caused by their intrusion also may play a part in enhancing the leachability of uranium.

Aerial Radiometric Surveys

In preparation for the NURE project, the Department of Energy contracted for airborne radiometric surveys to be flown for all the 1°×2° NTMS quadrangles in Colorado. Over the mountains the flight-line spacing was 1 mi. NURE aeroradiometric maps showing intensity of gamma radiation produced by uranium daughter products (specifically ^{214}Bi) confirm the geochemical data of Phair and Gottfried (1964), Hills and others (1982a, b), and Nash (1982). The Early Proterozoic gneiss complex and the Routt Plutonic Suite show on the NURE maps as being relatively unenriched in uranium, but plutons of the Berthoud Plutonic Suite and the Pikes Peak Granite show as prominent high-uranium anomalies (fig. 7).

GEOCHEMICAL ENRICHMENT IN WETLANDS

Dead and decaying organic matter is an effective sorber of uranium and other metals. Kochenov and others (1965) found that concentrations of uranium were forming in wetlands where the groundwater input contained only background levels of uranium. They calculated an effective enrichment factor between peat and the uranium carrying water to be as high as 2×10^6. Lopatkina (1967) reported enrichment factors in nature between 50,000 and 500. Szalay (1974) calculated a geochemical enrichment factor (G.E.F.) of 10,000 during laboratory experiments with peat and concluded that "peat absorbs uranium almost perfectly, even from very dilute solutions occurring in nature." Idiz and others (1986) found a G.E.F. of 10,000 for uranium in a California wetland. One wetland currently being studied in northern Colorado shows uranium enrichment factors between 10,000 and 20,000 (R.A. Zielinski, USGS, oral commun., 1990). Moore (1954), in laboratory experiments with uranyl sulfate, found that peat was 98 percent effective in removing uranium from solutions. Titayeva (1967) found that in peat the uranium is bound to the humic and fulvic acids. Borovec and others (1979) reported on the sorption of uranyl by humic acids and concluded that during the migration of uranium in the form of UO_2^{2+}, the binding of uranium by humic acids produces insoluble humates of uranyl. Kribek and Podlaha (1980) found that between pH 3.5 and 7 humic acids form a water-soluble humic acid complex with the uranyl ion UO_2^{2+}. Our limited number of pH measurements in mountain wetlands all cluster around pH 7, the upper end of Kribek and Podlaha's water-soluble-complex range. Shanbhag and Choppin (1981) conducted laboratory experiments where the binding of UO_2^{2+} to a soil humic acid was measured by a solvent extraction technique. They concluded that in a natural system soil humics strongly retain uranyl from groundwater. The work of Idiz and others (1986) also suggests that the mechanism of uranium entrapment is the complexation of the uranyl cation UO_2^{2+} by carboxyl functional groups on humic and fulvic acid molecules. Data reported by Mathur and Farnham (1985) show that humic and fulvic acids generally comprise 6–40 percent of the total carbon in peats, peaty mucks, and mucks.

Kochenov and others (1965) performed mechanical fractionations of uraniferous peat and found that the largest portion of the uranium is in the humic material. The uranium content in the plant debris was lower by a factor of 1.5–2 and was lowest in natural-colored undecomposed woody tissues. Idiz and others (1986) analyzed the organic constituents of sediments from a uranium-rich wetland in California and found that the humic substances, not living plant material, were responsible for uranium entrapment and enrichment.

Similar to uranium, other polyvalent cations of high atomic weight have large geochemical enrichment factors (Szalay, 1974). Ibarra and others (1979) reported that heavy metals have very high geochemical enrichment factors and that high pH, high atomic weight, and high valence all favor metal retention. Cation exchange capacity and organic content are positively correlated (fig. 8). Peat and peaty muck, because they have high organic contents, exhibit a large cation exchange capacity. Stednick (1988) pointed out that the pH of most riparian-wetland systems is near neutral (our limited measurements support this observation), which helps limit metal solubility. Ibarra and others (1979) concluded that humic acids that result from peat-forming processes, as well as those that exist in already formed peats, can exert a strong concentrating-accumulating effect on heavy metals being transported by natural waters even in low concentrations. Tannins, which are water-soluble secondary plant products, also remove ions from solution by complexing, similar to humic acids (Crum, 1988).

Bacteria and fungi also play a role in concentrating metals in wetlands. They are prime degraders of vegetation in the peat-forming process (Waksman, 1930; Moore and Bellamy, 1974). Degradation greatly increases the surface area available for sorption and yields humic material, humic acids, and fulvic acids, all of which facilitate geochemical enrichment (Robbins and others, 1990). Bacteria themselves may trap metals in or on their cell walls. Beveridge (1978) found that most transition elements have a high affinity for the cell wall of the bacteria *Bacillus subtilis*. Beveridge (1984) found that *Sporosarcinia urea* bacteria survive and grow in toxic environments by using their surface arrays to

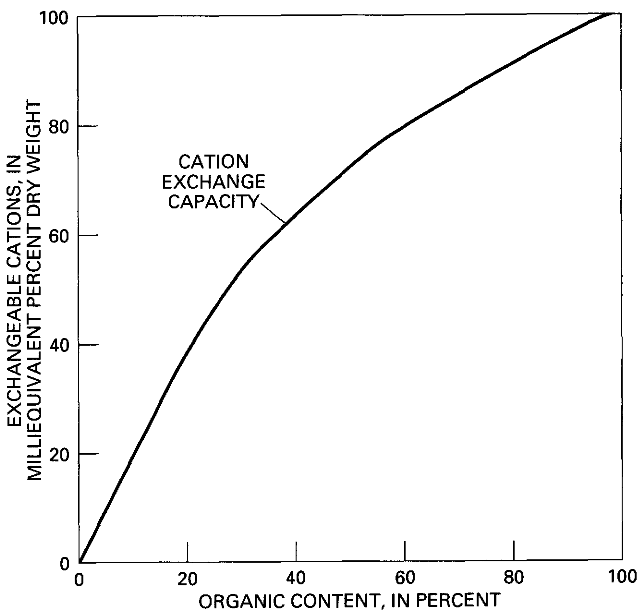


Figure 8. Relationship between cation exchange capacity and organic content for wetland soils. Modified after Mitsch and Gosselink (1986, p. 91) with permission.

bind and immobilize heavy metals; he proposed that initially bound metal acts as nucleation sites for the growth of metal aggregates that can sequester significant additional amounts of metal from solution.

Sikora and Keeney (1983) found that fen peats contain more bacteria than bog peats. Fens, and therefore most mountain wetlands, are more favorable sites for microbially assisted geochemical enrichment. In the laboratory, Mohagheghi and others (1985) demonstrated that sulfur-reducing bacteria can be effective in the concentration and deposition of uranium. The common fungus *Rhizopus arrhizus* has been reported to be very efficient (180 mg U^{6+} per gram) in taking up uranium (Shumate and others, 1980; Tsezos and Volesky, 1981, 1982). Although the size of the role that microbes play in geochemical enrichment of wetlands remains to be determined, it is certain that microbial populations contribute to metal enrichment.

RESULTS AND DISCUSSION

The complete results of all analyses performed on each auger sample, a description of each sample, the depth interval the sample came from, and the sampling site number are given in the appendix. In the appendix samples are grouped and presented alphabetically by 7½-minute quadrangle. Sampling sites are shown on plate 1.

Much of the terrain surrounding the wetlands investigated in this study is composed of rocks of granitic composition. Eisenbud (1987) reported data that show "normal granite" has a uranium concentration of 4 ppm, and Fairbridge (1972), using a compilation of data from other researchers, reported a median value of 3.9 ppm U for sialic igneous rocks (granite, syenite, and monzonite). In contrast to these "normal" granitic rocks, granitic rocks in Colorado are enriched in uranium: the Early Proterozoic gneiss complex contains an average of 4.7 ppm U, the Berthoud Plutonic Suite 5–7.4 ppm, the Pikes Peak Granite 4–19 ppm, and the Laramide stocks 7.6 ppm. Only the Routt Plutonic Suite has a below "normal" average uranium content (2.7 ppm). Considering the concentrating and accumulating ability of organic-rich sediments in wetlands, virtually all of these rocks contain sufficient uranium to serve as a source, provided the uranium is labile.

For comparison purposes, a table listing the highest uranium concentration at each of the sampling sites is given on plate 1. Figure 7 shows outlines of the study areas superimposed on the geologic map. By using figure 7 in conjunction with the plate, the general geology of the area encompassing a sampling site can be determined and compared with the uranium abundance in the wetland listed in the table. These comparisons indicate that there is little correlation between the uranium concentrations in the wetlands and the average uranium content of the rocks. For example, for the wetlands areas south of Denver (plate 1), some of the highest uranium concentrations are in wetlands associated with the Routt Plutonic Suite (avg. 2.7 ppm), whereas wetlands associated with Pikes Peak Granite (avg. 4–19 ppm) have lower uranium concentrations. There are a several reasons for the poor correlation. First, knowing the uranium content of the rocks does not provide information about the lability of the uranium; therefore, at the present time uraniferous wetlands are more useful in identifying source rocks that are fertile than vice versa.

The second reason for a poor correlation is that the general geology provides little information regarding small areas of mineralized rocks or variability in uranium content. Because fracture systems serve as conduits for groundwaters into wetlands, even minor amounts of mineralization (noneconomic) along these fracture systems can have a significant effect on the amount of metals reaching a wetland. For example, the wetland at sampling site A22 (plate 1) lies astride fractures having the same orientations as those at the Schwartzwalder uranium mine 9 km (5.6 mi) to the east. It is quite possible that some of the fractures feeding waters to this wetland are mineralized and are responsible for the elevated uranium concentrations in the wetland. Because of variability in uranium content of the rocks themselves as well as that of fractures and shears, studies other than reconnaissance should include a thorough examination of the local geology.

Both reconnaissance for uraniferous wetlands and detailed studies of uraniferous wetlands in the future should include the determination of uranium concentrations of spring waters feeding wetlands. (Some HSSR and other data are already available.) Waters containing more than 20 ppb U are indicative of fertile source rocks and (or) mineralized fractures that are being leached by the waters. In addition, because organic-rich wetland sediments have such high geochemical enrichment factors, it is likely that wetlands being fed by such waters are also uraniferous.

A statistical comparison of metal concentrations between various wetlands is a case of comparing apples and oranges for several reasons: (1) the geology surrounding one wetland is commonly different from that surrounding another (particularly at a local scale), (2) the hydrologic pathways feeding wetlands differ, and (3) wetlands are of different sizes and types. Even within the same wetland, metal concentrations can differ significantly over short distances. Organic-rich wetland sediments have such high geochemical enrichment factors that uranium and other metal concentrations may be localized near sources of groundwater input. For example, a wetland currently being studied in detail by the USGS in northern Colorado has uranium concentrations of more than 3,000 ppm near some spring inputs, although most of the wetland's organic-rich sediments contain less than 150 ppm U. Because many of the wetlands sampled in this reconnaissance study also had auger holes placed so as to get an estimation of the maximum thickness of organic-rich sediments, some zones of high metal concentration probably were not detected.

Because some zones of high uranium concentration were probably missed during sampling for reasons discussed previously and because from both an environmental and a health standpoint the worst case scenario is the most important, the highest uranium concentration at each of the 145 sampling stations (wetlands) (listed in table on plate 1) was used in the data summary that follows, and an arbitrary scale of uranium enrichment was selected to facilitate the description of the findings. Concentrations (dry weight basis, not ashed) are suggested to represent the following: 0–20 ppm U, low enrichment; 20–100 ppm U, moderate enrichment; 100–1,000 ppm U, high enrichment; and more than 1,000 ppm U, very high enrichment. The percentage of wetlands in each uranium enrichment category is as follows: 54 percent, low; 30 percent, moderate; 15 percent, high; and 1 percent, very high. Forty-six percent of all the wetlands investigated showed moderate or greater enrichment in uranium.

Other elements besides uranium show significant enrichment in the wetland samples (appendix). Using a scale for enrichment similar to that for uranium, the following elemental enrichments are present in samples from at least one sampling site (wetland): (1) very high enrichment or maximum concentrations greater than 1,000 ppm for barium, manganese, thorium, yttrium, and zinc; (2) high enrichment or maximum concentrations between 100 and 1,000 ppm for cerium, lanthanum, lead, lithium, neodymium, strontium, vanadium, and ytterbium; (3) some enrichment or concentrations between 10 and 100 ppm for arsenic, beryllium, bismuth, chromium, cobalt, copper, gallium, holmium, molybdenum, nickel, niobium, scandium, silver, tantalum, and tin.

IMPLICATIONS

Economic Implications

Szalay (1974) stated that the largest future reserves of uranium for atomic energy that mankind has have accumulated in nature primarily by organic matter absorbing uranium from very dilute solutions. Although the only wetland surficial uranium deposit mined in the United States is on the north fork of Flodelle Creek in northeastern Washington (Johnson and others, 1987), understanding the processes of uranium enrichment in wetlands may enhance our understanding of all organic-sediment-hosted uranium deposits.

The standard for the release of radon from mines into the atmosphere is currently under review by the U.S. Environmental Protection Agency (EPA). If the new standard is very strict, operators of underground uranium mines will have a difficult time complying with the new regulations, and many mines may shut down. This could provide a new impetus for the identification and mining of wetland and other surficial uranium deposits in some parts of the country.

Studies done by the USGS in a number of States indicate that individual wetland uranium deposits are small (less than 500,000 kg, 1,100,000 lbs) and of modest average-grade (0.05–0.12 percent, 500–1,200 ppm); thus exploration must focus on finding clusters of deposits rather than on finding one large or exceptionally high grade deposit. The economic feasibility of developing a particular deposit depends on local hydrology, vegetation cover, land use, nature of fixation, access, and the prevailing price of uranium (Owen, in press). Heap leaching was employed to extract uranium from organic-rich sediments in the Flodelle Creek deposit, but, because uranium in uraniferous wetlands typically is loosely held, in situ extraction is an attractive alternative method of mining (Culbert and Leighton, 1988). Lixiviants composed of ammonium bicarbonate and ammonium carbonate (strong fertilizers) are environmentally benign and relatively efficient in removing uranium from wetland sediments. In situ leaching leaves the wetland intact and thus preserves the natural filtration capacity of the wetland; however, it is impractical in wetlands that have heavy shrub cover or where wetland hydrology short-circuits the leach cycle through rapid loss of lixiviants or rapid addition of groundwater. Wetland uranium deposits are well suited to in situ extraction utilizing a mobile processing plant that has ion exchange columns on flatbed semitrailers (Hunkin Engineering, 1979). This type of processing is compatible with the exploitation of numerous small deposits in a geologically favorable area. Finally, because montane and subalpine wetland uranium deposits are young (late Pleistocene or Holocene in age) and have low radioactivity, they pose a low health risk to miners.

Environmental and Health Implications

Processes that liberate uranium or other possibly toxic elements from enriched wetlands are an important concern. Experiments by Kochenov and others (1965) show that sorption of uranium on peat is a reversible process under oxidizing conditions. This reversibility has implications for natural and man-induced changes to the water table or to the water supply of wetlands that change the environment of the sediments from anoxic to oxygenated. If a wetland is partly or completely drained, the subsequent oxidation of the organic-rich sediments may liberate metals that have been accumulating from very dilute solutions for thousands of years; this could result in adverse consequences for ground and surface waters. Human activities that can affect the geochemistry of the water supply or affect the water table and result in release of uranium or other metals include the introduction of nitrates, sulfates, and phosphates from pollution or agricultural sources; acid mine drainage; road construction; pumping to keep mines dry; and deliberate draining of wetlands to harvest peat or to reclaim the wetlands for other uses.

Szalay (1974) found that a 1 percent HCl solution totally liberates uranyl (UO_2^{2+}) from peat and that a 1 percent acetic acid solution partially removes uranyl when the peat has a pH between 3 and 7. In laboratory experiments, Zielinski and Meier (1988) found that concentrated sulfuric acid is a very effective leach solution to remove uranium from peat. Because these experiments demonstrate that acid solutions can liberate metals held in peats, acid rain and acid mine drainage entering a wetland is of concern. Acid mine drainage forms as rain and snow melt percolate through mine or mill tailings that contain sulfide minerals. There are approximately 10,000 inactive mines in the State of Colorado (Mark Davis, Colorado Geological Survey, oral commun., 1989), and the potential magnitude of the problem is great. Studies are being conducted in the Southern Rocky Mountains of Colorado to determine the effects on and capacity of wetlands to handle acid mine drainage (Cooper and Emerick, 1987; Emerick, 1988; Walton-Day and others, 1989; Wildeman and Landon, 1989). The results so far indicate that although wetlands receiving acid mine drainage can continue to remove metals from solution, a point is reached when the natural filter system is overwhelmed.

Many metals that are needed by the body in trace amounts are toxic in high concentrations. Uranium ingested by humans goes both to the kidneys and to the bone. It is known that 1–5 percent of ingested uranium goes to the bone; however, no direct epidemiology study of the radiotoxicity of uranium has been made (Cothern, 1987). The primary toxic effect of natural uranium is as a chemical poison to the kidneys. Inflammation of the kidneys (nephritis) is one of the symptoms of uranium poisoning, and continued uranium poisoning results in total kidney failure and death. The adjusted acceptable daily intake of uranium per liter of water is 60 micrograms, or a concentration of 60 ppb (Cothern, 1987). The EPA has not set a final standard for uranium in drinking water; however, it will probably be between 15 and 45 ppb. Very little uranium has to be released from a uraniferous wetland in order to produce water concentrations in this range—hence the concern about wetlands that are a part of the watersheds for so many mountain communities. For a discussion of the toxicity of other elements and additional information on uranium toxicity, see Wrenn and others (1985), Cothern and others (1983), Gough and others (1979), and Hem (1985).

CONCLUSIONS

Much remains to be learned about the processes that concentrate metals in wetlands. Understanding these processes will help to develop (1) better exploration guidelines, (2) better understanding of many kinds of uranium and other metal deposits, and (3) guidelines for environmental management of lands and resources. Some wetlands are potential environmental hazards because of their high metal contents, and these should be disturbed only after careful consideration of possible consequences. Furthermore, the consequences of using peat from metalliferous wetlands for agricultural purposes need investigation. Finally, if economic concentrations of metals are mined, safeguards should be developed to protect ground and surface waters from contamination during mining, and restoration techniques need to be developed to restore the wetland and thereby reestablish the natural filtration system that was protecting water quality before mining began.

Our investigations of uranium in surficial organic-rich sediments in Colorado suggest that accumulations of uranium having a grade and tonnage sufficient to support uranium mining and milling activities under 1990 uranium market conditions are unlikely to be present. Uranium accumulations are widespread enough, however, to suggest that potentially hazardous concentrations of uranium and other radionuclides are present in shallow groundwaters and surface waters in many areas underlain by uraniferous granitic rocks and in areas where uranium is present in faults and fractures, and uranium accumulations in wetland systems are common enough in the Colorado Rockies that disturbance of wetlands by human activities has a high chance of releasing uranium and other metals into the environment.

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Appendix. Analyses of samples, Colorado Rocky Mountains

[Map numbers are sample site designations used on location maps shown on plate 1. Abbreviations: Inorg. Txt. Muck, inorganic texture muck; Mucky Inorg. Txt., mucky inorganic texture (sediment); Inorg. Txt., inorganic texture (sediment). Leaders (---), not determined or sample was not analyzed for element. Peat, 0–25 percent ash; peaty muck, 25–45 percent ash; muck, 45–65 percent ash; inorganic texture muck, 65–85 percent ash; mucky inorganic texture (sediment), 85–95 percent ash; inorganic texture (sediment), 95–100 percent ash. Sample depth in feet. Uranium and thorium were determined using delayed neutron activation; other elements were determined using inductively coupled plasma-atomic emission spectrometry. For details, see the section on sampling procedures]

Allens Park Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)
AP86-1A	A1	89.4	Mucky Inorg. Txt.	0-1	10.9
AP86-1B	A1	96.2	Inorg. Txt.	1-2	10.9
AP86-2	A1	72.5	Inorg. Txt. Muck	Surf.	18.4

Big Bull Mountain Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
PU85-13A	B45	48.6	Muck	0-1	23.7	< 9.5	3.80	1.40	3.00	1.20	0.64	0.58	0.13	0.25	580.0	< 2.0	< 10.0	< 8.0	460.0	1.0	< 10.0	< 2.0
PU85-13B	B45	63.7	Muck	1-2	88.8	< 21.0	5.40	1.40	2.20	1.70	0.57	0.82	0.08	0.23	430.0	< 2.0	< 10.0	< 8.0	680.0	2.0	< 10.0	< 2.0
PU85-13C	B45	95.0	Inorg. Txt.	2-3	58.2	< 14.0	7.50	1.00	1.90	3.40	0.64	1.90	0.10	0.41	370.0	< 2.0	< 10.0	< 8.0	1000.0	2.0	< 10.0	< 2.0
PU85-13D	B45	96.4	Inorg. Txt.	3-4	32.1	< 8.8	7.70	0.87	1.50	3.90	0.48	1.90	0.07	0.34	280.0	< 2.0	< 10.0	< 8.0	1100.0	2.0	< 10.0	< 2.0
PU85-13E	B45	97.0	Inorg. Txt.	4-5	20.5	< 6.6	7.60	0.85	1.40	4.00	0.46	2.00	0.08	0.32	290.0	< 2.0	< 10.0	< 8.0	1100.0	2.0	< 10.0	< 2.0
PU85-14A	B44	83.4	Inorg. Txt. Muck	0-1	23.1	48.2	7.20	0.84	4.00	1.80	0.58	0.86	0.14	0.31	1000.0	< 2.0	< 10.0	< 8.0	630.0	12.0	< 10.0	< 2.0
PU85-14B	B44	94.8	Mucky Inorg. Txt.	1-2	14.8	33.6	7.40	0.52	2.30	3.70	0.33	1.80	0.06	0.19	1200.0	< 2.0	< 10.0	< 8.0	570.0	8.0	< 10.0	< 2.0
PU85-14C	B44	95.5	Inorg. Txt.	2-3	17.8	38.3	7.70	0.58	2.90	3.30	0.41	1.60	0.05	0.24	1400.0	< 2.0	< 10.0	< 8.0	620.0	9.0	< 10.0	< 2.0
PU85-14D	B44	97.0	Inorg. Txt.	3-4	16.3	39.8	7.40	0.41	3.00	3.90	0.29	1.90	0.04	0.20	870.0	< 2.0	< 10.0	< 8.0	580.0	7.0	< 10.0	< 2.0
PU85-15A	B44	89.0	Mucky Inorg. Txt.	0-1	17.9	50.5	7.20	0.88	2.90	2.80	0.38	1.70	0.07	0.27	1400.0	< 2.0	< 10.0	< 8.0	630.0	11.0	< 10.0	< 2.0
PU86-11A	B46	96.8	Inorg. Txt.	0-1	3.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
PU85-13A	85.0	11.0	28.0	21.0	< 2.0	11.0	< 4.0	53.0	29.0	8.0	---	46.0	14.0	38.0	8.0	< 20.0	150.0	< 40.0	40.0	23.0	2.0	120.0
PU85-13B	85.0	9.0	42.0	25.0	< 2.0	14.0	< 4.0	58.0	38.0	14.0	---	52.0	16.0	21.0	9.0	< 20.0	180.0	< 40.0	52.0	24.0	2.0	70.0
PU85-13C	100.0	10.0	44.0	18.0	2.0	17.0	< 4.0	59.0	42.0	< 2.0	---	54.0	17.0	23.0	11.0	< 20.0	260.0	< 40.0	51.0	33.0	3.0	77.0
PU85-13D	110.0	6.0	44.0	17.0	2.0	18.0	< 4.0	64.0	35.0	< 2.0	---	59.0	14.0	29.0	10.0	< 20.0	270.0	< 40.0	51.0	31.0	3.0	63.0
PU85-13E	87.0	6.0	33.0	14.0	< 2.0	16.0	< 4.0	53.0	34.0	< 2.0	---	49.0	11.0	27.0	8.0	< 20.0	290.0	< 40.0	46.0	25.0	3.0	58.0
PU85-14A	270.0	9.0	42.0	25.0	< 2.0	24.0	7.0	190.0	75.0	3.0	---	180.0	17.0	31.0	12.0	< 20.0	130.0	< 40.0	57.0	240.0	23.0	240.0
PU85-14B	180.0	5.0	24.0	13.0	< 2.0	24.0	4.0	130.0	48.0	< 2.0	---	110.0	10.0	30.0	7.0	< 20.0	97.0	< 40.0	34.0	140.0	15.0	120.0
PU85-14C	220.0	6.0	33.0	15.0	< 2.0	24.0	5.0	150.0	55.0	< 2.0	---	130.0	12.0	28.0	9.0	< 20.0	120.0	< 40.0	42.0	150.0	16.0	140.0
PU85-14D	240.0	6.0	21.0	10.0	< 2.0	24.0	< 4.0	150.0	47.0	< 2.0	---	130.0	8.0	30.0	7.0	< 20.0	100.0	< 40.0	30.0	120.0	13.0	100.0
PU85-15A	250.0	6.0	28.0	15.0	< 2.0	25.0	6.0	180.0	65.0	< 2.0	---	150.0	11.0	33.0	10.0	< 20.0	140.0	< 40.0	39.0	180.0	21.0	170.0
PU86-11A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Black Hawk Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
PB83-1A	A21	---	Muck	0-1	5.2	25.1	6.70	0.90	1.70	3.60	0.25	1.90	0.04	0.16	530.0	< 2.0	< 10.0	< 8.0	890.0	2.0	< 10.0	< 2.0
PB83-2A	A21	---	Muck	0-1	5.0	19.7	6.80	0.88	1.70	3.70	0.27	1.90	0.04	0.15	550.0	< 2.0	< 10.0	< 8.0	900.0	2.0	< 10.0	< 2.0
PB83-3A	A23	---	Muck	0-1	30.4	< 9.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-3B	A23	---	Muck	1-2	30.2	< 9.4	6.90	0.77	1.80	3.70	0.23	2.00	0.04	0.14	440.0	< 2.0	< 10.0	< 8.0	890.0	2.0	< 10.0	< 2.0
PB83-4A	A24	---	Muck	0-1	57.4	< 15.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-4B	A24	---	Muck	1-2	22.8	< 7.9	6.60	0.62	1.30	3.70	0.22	1.80	0.03	0.11	240.0	< 2.0	< 10.0	< 8.0	830.0	2.0	< 10.0	< 2.0
PB83-5A	A22	---	Muck	0-1	6.1	14.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-5B	A22	---	Peat	1-2	13.0	< 8.8	1.90	1.60	0.59	0.56	0.28	0.39	0.22	0.04	1900.0	< 2.0	< 10.0	< 8.0	340.0	< 1.0	< 10.0	< 2.0
PB83-6A	A22	---	Muck	0-1	1160.0	< 480.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-6B	A22	---	Muck	1-2	646.0	< 140.0	7.30	1.30	4.50	3.30	0.61	1.90	0.15	0.34	560.0	< 2.0	< 10.0	< 8.0	1300.0	3.0	< 10.0	< 2.0
PB83-6C	A22	---	Muck	2-3	428.0	< 94.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-1A	A27	92.4	Mucky Inorg. Txt.	0-1	12.6	17.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2A	A31	90.8	Mucky Inorg. Txt.	0-1	8.3	9.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2B	A31	87.6	Mucky Inorg. Txt.	1-2	17.2	< 7.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2C	A31	73.9	Inorg. Txt. Muck	2-3	21.1	< 8.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2D	A31	95.6	Inorg. Txt.	3-4	5.6	< 3.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2E	A31	90.2	Mucky Inorg. Txt.	4-5	7.9	8.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2F	A31	90.4	Mucky Inorg. Txt.	5-6	18.4	< 6.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2G	A31	92.9	Mucky Inorg. Txt.	6-7	18.3	19.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2H	A31	91.8	Mucky Inorg. Txt.	7-8	20.0	< 6.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
PB83-1A	90.0	6.0	21.0	8.0	< 2.0	19.0	< 4.0	49.0	18.0	< 2.0	< 4.0	35.0	8.0	36.0	4.0	---	240.0	< 40.0	34.0	11.0	< 1.0	40.0
PB83-2A	63.0	6.0	20.0	8.0	< 2.0	17.0	< 4.0	37.0	19.0	2.0	6.0	29.0	8.0	38.0	4.0	---	240.0	< 40.0	33.0	10.0	< 1.0	50.0
PB83-3A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-3B	65.0	5.0	16.0	9.0	< 2.0	17.0	< 4.0	36.0	14.0	6.0	5.0	30.0	6.0	33.0	4.0	---	220.0	< 40.0	32.0	11.0	< 1.0	30.0
PB83-4A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-4B	56.0	5.0	15.0	8.0	< 2.0	13.0	< 4.0	53.0	13.0	7.0	8.0	35.0	6.0	44.0	3.0	---	180.0	< 40.0	26.0	15.0	< 1.0	30.0
PB83-5A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-5B	22.0	4.0	8.0	23.0	< 2.0	6.0	< 4.0	18.0	7.0	4.0	< 4.0	17.0	8.0	33.0	< 2.0	---	120.0	< 40.0	10.0	10.0	< 1.0	180.0
PB83-6A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PB83-6B	110.0	13.0	46.0	15.0	2.0	22.0	< 4.0	60.0	27.0	< 2.0	< 4.0	56.0	13.0	26.0	9.0	---	390.0	< 40.0	87.0	25.0	2.0	80.0
PB83-6C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-1A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2E	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2G	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-2H	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Black Hawk Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
BU86-2I	A31	95.6	Inorg. Txt.	8-9	54.3	< 12.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-3A	A30	92.5	Mucky Inorg. Txt.	0-1	27.0	31.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-4A	A29	72.2	Inorg. Txt. Muck	0-1	279.0	< 52.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-4B	A29	88.5	Mucky Inorg. Txt.	1-2	121.0	< 23.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-5A	A28	78.6	Inorg. Txt. Muck	0-1	52.9	58.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-5B	A28	90.0	Mucky Inorg. Txt.	1-2	37.4	< 10.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-5C	A28	96.4	Inorg. Txt.	2-3	17.2	28.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6A	A25	49.0	Muck	0-1	7.9	18.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6B	A25	44.1	Peaty Muck	1-2	10.4	27.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6C	A25	45.0	Muck	2-3	12.3	24.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6D	A25	87.8	Mucky Inorg. Txt.	3-4	6.6	18.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6E	A25	96.2	Inorg. Txt.	4-5	4.2	17.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7A	A26	76.6	Inorg. Txt. Muck	0-1	9.6	15.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7B	A26	42.0	Peaty Muck	1-2	11.1	14.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7C	A26	87.0	Mucky Inorg. Txt.	2-3	9.1	14.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7D	A26	91.5	Mucky Inorg. Txt.	3-4	9.1	14.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7E	A26	91.2	Mucky Inorg. Txt.	4-5	13.9	15.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7F	A26	92.6	Mucky Inorg. Txt.	5-6	15.6	< 5.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7G	A26	94.4	Mucky Inorg. Txt.	6-7	9.6	11.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7H	A26	95.6	Inorg. Txt.	7-8	7.4	10.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
BU86-2I	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-3A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-4A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-4B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-5A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-5B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-5C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-6E	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7E	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7G	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
BU86-7H	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Boettcher Lake Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-10A	C41	84.0	Inorg. Txt. Muck	0-1	3.8	< 21.0
NP85-10B	C41	92.7	Mucky Inorg. Txt.	1-2	2.4	< 15.0

Buffalo Pass Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-1A	C48	80.4	Inorg. Txt. Muck	0-1	22.1	< 7.8
NP85-1B	C48	86.6	Mucky Inorg. Txt.	1-2	15.3	< 6.1
NP85-1C	C48	92.5	Mucky Inorg. Txt.	2-3	22.9	< 7.7
NP85-1D	C48	95.1	Inorg. Txt.	3-4	24.4	< 7.8

Central City Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
CC86-1A	A20	95.1	Inorg. Txt.	0-1	4.1	13.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-1B	A20	59.2	Muck	1-2	3.4	10.1	4.70	1.10	3.20	1.30	0.59	0.67	0.13	0.17	440.0	< 2.0	< 10.0	< 8.0	640.0	1.0	< 10.0	< 2.0
CC86-1C	A20	55.1	Muck	2-3	3.4	8.1	4.20	1.20	3.10	1.20	0.56	0.64	0.10	0.15	460.0	< 2.0	< 10.0	< 8.0	550.0	1.0	< 10.0	< 2.0
CC86-1D	A20	46.6	Muck	3-4	4.2	7.1	3.60	1.40	2.90	0.99	0.53	0.50	0.10	0.14	560.0	< 2.0	< 10.0	< 8.0	500.0	< 1.0	< 10.0	< 2.0
CC86-1E	A20	47.4	Muck	4-5	4.2	6.5	3.70	1.30	2.80	1.10	0.58	0.48	0.08	0.15	530.0	< 2.0	< 10.0	< 8.0	520.0	< 1.0	< 10.0	< 2.0
CC86-1F	A20	47.2	Muck	5-6	4.3	11.2	3.70	1.40	3.00	0.91	0.53	0.51	0.06	0.12	440.0	< 2.0	< 10.0	< 8.0	460.0	< 1.0	< 10.0	< 2.0
CC86-1G	A20	93.3	Mucky Inorg. Txt.	6-7	5.0	18.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2A	A19	84.6	Inorg. Txt. Muck	0-1	4.7	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2B	A19	83.9	Inorg. Txt. Muck	1-2	4.9	10.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2C	A19	91.1	Mucky Inorg. Txt.	2-3	5.0	15.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
CC86-1A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-1B	40.0	13.0	76.0	31.0	< 2.0	11.0	< 4.0	21.0	17.0	5.0	< 4.0	18.0	34.0	23.0	8.0	< 10.0	200.0	< 40.0	50.0	9.0	< 1.0	89.0
CC86-1C	43.0	13.0	51.0	28.0	< 2.0	10.0	< 4.0	22.0	14.0	6.0	< 4.0	19.0	33.0	23.0	7.0	< 10.0	200.0	< 40.0	46.0	9.0	< 1.0	70.0
CC86-1D	33.0	21.0	53.0	35.0	< 2.0	10.0	< 4.0	18.0	14.0	7.0	< 4.0	16.0	37.0	18.0	6.0	< 10.0	180.0	< 40.0	47.0	8.0	< 1.0	95.0
CC86-1E	40.0	17.0	52.0	32.0	< 2.0	10.0	< 4.0	21.0	17.0	6.0	4.0	17.0	35.0	19.0	7.0	< 10.0	180.0	< 40.0	53.0	9.0	< 1.0	120.0
CC86-1F	43.0	18.0	51.0	32.0	< 2.0	9.0	< 4.0	22.0	14.0	8.0	< 4.0	20.0	36.0	16.0	6.0	< 10.0	190.0	< 40.0	54.0	9.0	< 1.0	170.0
CC86-1G	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Central City Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
CC86-2D	A19	91.8	Mucky Inorg. Txt.	3-4	6.0	15.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2E	A19	93.7	Mucky Inorg. Txt.	4-5	7.8	28.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2F	A19	97.1	Inorg. Txt.	5-6	5.7	20.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-3A	A16	18.1	Peat	0-1	0.5	3.7	1.10	0.57	0.62	0.34	0.16	0.16	0.10	0.05	490.0	< 2.0	< 10.0	< 8.0	210.0	< 1.0	< 10.0	< 2.0
CC86-3B	A16	17.7	Peat	1-2	0.5	< 3.3	0.86	0.50	0.43	0.22	0.11	0.12	0.09	0.04	230.0	< 2.0	< 10.0	< 8.0	320.0	< 1.0	< 10.0	< 2.0
CC86-3C	A16	13.4	Peat	2-3	0.6	3.4	0.88	0.49	0.50	0.21	0.09	0.11	0.10	0.04	160.0	< 2.0	< 10.0	< 8.0	210.0	< 1.0	< 10.0	< 2.0
CC86-3D	A16	13.7	Peat	3-4	0.7	< 2.7	0.86	0.50	0.56	0.20	0.08	0.09	0.10	0.03	160.0	< 2.0	< 10.0	< 8.0	220.0	< 1.0	< 10.0	< 2.0
CC86-3E	A16	13.2	Peat	4-5	0.5	3.9	0.71	0.45	0.51	0.15	0.07	0.07	0.09	0.03	140.0	< 2.0	< 10.0	< 8.0	190.0	< 1.0	< 10.0	< 2.0
CC86-3F	A16	12.2	Peat	5-6	0.7	< 2.7	0.72	0.44	0.50	0.17	0.07	0.09	0.07	0.03	130.0	< 2.0	< 10.0	< 8.0	190.0	< 1.0	< 10.0	< 2.0
CC86-3G	A16	13.2	Peat	6-7	0.8	3.3	0.79	0.42	0.51	0.18	0.07	0.08	0.09	0.03	110.0	< 2.0	< 10.0	< 8.0	180.0	< 1.0	< 10.0	< 2.0
CC86-3H	A16	17.8	Peat	7-8	0.9	4.6	0.85	0.38	0.49	0.19	0.08	0.09	0.07	0.03	110.0	< 2.0	< 10.0	< 8.0	170.0	< 1.0	< 10.0	< 2.0
CC86-3I	A16	19.4	Peat	8-9	1.5	< 3.4	1.10	0.45	0.62	0.21	0.10	0.09	0.09	0.04	120.0	< 2.0	< 10.0	< 8.0	190.0	< 1.0	< 10.0	< 2.0
CC86-3J	A16	15.6	Peat	9-10	1.0	< 3.5	1.00	0.47	0.61	0.28	0.10	0.10	0.09	0.04	150.0	< 2.0	< 10.0	< 8.0	230.0	< 1.0	< 10.0	< 2.0
CC86-3K	A16	98.0	Inorg. Txt.	10-11	3.2	16.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-4A	A17	59.8	Muck	0-1	3.0	10.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-4B	A17	80.7	Inorg. Txt. Muck.	1-2	5.0	16.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-4C	A17	92.4	Mucky Inorg. Txt.	2-3	3.7	19.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-5A	A18	42.0	Peaty Muck	0-1	1.9	7.4	3.50	0.78	1.40	0.86	0.28	0.47	0.13	0.15	210.0	< 2.0	< 10.0	< 8.0	400.0	< 1.0	< 10.0	< 2.0
CC86-5B	A18	73.6	Inorg. Txt. Muck	1-2	6.8	9.6	6.60	1.10	2.90	1.60	0.56	1.10	0.09	0.28	500.0	< 2.0	< 10.0	< 8.0	660.0	2.0	< 10.0	< 2.0
CC86-5C	A18	72.6	Inorg. Txt. Muck	2-3	6.0	8.8	6.60	1.10	3.20	1.60	0.62	1.10	0.08	0.29	650.0	< 2.0	< 10.0	< 8.0	670.0	2.0	< 10.0	< 2.0
CC86-5D	A18	97.2	Inorg. Txt.	3-4	3.8	9.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
CC86-2D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2E	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-2F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-3A	14.0	3.0	18.0	20.0	< 2.0	4.0	< 4.0	8.0	3.0	2.0	< 4.0	6.0	10.0	250.0	< 2.0	< 10.0	67.0	< 40.0	13.0	4.0	< 1.0	70.0
CC86-3B	11.0	2.0	11.0	16.0	< 2.0	4.0	< 4.0	6.0	3.0	2.0	< 4.0	5.0	9.0	70.0	< 2.0	< 10.0	57.0	< 40.0	10.0	4.0	< 1.0	35.0
CC86-3C	15.0	2.0	13.0	15.0	< 2.0	4.0	< 4.0	9.0	2.0	5.0	< 4.0	8.0	10.0	18.0	< 2.0	< 10.0	58.0	< 40.0	10.0	6.0	< 1.0	20.0
CC86-3D	13.0	2.0	16.0	13.0	< 2.0	4.0	< 4.0	8.0	2.0	5.0	< 4.0	8.0	10.0	7.0	< 2.0	< 10.0	60.0	< 40.0	9.0	7.0	< 1.0	13.0
CC86-3E	11.0	2.0	10.0	15.0	< 2.0	4.0	< 4.0	7.0	< 2.0	5.0	< 4.0	6.0	9.0	19.0	< 2.0	< 10.0	53.0	< 40.0	8.0	6.0	< 1.0	9.0
CC86-3F	10.0	2.0	10.0	13.0	< 2.0	4.0	< 4.0	6.0	< 2.0	4.0	< 4.0	5.0	10.0	7.0	< 2.0	< 10.0	53.0	< 40.0	8.0	4.0	< 1.0	10.0
CC86-3G	11.0	2.0	12.0	17.0	< 2.0	4.0	< 4.0	7.0	2.0	7.0	< 4.0	7.0	11.0	6.0	< 2.0	< 10.0	51.0	< 40.0	11.0	6.0	< 1.0	22.0
CC86-3H	15.0	2.0	13.0	18.0	< 2.0	4.0	< 4.0	9.0	2.0	5.0	< 4.0	10.0	10.0	10.0	< 2.0	< 10.0	47.0	< 40.0	11.0	7.0	< 1.0	12.0
CC86-3I	27.0	3.0	15.0	24.0	< 2.0	4.0	< 4.0	18.0	3.0	8.0	< 4.0	17.0	15.0	34.0	3.0	< 10.0	54.0	< 40.0	17.0	15.0	1.0	22.0
CC86-3J	17.0	2.0	15.0	17.0	< 2.0	4.0	< 4.0	11.0	2.0	8.0	< 4.0	9.0	11.0	8.0	2.0	< 10.0	59.0	< 40.0	13.0	8.0	< 1.0	31.0
CC86-3K	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-4A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-4B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-4C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CC86-5A	38.0	7.0	30.0	22.0	< 2.0	9.0	< 4.0	21.0	13.0	9.0	< 4.0	17.0	12.0	32.0	5.0	< 10.0	130.0	< 40.0	40.0	14.0	1.0	68.0
CC86-5B	82.0	17.0	91.0	42.0	< 2.0	18.0	< 4.0	49.0	26.0	17.0	6.0	43.0	28.0	24.0	10.0	< 10.0	240.0	< 40.0	61.0	37.0	4.0	100.0
CC86-5C	91.0	21.0	82.0	41.0	2.0	17.0	< 4.0	53.0	25.0	15.0	9.0	46.0	34.0	23.0	10.0	< 10.0	270.0	< 40.0	73.0	37.0	3.0	110.0
CC86-5D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Cripple Creek North Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
PU85-9A	B26	34.4	Peaty Muck	0-1	1.7	< 4.5	1.50	0.86	0.74	0.37	0.19	0.20	0.08	0.07	47.0	< 2.0	< 10.0	< 8.0	230.0	1.0	< 10.0	< 2.0
PU85-9B	B26	31.4	Peaty Muck	1-2	2.8	< 5.3	1.50	0.80	0.58	0.29	0.21	0.13	0.06	0.06	52.0	< 2.0	< 10.0	< 8.0	190.0	2.0	< 10.0	< 2.0
PU85-9C	B26	69.4	Inorg. Txt. Muck	2-3	2.4	7.8	3.10	0.40	0.33	2.20	0.10	0.77	0.02	0.05	28.0	< 2.0	< 10.0	< 8.0	540.0	2.0	< 10.0	< 2.0
PU85-9D	B26	96.6	Inorg. Txt.	3-4	< 0.2	33.1	5.70	0.43	0.55	4.00	0.15	1.70	0.02	0.11	72.0	< 2.0	< 10.0	< 8.0	830.0	3.0	< 10.0	< 2.0
PU85-9E	B26	97.8	Inorg. Txt.	4-5	3.4	15.0	6.00	0.49	0.83	3.90	0.23	1.70	0.02	0.14	95.0	< 2.0	< 10.0	< 8.0	840.0	3.0	< 10.0	< 2.0
PU86-4A	B29	37.9	Peaty Muck	0-1	3.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-4B	B29	41.2	Peaty Muck	1-2	5.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-4C	B29	63.5	Muck	2-3	7.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-4D	B29	93.1	Mucky Inorg. Txt.	3-4	6.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-5A	B25	89.2	Mucky Inorg. Txt.	0-1	17.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-5B	B25	95.1	Inorg. Txt.	1-2	12.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-6A	B28	72.4	Inorg. Txt. Muck	0-1	20.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-6B	B28	78.5	Inorg. Txt. Muck	1-2	26.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-6C	B28	85.3	Mucky Inorg. Txt.	2-3	34.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7A	B28	81.5	Inorg. Txt. Muck	0-1	14.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7B	B28	75.4	Inorg. Txt. Muck	1-2	21.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7C	B28	78.9	Inorg. Txt. Muck	2-3	33.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7D	B28	84.9	Inorg. Txt. Muck	3-4	42.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-8A	B27	93.8	Mucky Inorg. Txt.	0-1	13.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-9B	B23	30.6	Peaty Muck	1-2	4.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
PU85-9A	40.0	2.0	10.0	10.0	< 2.0	4.0	< 4.0	23.0	8.0	< 2.0	---	21.0	8.0	23.0	3.0	< 20.0	71.0	< 40.0	16.0	12.0	1.0	35.0
PU85-9B	70.0	1.0	11.0	11.0	< 2.0	5.0	< 4.0	38.0	8.0	2.0	---	39.0	11.0	7.0	3.0	< 20.0	59.0	< 40.0	18.0	26.0	2.0	39.0
PU85-9C	63.0	1.0	5.0	7.0	< 2.0	8.0	< 4.0	31.0	7.0	< 2.0	---	29.0	7.0	13.0	2.0	< 20.0	67.0	< 40.0	14.0	18.0	2.0	17.0
PU85-9D	99.0	3.0	9.0	4.0	< 2.0	15.0	< 4.0	47.0	14.0	< 2.0	---	39.0	6.0	24.0	3.0	< 20.0	120.0	< 40.0	15.0	22.0	3.0	41.0
PU85-9E	120.0	4.0	9.0	6.0	< 2.0	15.0	< 4.0	55.0	17.0	< 2.0	---	47.0	8.0	22.0	4.0	< 20.0	130.0	< 40.0	22.0	28.0	3.0	43.0
PU86-4A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-4B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-4C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-4D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-5A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-5B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-6A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-6B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-6C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-7D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-8A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-9B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Cripple Creek North Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)
PU86-9C	B23	23.4	Peat	2-3	9.9
PU86-9D	B23	44.7	Peaty Muck	3-4	27.4
PU86-9E	B23	83.4	Inorg. Txt. Muck	4-5	11.8
PU86-9F	B23	82.3	Inorg. Txt. Muck	5-6	10.2
PU86-10A	B24	89.1	Mucky Inorg. Txt.	0-1	9.2
PU86-10B	B24	91.9	Mucky Inorg. Txt.	1-2	15.8
PU86-10C	B24	86.5	Mucky Inorg. Txt.	2-3	18.6

Cripple Creek South Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)
PU86-1A	B32	92.9	Mucky Inorg. Txt.	0-1	11.3
PU86-2A	B31	76.3	Inorg. Txt. Muck	0-1	8.8
PU86-2B	B31	88.6	Mucky Inorg. Txt.	1-2	8.2
PU86-3A	B30	91.3	Mucky Inorg. Txt.	0-1	11.1
PU86-3B	B30	87.8	Mucky Inorg. Txt.	1-2	10.8
PU86-3C	B30	67.3	Inorg. Txt. Muck	2-3	6.8
PU86-3D	B30	82.2	Inorg. txt. Muck	3-4	10.4
PU86-3E	B30	81.6	Inorg. Txt. Muck	4-5	11.7
PU86-3F	B30	94.0	Mucky Inorg. Txt.	5-6	8.4

Crystal Creek Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
FR83-22A	B4	---	Muck	0-1	129.0	< 23.0
FR83-23A	B4	---	Muck	0-1	178.0	< 31.0
FR83-24A	B4	---	Muck	0-1	386.0	< 170.0
FR83-25A	B4	---	Muck	0-1	185.0	< 31.0
FR83-26A	B5	---	Peaty Muck	0-1	321.0	< 75.0
FR83-26B	B5	---	Inorg. Txt.	1-2	369.0	< 84.0
FR83-26C	B5	---	Inorg. Txt.	2-3	292.0	< 67.0
FR83-27A	B5	---	Peaty Muck	0-1	351.0	< 81.0
FR83-27B	B5	---	Peaty Muck	1-2	679.0	< 150.0
FR83-28A	B4	---	Muck	0-1	122.0	< 31.0
FR83-29A	B3	---	Peaty Muck	0-1	60.7	< 20.0
FR83-30A	B3	---	Muck	0-1	181.0	< 43.0
FR83-31A	B3	---	Peaty Muck	0-1	154.0	< 43.0
FR83-31B	B3	---	Inorg. Txt.	1-2	687.0	< 150.0
FR83-32A	B3	---	Peaty Muck	0-1	190.0	< 53.0
FR83-32B	B3	---	Peaty Muck	1-2	270.0	< 67.0
FR83-32C	B3	---	Inorg. Txt.	2-3	657.0	< 150.0
FR83-33A	B2	---	Peat	0-1	38.1	< 17.0
FR83-34A	B1	---	Muck	0-1	11.7	< 6.5
FR83-34B	B1	---	Muck	1-2	17.5	18.7

Crystal Creek Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
FR83-34C	B1	---	Inorg. Txt.	2-3	14.3	15.0
FR83-35A	B6	---	Peaty Muck	0-1	21.1	< 13.0
FR83-36A	B6	---	Peaty Muck	0-1	19.0	< 8.7
FR83-37A	B6	---	Peaty Muck	0-1	46.0	< 19.0
FR83-37B	B6	---	Peaty Muck	1-2	55.3	< 15.0
FR83-38A	B6	---	Peaty Muck	0-1	30.6	< 12.0
FR83-39A	B6	---	Muck	0-1	138.0	< 30.0
FR83-39B	B6	---	Muck	1-2	61.0	< 15.0
FR83-40A	B6	---	Muck	0-1	36.7	41.6
FR83-40B	B6	---	Inorg. Txt.	1-2	24.0	31.1
FR83-41A	B6	---	Peat	0-1	17.7	< 9.5
FR83-41B	B6	---	Peaty Muck	1-2	19.0	< 8.4
FR83-41C	B6	---	Peaty Muck	2-3	30.8	34.3
FR83-41D	B6	---	Inorg. Txt.	3-4	38.3	< 11.0
FR83-42A	B6	---	Muck	0-1	12.4	25.7
FR83-43A	B6	---	Peaty Muck	0-1	57.1	< 14.0

Davis Peak Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-15A	C30	39.2	Peaty Muck	0-1	37.4	< 53.0
NP85-15B	C30	38.0	Peaty Muck	1-2	104.0	< 79.0
NP85-15C	C30	40.7	Peaty Muck	2-3	36.6	< 46.0
NP85-15D	C30	93.3	Mucky Inorg. Txt.	3-4	26.9	< 30.0
NP85-16A	C29	52.5	Muck	0-1	17.4	< 36.0

Davis Peak Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-16B	C29	70.0	Inorg.Txt. Muck	1-2	15.3	< 33.0
NP85-16C	C29	89.3	Mucky Inorg. Txt.	2-3	6.9	< 19.0
NP85-16D	C29	64.7	Muck	3-4	10.7	< 28.0
NP85-16E	C29	58.6	Muck	4-5	19.4	< 35.0
NP85-16F	C29	69.3	Inorg. Txt. Muck	5-6	31.5	< 41.0

Davis Peak Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-17A	C29	87.2	Mucky Inorg. Txt.	0-1	14.6	< 18.0
NP85-18A	C28	86.0	Mucky Inorg. Txt.	0-1	11.2	< 16.0
NP85-19A	C27	83.9	Inorg. Txt. Muck	0-1	10.1	< 16.0
NP85-21A	C26	92.9	Mucky Inorg. Txt.	0-1	2.8	< 12.0
NP85-22A	C31	82.3	Inorg. Txt. Muck	0-1	2.2	< 12.0
NP85-23A	C31	83.8	Inorg. Txt. Muck	0-1	2.4	< 11.0
NP85-23B	C31	54.5	Muck	1-2	3.1	< 14.0
NP85-23C	C31	87.0	Mucky Inorg. Txt.	2-3	1.6	< 12.0
NP85-23D	C31	29.2	Peaty Muck	3-4	< 1.7	< 16.0
NP85-23E	C31	84.6	Inorg. Txt. Muck	4-5	3.9	< 13.0
NP85-24A	C32	63.0	Muck	0-1	3.7	< 15.0
NP85-24B	C32	51.7	Muck	1-2	4.2	< 19.0
NP85-24C	C32	63.8	Muck	2-3	6.4	< 18.0
NP85-24D	C32	91.0	Mucky Inorg. Txt.	3-4	5.6	< 12.0
NP85-25A	C33	57.1	Muck	0-1	4.6	< 16.0
NP85-25B	C33	73.4	Inorg. Txt. Muck	1-2	8.8	< 23.0
NP85-25C	C33	92.8	Mucky Inorg. Txt.	2-3	7.1	< 18.0
NP85-25D	C33	96.4	Inorg. Txt.	3-4	6.9	< 14.0
NP85-26A	C34	93.4	Mucky Inorg. Txt.	0-1	7.3	< 16.0

Divide Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)
PU86-13A	B22	89.4	Mucky Inorg. Txt.	0-1	5.7

Fairview Peak Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
FR83-1A	B16	---	Inorg. Txt. Muck	0-1	5.5	8.8
FR83-1B	B16	---	Muck	1-2	4.7	4.9
FR83-2A	B16	---	Peaty Muck	0-1	64.1	< 14.0
FR83-2B	B16	---	Peaty Muck	1-2	138.0	< 25.0
FR83-2C	B16	---	Muck	2-3	114.0	< 21.0
FR83-3A	B17	---	Peaty Muck	0-1	5.1	7.4
FR83-3B	B17	---	Muck	1-2	4.2	< 2.8
FR83-4A	B18	---	Peaty Muck	0-1	206.0	< 35.0
FR83-4B	B18	---	Muck	1-2	169.0	< 29.0
FR83-5A	B19	---	Peaty Muck	0-1	56.9	< 12.0
FR83-5B	B19	---	Peaty Muck	1-2	40.9	< 10.0
FR83-5C	B19	---	Peaty Muck	2-3	98.5	< 19.0
FR83-5D	B19	---	Inorg. Txt. Muck	3-4	41.8	< 8.9
FR83-6A	B20	---	Muck	0-1	3.1	6.1
FR83-7A	B21	---	Peat	0-1	57.8	< 14.0
FR83-7B	B21	---	Peaty Muck	1-2	125.0	< 22.0
FR83-8A	B15	---	Peaty Muck	0-1	647.0	< 280.0
FR83-9A	B14	---	Peaty Muck	0-1	22.9	< 8.8
FR83-9B	B14	---	Muck	1-2	18.8	20.3
FR83-10A	B14	---	Muck	0-1	22.9	< 8.1
FR83-10B	B14	---	Muck	1-2	19.8	< 7.6
FR83-10C	B14	---	Inorg. Txt.	2-3	239.0	< 40.0
FR83-11A	B14	---	Muck	0-1	159.0	< 28.0
FR83-12A	B14	---	Muck	0-1	117.0	< 22.0
FR83-13A	B13	---	Muck	0-1	9.8	< 5.0
FR83-13B	B13	---	Peaty Muck	1-2	124.0	< 23.0
FR83-14A	B12	---	Inorg. Txt. Muck	0-1	10.6	14.7
FR83-15A	B11	---	Muck	0-1	127.0	< 23.0
FR83-16A	B10	---	Muck	0-1	329.0	< 57.0
FR83-17A	B10	---	Moss	0-1	598.0	< 100.0
FR83-18A	B9	---	Peaty Muck	0-1	378.0	< 64.0
FR83-19A	B8	---	Inorg. Txt. Muck	0-1	249.0	< 42.0
FR83-20A	B7	---	Peaty Muck	0-1	3190.0	< 1,200.0

Harris Park Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
HP83-1A	A32	---	Inorg. Txt. Muck	0-1	8.0	26.1	7.70	1.10	2.80	3.40	0.74	1.50	0.13	0.31	660.0	< 2.0	< 10.0	< 8.0	1100.0	3.0	< 10.0	< 2.0
HP83-1B	A32	---	Inorg. Txt. Muck	1-2	4.3	13.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-2A	A33	---	Peat	0-1	0.8	< 3.1	0.39	0.48	13.00	0.23	0.14	0.06	0.59	0.02	620.0	< 2.0	< 10.0	< 8.0	320.0	< 1.0	< 10.0	< 2.0
HP83-3A	A34	---	Peaty Muck	0-1	8.2	21.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-4A	A34	---	Inorg. Txt. Muck	0-1	6.6	21.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-4B	A34	---	Inorg. Txt. Muck	1-2	4.4	13.3	6.80	0.83	1.20	4.20	0.36	1.70	0.05	0.18	190.0	7.0		< 8.0	1300.0	2.0	< 10.0	< 2.0
HP83-5A	A35	---	Inorg. Txt. Muck	0-1	4.6	13.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-5B	A35	---	Inorg. Txt.	1-2	6.5	24.0	7.80	1.50	1.90	3.50	0.67	2.10	0.12	0.38	320.0	< 2.0	< 10.0	< 8.0	1400.0	3.0	< 10.0	< 2.0
HP83-6A	A36	---	Inorg. Txt. Muck	0-1	14.4	16.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-6B	A36	---	Inorg. Txt.	1-2	7.3	20.7	3.60	2.20	1.50	0.42	0.40	0.14	0.08	0.08	160.0	< 2.0	< 10.0	< 8.0	160.0	1.0	< 10.0	< 2.0
HP86-10A	A37	---	Muck	0-1	3.7	19.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-11A	A37	---	Peaty Muck	0-1	5.3	11.0	4.80	0.87	1.50	2.70	0.32	1.00	0.14	0.13	150.0	< 2.0	< 10.0	< 8.0	840.0	2.0	< 10.0	< 2.0

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
HP83-1A	230.0	10.0	38.0	17.0	4.0	22.0	< 4.0	170.0	43.0	5.0	10.0	130.0	17.0	45.0	10.0	---	400.0	< 40.0	61.0	51.0	4.0	90.0
HP83-1B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-2A	18.0	7.0	7.0	8.0	< 2.0	4.0	< 4.0	10.0	< 2.0	2.0	< 4.0	8.0	3.0	29.0	< 2.0	---	75.0	< 40.0	15.0	4.0	< 1.0	60.0
HP83-3A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-4A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-4B	61.0	6.0	19.0	8.0	< 2.0	15.0	< 4.0	50.0	19.0	7.0	12.0	36.0	8.0	45.0	4.0	---	410.0	< 40.0	29.0	13.0	1.0	40.0
HP83-5A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-5B	130.0	10.0	34.0	12.0	2.0	24.0	< 4.0	87.0	28.0	< 2.0	8.0	70.0	13.0	30.0	9.0	---	420.0	< 40.0	54.0	25.0	2.0	70.0
HP83-6A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-6B	67.0	6.0	31.0	21.0	< 2.0	13.0	< 4.0	47.0	22.0	17.0	< 4.0	44.0	12.0	18.0	5.0	---	170.0	< 40.0	42.0	37.0	3.0	50.0
HP86-10A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-11A	83.0	4.0	20.0	11.0	< 2.0	14.0	< 4.0	41.0	14.0	< 2.0	< 4.0	34.0	7.0	45.0	4.0	---	210.0	< 40.0	25.0	13.0	< 1.0	40.0

Jefferson Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
KU85-1A	A47	84.2	Inorg. Txt. Muck	0-1	17.4	< 28.0
KU85-1C	A47	85.4	Mucky Inorg. Txt.	2-3	32.9	< 33.0
KU85-2A	A46	87.2	Mucky Inorg. Txt.	0-1	21.3	< 28.0
KU85-3A	A45	90.6	Mucky Inorg. Txt.	0-1	12.6	< 22.0
KU85-4A	A44	51.3	Muck	0-1	104.0	< 150.0
KU85-4B	A44	59.6	Muck	1-2	78.6	< 100.0
KU85-4C	A44	84.4	Inorg. Txt. Muck	2-3	41.3	< 75.0
KU85-4D	A44	93.4	Mucky Inorg. Txt.	3-4	24.4	< 28.0
KU85-5A	A44	88.5	Mucky Inorg. Txt.	0-1	152.0	< 200.0
KU85-6A	A44	93.4	Mucky Inorg. Txt.	0-1	6.6	22.0
KU85-6B	A44	94.8	Mucky Inorg. Txt.	1-2	17.7	< 22.0
KU85-7A	A48	85.7	Mucky Inorg. Txt.	0-1	48.2	< 75.0
KU85-8A	A49	85.8	Mucky Inorg. Txt.	0-1	10.2	< 21.0
KU85-9A	A50	88.1	Mucky Inorg. Txt.	0-1	14.0	< 21.0
KU85-9B	A50	94.3	Mucky Inorg. Txt.	1-2	14.0	< 20.0

Jefferson Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
KU85-9C	A50	95.4	Inorg. Txt.	2-3	13.1	< 19.0
KU85-9D	A50	94.1	Mucky Inorg. Txt.	3-4	16.5	< 21.0
KU85-9E	A50	95.8	Inorg. Txt.	4-5	14.1	< 20.0
KU85-10A	A51	89.2	Mucky Inorg. Txt.	0-1	70.5	< 100.0
KU85-10B	A51	94.4	Mucky Inorg. Txt.	1-2	40.4	< 60.0
KU85-10C	A51	93.7	Mucky Inorg. Txt.	2-3	53.0	< 75.0
KU85-11A	A41	84.8	Inorg. Txt. Muck	0-1	46.1	< 75.0
KU85-11B	A41	80.2	Inorg. Txt. Muck	1-2	55.9	< 75.0
KU85-12A	A42	87.9	Mucky Inorg. Txt.	0-1	20.7	< 24.0
KU85-13A	A43	81.7	Inorg. Txt. Muck	0-1	163.0	< 250.0
KU85-13B	A43	83.4	Inorg. Txt. Muck	1-2	91.7	< 150.0
KU85-13C	A43	92.7	Mucky Inorg. Txt.	2-3	38.7	< 60.0

Kinikinik Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-32A	C17	62.1	Muck	0-1	< 2.7	< 24.0
NP85-33A	C18	84.3	Inorg. Txt. Muck	0-1	6.7	< 27.0

Manitou Springs Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
PU85-5A	B40	25.8	Peaty Muck	0-1	1.6	< 4.2	1.10	0.59	1.50	0.29	0.18	0.14	0.11	0.05	560.0	< 2.0	< 10.0	< 8.0	120.0	4.0	< 10.0	< 2.0
PU85-5B	B40	17.5	Peat	1-2	1.8	< 4.7	0.98	0.49	0.88	0.27	0.11	0.14	0.07	0.05	210.0	< 2.0	< 10.0	< 8.0	130.0	4.0	< 10.0	< 2.0
PU85-5C	B40	38.0	Peaty Muck	2-3	6.1	16.1	2.50	0.58	1.30	0.86	0.23	0.46	0.06	0.19	230.0	< 2.0	< 10.0	< 8.0	270.0	6.0	< 10.0	< 2.0
PU85-5D	B40	22.6	Peat	3-4	6.0	12.0	1.30	0.66	1.20	0.31	0.15	0.13	0.06	0.07	220.0	< 2.0	< 10.0	< 8.0	140.0	6.0	< 10.0	< 2.0
PU85-6A	B41	53.3	Muck	0-1	55.4	< 17.0	3.50	1.20	2.40	2.00	0.16	1.30	0.03	0.20	550.0	< 2.0	< 10.0	< 8.0	170.0	13.0	< 10.0	< 2.0
PU85-7A	B41	95.7	Inorg. Txt.	0-1	10.2	26.8	5.70	0.24	1.60	3.80	0.11	2.40	0.02	0.12	490.0	< 2.0	< 10.0	< 8.0	340.0	6.0	< 10.0	< 2.0
PU85-8A	B42	86.6	Mucky Inorg. Txt.	0-1	6.0	20.2	5.30	0.41	1.70	3.10	0.16	1.80	0.05	0.23	200.0	< 2.0	< 10.0	< 8.0	390.0	5.0	< 10.0	< 2.0
PU85-8B	B42	92.8	Mucky Inorg. Txt.	1-2	10.0	33.6	5.90	0.29	2.90	3.40	0.16	2.20	0.02	0.32	310.0	< 2.0	< 10.0	< 8.0	360.0	6.0	< 10.0	< 2.0
PU85-8C	B42	95.3	Inorg. Txt.	2-3	17.3	76.0	5.90	0.23	3.10	3.40	0.17	2.20	0.03	0.38	390.0	< 2.0	< 10.0	< 8.0	370.0	6.0	< 10.0	< 2.0
PU85-8D	B42	95.1	Inorg. Txt.	3-4	25.3	118.0	6.10	0.20	3.50	3.30	0.20	2.10	0.03	0.45	510.0	< 2.0	< 10.0	< 8.0	360.0	9.0	< 10.0	< 2.0
PU85-8E	B42	91.1	Mucky Inorg. Txt.	4-5	29.3	115.0	5.90	0.27	3.50	3.00	0.21	2.00	0.03	0.45	520.0	< 2.0	< 10.0	< 8.0	340.0	9.0	< 10.0	< 2.0
PU85-16A	B43	60.5	Muck	0-1	7.0	25.9	4.90	0.70	1.40	1.10	0.44	0.50	0.08	0.20	120.0	< 2.0	< 10.0	< 8.0	270.0	3.0	< 10.0	< 2.0
PU85-16B	B43	86.5	Mucky Inorg. Txt.	1-2	8.4	36.2	6.40	0.51	1.20	2.50	0.29	2.00	0.03	0.32	150.0	< 2.0	< 10.0	< 8.0	520.0	4.0	< 10.0	< 2.0
PU85-16C	B43	73.3	Inorg. Txt. Muck	2-3	10.8	30.3	5.70	0.62	1.40	2.00	0.34	1.40	0.04	0.30	160.0	< 2.0	< 10.0	< 8.0	510.0	5.0	< 10.0	< 2.0
PU85-16D	B43	71.2	Inorg. Txt. Muck	3-4	8.1	33.6	5.80	0.71	1.50	2.00	0.39	1.20	0.06	0.26	150.0	< 2.0	< 10.0	< 8.0	480.0	6.0	< 10.0	< 2.0
PU85-16E	B43	91.2	Mucky Inorg. Txt.	4-5	7.3	22.2	6.00	0.26	0.80	3.60	0.15	2.30	0.02	0.12	67.0	< 2.0	< 10.0	< 8.0	200.0	5.0	< 10.0	< 2.0

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
PU85-5A	53.0	2.0	7.0	12.0	< 2.0	4.0	< 4.0	18.0	5.0	8.0	---	18.0	6.0	19.0	< 2.0	< 20.0	36.0	< 40.0	13.0	20.0	3.0	55.0
PU85-5B	65.0	2.0	8.0	7.0	< 2.0	4.0	< 4.0	27.0	4.0	4.0	---	26.0	5.0	5.0	< 2.0	< 20.0	33.0	< 40.0	11.0	29.0	3.0	18.0
PU85-5C	130.0	2.0	17.0	13.0	< 2.0	10.0	< 4.0	120.0	16.0	11.0	---	82.0	7.0	16.0	5.0	< 20.0	61.0	< 40.0	27.0	74.0	6.0	170.0
PU85-5D	150.0	1.0	12.0	9.0	< 2.0	5.0	< 4.0	230.0	8.0	17.0	---	160.0	7.0	6.0	3.0	< 20.0	37.0	< 40.0	15.0	130.0	9.0	62.0
PU85-6A	280.0	1.0	13.0	8.0	< 2.0	14.0	5.0	200.0	30.0	3.0	---	170.0	9.0	29.0	4.0	< 20.0	43.0	< 40.0	6.0	160.0	17.0	140.0
PU85-7A	160.0	2.0	14.0	5.0	< 2.0	23.0	< 4.0	95.0	26.0	3.0	---	73.0	11.0	20.0	3.0	< 20.0	41.0	< 40.0	9.0	47.0	6.0	110.0
PU85-8A	150.0	2.0	17.0	7.0	< 2.0	22.0	< 4.0	98.0	20.0	7.0	---	79.0	11.0	29.0	4.0	< 20.0	62.0	< 40.0	17.0	47.0	5.0	90.0
PU85-8B	340.0	1.0	10.0	7.0	< 2.0	25.0	< 4.0	200.0	29.0	6.0	---	150.0	6.0	29.0	5.0	< 20.0	57.0	< 40.0	19.0	85.0	10.0	180.0
PU85-8C	680.0	2.0	8.0	9.0	2.0	26.0	7.0	380.0	37.0	3.0	---	280.0	6.0	30.0	7.0	< 20.0	57.0	< 40.0	21.0	170.0	18.0	250.0
PU85-8D	940.0	3.0	9.0	11.0	3.0	28.0	11.0	530.0	63.0	5.0	---	400.0	8.0	36.0	8.0	< 20.0	52.0	< 40.0	20.0	280.0	32.0	370.0
PU85-8E	970.0	3.0	14.0	12.0	3.0	25.0	13.0	560.0	58.0	7.0	---	420.0	9.0	35.0	8.0	< 20.0	52.0	< 40.0	21.0	320.0	36.0	380.0
PU85-16A	200.0	3.0	36.0	15.0	< 2.0	20.0	< 4.0	130.0	43.0	4.0	---	100.0	11.0	23.0	8.0	< 20.0	71.0	< 40.0	51.0	92.0	7.0	130.0
PU85-16B	190.0	2.0	29.0	11.0	< 2.0	24.0	< 4.0	120.0	42.0	< 2.0	---	97.0	8.0	19.0	6.0	< 20.0	130.0	< 40.0	41.0	88.0	10.0	140.0
PU85-16C	220.0	3.0	32.0	17.0	< 2.0	23.0	< 4.0	120.0	38.0	4.0	---	98.0	10.0	27.0	7.0	< 20.0	110.0	< 40.0	48.0	110.0	11.0	310.0
PU85-16D	200.0	3.0	33.0	20.0	< 2.0	20.0	< 4.0	110.0	40.0	5.0	---	86.0	10.0	22.0	7.0	< 20.0	110.0	< 40.0	47.0	95.0	9.0	370.0
PU85-16E	150.0	2.0	12.0	6.0	< 2.0	26.0	< 4.0	88.0	26.0	2.0	---	57.0	4.0	12.0	3.0	< 20.0	38.0	< 40.0	16.0	57.0	7.0	150.0

Meridian Hill Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
HP83-7A	A38	---	Peat	0-1	46.8	< 22.0	2.00	1.00	0.52	0.33	0.30	0.12	0.19	0.07	46.0	< 2.0	< 10.0	< 8.0	180.0	7.0	< 10.0	< 2.0
HP83-8A	A38	---	Peat	0-1	1.8	7.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-9A	A39	---	Inorg. Txt. Muck	0-1	1.8	15.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-9B	A39	---	Inorg. Txt. Muck	1-2	4.0	28.8	7.40	0.48	1.40	4.40	0.24	1.60	0.04	0.20	140.0	< 2.0	< 10.0	< 8.0	1100.0	2.0	< 10.0	< 2.0
HP83-12A	A40	---	Inorg. Txt. Muck	0-1	5.4	15.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
HP83-7A	110.0	3.0	72.0	30.0	3.0	6.0	< 4.0	76.0	9.0	4.0	< 4.0	80.0	18.0	71.0	6.0	---	110.0	< 40.0	14.0	150.0	14.0	40.0
HP83-8A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-9A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
HP83-9B	97.0	5.0	24.0	10.0	< 2.0	19.0	< 4.0	53.0	17.0	< 2.0	4.0	40.0	9.0	40.0	5.0	---	230.0	< 40.0	40.0	12.0	1.0	50.0
HP83-12A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Nederland Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
ND86-1A	A15	60.3	Muck	0-1	4.2	8.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-1B	A15	83.2	Inorg. Txt. Muck	1-2	8.0	14.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-1C	A15	92.7	Mucky Inorg. Txt.	2-3	6.6	15.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-1D	A15	97.2	Inorg. Txt.	3-4	5.3	14.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-2A	A8	26.7	Peaty Muck	0-1	3.2	< 4.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-2B	A8	20.8	Peat	1-2	4.0	< 4.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-2C	A8	81.9	Inorg. Txt. Muck	2-3	4.5	10.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-3A	A8	77.1	Inorg. Txt. Muck	0-1	2.8	6.4	6.50	1.40	4.20	5.20	0.76	0.63	0.22	0.16	1100.0	59.0	< 10.0	< 8.0	720.0	2.0	< 10.0	4.0
ND86-3B	A8	50.8	Muck	1-2	2.3	6.9	4.30	1.10	2.80	2.20	0.50	0.49	0.19	0.15	630.0	26.0	< 10.0	< 8.0	460.0	1.0	< 10.0	< 2.0
ND86-3C	A8	72.7	Inorg. Txt. Muck	2-3	3.6	12.8	6.40	1.40	2.20	1.70	0.74	0.99	0.16	0.32	400.0	3.0	< 10.0	< 8.0	620.0	1.0	< 10.0	< 2.0
ND86-3D	A8	70.0	Inorg. Txt. Muck	3-4	3.5	14.9	6.10	1.40	2.40	1.70	0.77	0.94	0.18	0.29	430.0	6.0	< 10.0	< 8.0	610.0	1.0	< 10.0	< 2.0
ND86-4A	A9	85.2	Mucky Inorg. Txt.	0-1	2.9	8.3	7.20	2.10	5.70	2.20	1.30	1.20	0.22	0.44	1200.0	2.0	< 10.0	< 8.0	810.0	2.0	< 10.0	< 2.0
ND86-4B	A9	94.4	Mucky Inorg. Txt.	1-2	2.1	6.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-5A	A10	85.3	Mucky Inorg. Txt.	0-1	8.3	22.9	7.50	1.10	4.00	3.00	0.86	0.85	0.09	0.29	470.0	11.0	< 10.0	< 8.0	890.0	2.0	< 10.0	3.0
ND86-5B	A10	84.6	Inorg. Txt. Muck	1-2	5.9	25.1	7.00	1.20	4.70	2.50	0.87	0.90	0.12	0.29	560.0	6.0	< 10.0	< 8.0	760.0	1.0	< 10.0	< 2.0
ND86-5C	A10	91.0	Mucky Inorg. Txt.	2-3	4.0	26.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-5D	A10	95.5	Inorg. Txt.	3-4	4.2	29.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-6A	A13	33.8	Peaty Muck	0-1	1.7	8.9	3.10	1.30	1.40	0.62	0.34	0.23	0.09	0.11	190.0	< 2.0	< 10.0	< 8.0	630.0	< 1.0	< 10.0	< 2.0
ND86-6B	A13	47.4	Muck	1-2	2.0	11.3	4.20	1.10	1.30	0.79	0.39	0.27	0.10	0.15	160.0	< 2.0	< 10.0	< 8.0	650.0	1.0	< 10.0	< 2.0
ND86-6C	A13	44.6	Peaty Muck	2-3	1.8	10.9	4.20	1.10	1.20	0.69	0.37	0.24	0.10	0.14	150.0	< 2.0	< 10.0	< 8.0	650.0	1.0	< 10.0	< 2.0
ND86-7A	A13	88.8	Mucky Inorg. Txt.	0-1	1.7	12.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7B	A13	82.4	Inorg. Txt. Muck	1-2	3.1	11.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7C	A13	87.8	Mucky Inorg. Txt.	2-3	3.6	18.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7D	A13	88.2	Mucky Inorg. Txt.	3-4	4.7	15.8	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7E	A13	94.3	Mucky Inorg. Txt.	4-5	3.5	21.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-8A	A14	73.9	Inorg. Txt. Muck	0-1	31.4	< 8.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-8B	A14	76.9	Inorg. Txt. Muck	1-2	24.3	25.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-9A	A12	91.5	Mucky Inorg. Txt.	0-1	2.6	19.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-10A	A11	93.7	Mucky Inorg. Txt.	0-1	2.8	31.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Nederland Quadrangle (continued)

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
ND86-1A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-1B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-1C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-1D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-2A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-2B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-2C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-3A	71.0	17.0	24.0	62.0	< 2.0	15.0	< 4.0	38.0	8.0	6.0	5.0	31.0	12.0	700.0	12.0	< 10.0	490.0	< 40.0	79.0	16.0	1.0	1100.0
ND86-3B	51.0	10.0	27.0	34.0	< 2.0	10.0	< 4.0	28.0	11.0	2.0	< 4.0	23.0	9.0	310.0	8.0	< 10.0	270.0	< 40.0	60.0	12.0	1.0	430.0
ND86-3C	84.0	8.0	44.0	23.0	< 2.0	16.0	< 4.0	46.0	23.0	< 2.0	8.0	38.0	12.0	61.0	14.0	< 10.0	300.0	< 40.0	89.0	19.0	2.0	91.0
ND86-3D	83.0	9.0	39.0	24.0	< 2.0	15.0	< 4.0	46.0	20.0	< 2.0	8.0	40.0	12.0	78.0	13.0	< 10.0	300.0	< 40.0	97.0	20.0	2.0	130.0
ND86-4A	78.0	24.0	46.0	92.0	< 2.0	19.0	< 4.0	44.0	26.0	< 2.0	10.0	40.0	18.0	70.0	19.0	< 10.0	480.0	< 40.0	180.0	23.0	2.0	170.0
ND86-4B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-5A	110.0	15.0	70.0	67.0	< 2.0	18.0	< 4.0	56.0	23.0	8.0	8.0	49.0	28.0	360.0	13.0	< 10.0	270.0	< 40.0	86.0	22.0	2.0	590.0
ND86-5B	110.0	17.0	71.0	47.0	< 2.0	17.0	< 4.0	58.0	22.0	6.0	8.0	50.0	27.0	200.0	14.0	< 10.0	260.0	< 40.0	96.0	25.0	3.0	370.0
ND86-5C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-5D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-6A	47.0	6.0	28.0	21.0	< 2.0	8.0	< 4.0	25.0	12.0	5.0	< 4.0	21.0	13.0	27.0	5.0	< 10.0	270.0	< 40.0	31.0	12.0	1.0	38.0
ND86-6B	58.0	6.0	44.0	35.0	< 2.0	11.0	< 4.0	32.0	15.0	7.0	< 4.0	26.0	19.0	16.0	7.0	< 10.0	220.0	< 40.0	39.0	16.0	1.0	51.0
ND86-6C	60.0	6.0	45.0	34.0	< 2.0	11.0	< 4.0	33.0	15.0	7.0	< 4.0	29.0	19.0	14.0	7.0	< 10.0	220.0	< 40.0	39.0	17.0	1.0	49.0
ND86-7A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-7E	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-8A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-8B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-9A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ND86-10A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Pearl Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-11A	C38	93.5	Mucky Inorg. Txt.	0-1	5.5	< 19.0
NP85-12A	C38	69.4	Inorg. Txt. Muck	0-1	16.8	< 30.0
NP85-13A	C39	61.6	Muck	0-1	62.0	< 52.0
NP85-13B	C39	71.4	Inorg. Txt. Muck	1-2	39.5	< 42.0
NP85-14A	C39	62.9	Muck	0-1	23.9	< 32.0
NP85-14B	C39	85.0	Inorg. Txt. Muck	1-2	16.3	< 26.0
NP85-27A	C40	93.7	Mucky Inorg. Txt.	0-1	4.5	< 14.0
NP85-27B	C40	96.7	Inorg. Txt.	1-2	4.4	< 21.0
NP85-28A	C40	62.2	Muck	0-1	42.5	< 48.0
NP85-28B	C40	88.9	Mucky Inorg. Txt.	1-2	13.2	< 27.0
NP85-28C	C40	92.8	Mucky Inorg. Txt.	2-3	9.9	< 23.0

Pearl Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-28D	C40	88.6	Mucky Inorg. Txt.	3-4	19.3	< 31.0
NP85-28E	C40	92.0	Mucky Inorg. Txt.	4-5	8.2	< 22.0
NP85-29A	C37	81.1	Inorg. Txt. Muck	0-1	3.8	< 23.0
NP85-29B	C37	88.3	Mucky Inorg. Txt.	1-2	5.1	< 22.0
NP85-29C	C37	90.0	Mucky Inorg. Txt.	2-3	7.7	< 23.0
NP85-29D	C37	94.1	Mucky Inorg. Txt.	3-4	2.7	< 21.0
NP85-30A	C36	91.3	Mucky Inorg. Txt.	0-1	3.6	< 22.0
NP85-31A	C35	88.0	Mucky Inorg. Txt.	0-1	7.0	< 21.0
NP85-31B	C35	92.7	Mucky Inorg. Txt.	1-2	10.1	< 24.0
NP85-31C	C35	95.6	Inorg. Txt.	2-3	5.1	< 20.0
NP85-31D	C35	98.7	Inorg. Txt.	3-4	3.1	23.0

Pikes Peak Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)	Al (%)	Ca (%)	Fe (%)	K (%)	Mg (%)	Na (%)	P (%)	Ti (%)	Mn (ppm)	Ag (ppm)	As (ppm)	Au (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Cd (ppm)
PU85-1A	B36	90.0	Mucky Inorg. Txt.	0-1	4.6	23.1	5.90	0.32	1.90	3.50	0.25	1.70	0.09	0.19	280.0	< 2.0	< 10.0	< 8.0	670.0	4.0	< 10.0	< 2.0
PU85-2A	B33	31.4	Peaty Muck	0-1	4.4	9.6	2.10	0.58	0.80	0.67	0.24	0.36	0.08	0.10	76.0	< 2.0	< 10.0	< 8.0	200.0	5.0	< 10.0	< 2.0
PU85-2B	B33	49.8	Muck	1-2	4.5	19.3	3.30	0.44	0.51	1.70	0.14	0.76	0.06	0.11	77.0	< 2.0	< 10.0	< 8.0	450.0	3.0	< 10.0	< 2.0
PU85-2C	B33	91.9	Mucky Inorg. Txt.	2-3	6.8	27.6	5.90	0.32	0.78	3.90	0.16	1.60	0.03	0.16	130.0	< 2.0	< 10.0	< 8.0	880.0	4.0	< 10.0	< 2.0
PU85-3A	B34	57.4	Muck	0-1	44.0	< 14.0	3.70	0.67	1.20	1.30	0.32	0.61	0.10	0.15	220.0	< 2.0	< 10.0	< 8.0	180.0	8.0	< 10.0	4.0
PU85-4A	B35	52.6	Muck	0-1	23.0	34.7	3.20	0.48	1.60	1.00	0.30	0.49	0.07	0.16	120.0	< 2.0	< 10.0	< 8.0	210.0	4.0	< 10.0	2.0
PU85-4B	B35	70.5	Inorg. Txt. Muck	1-2	30.1	60.4	5.00	0.48	2.10	1.60	0.33	0.82	0.06	0.22	200.0	< 2.0	< 10.0	< 8.0	300.0	7.0	< 10.0	< 2.0
PU85-4C	B35	71.0	Inorg. Txt. Muck	2-3	28.4	62.3	5.00	0.45	2.30	1.60	0.33	0.81	0.05	0.23	210.0	< 2.0	< 10.0	< 8.0	300.0	8.0	< 10.0	< 2.0
PU85-4D	B35	76.3	Inorg. Txt. Muck	3-4	32.6	47.0	5.00	0.38	2.30	1.30	0.32	0.62	0.04	0.18	170.0	< 2.0	< 10.0	< 8.0	270.0	10.0	< 10.0	< 2.0
PU85-4E	B35	81.0	Inorg.txt. muck	4-5	27.0	55.1	5.20	0.36	2.50	1.40	0.34	0.66	0.04	0.20	190.0	< 2.0	< 10.0	< 8.0	310.0	12.0	< 10.0	< 2.0
PU85-4F	B35	78.4	Inorg. Txt. Muck	5-6	36.9	61.2	5.60	0.38	2.70	1.30	0.36	0.58	0.05	0.20	190.0	< 2.0	< 10.0	< 8.0	310.0	13.0	< 10.0	< 2.0
PU85-4G	B35	77.5	Inorg. Txt. Muck	6-7	40.9	71.4	5.90	0.39	2.90	1.40	0.39	0.57	0.07	0.20	190.0	< 2.0	< 10.0	< 8.0	310.0	15.0	< 10.0	2.0
PU85-4H	B35	76.4	Inorg. Txt. muck	7-8	52.2	75.5	5.80	0.38	3.10	1.10	0.36	0.44	0.07	0.17	180.0	< 2.0	< 10.0	< 8.0	250.0	17.0	< 10.0	2.0
PU85-4I	B35	77.2	Inorg. Txt. Muck	8-9	50.2	81.3	6.00	0.35	3.90	1.20	0.36	0.48	0.08	0.19	200.0	< 2.0	< 10.0	< 8.0	260.0	18.0	< 10.0	2.0
PU85-4J	B35	77.4	Inorg. Txt. muck	9-10	45.3	67.5	5.20	0.31	4.10	1.10	0.32	0.44	0.07	0.16	190.0	< 2.0	< 10.0	< 8.0	230.0	16.0	< 10.0	< 2.0
PU85-4K	B35	76.8	Inorg. Txt. Muck	10-11	51.5	81.7	6.00	0.34	5.20	1.10	0.34	0.43	0.08	0.16	200.0	< 2.0	< 10.0	< 8.0	240.0	21.0	< 10.0	2.0
PU85-4L	B35	77.5	Inorg. Txt. Muck	11-12	40.3	58.2	5.90	0.38	3.60	1.50	0.37	0.65	0.07	0.20	220.0	< 2.0	< 10.0	< 8.0	310.0	14.0	< 10.0	2.0
PU85-4M	B35	89.1	Mucky Inorg. Txt.	12-13	30.5	58.1	7.10	0.40	4.70	2.50	0.49	1.10	0.08	0.29	350.0	< 2.0	< 10.0	< 8.0	480.0	13.0	< 10.0	< 2.0
PU85-4N	B35	88.2	Mucky Inorg. Txt.	13-14	26.1	52.1	6.70	0.36	4.30	2.10	0.46	0.98	0.06	0.24	300.0	< 2.0	< 10.0	< 8.0	390.0	14.0	< 10.0	< 2.0
PU85-4O	B35	86.7	Mucky Inorg. Txt.	14-15	30.0	47.0	6.70	0.40	4.30	2.10	0.49	0.86	0.07	0.24	350.0	< 2.0	< 10.0	< 8.0	460.0	16.0	< 10.0	< 2.0
PU85-4P	B35	86.4	Mucky Inorg. Txt.	15-16	25.8	52.1	6.50	0.42	3.90	1.90	0.53	0.82	0.06	0.24	300.0	< 2.0	< 10.0	< 8.0	430.0	15.0	< 10.0	< 2.0
PU85-10A	B37	57.3	Muck	0-1	5.5	26.2	5.20	0.87	2.30	1.10	0.50	0.37	0.12	0.19	360.0	< 2.0	< 10.0	< 8.0	980.0	5.0	< 10.0	< 2.0
PU85-10B	B37	75.9	Inorg. Txt. Muck	1-2	8.6	36.8	6.10	0.84	2.00	1.70	0.47	0.77	0.08	0.26	260.0	< 2.0	< 10.0	< 8.0	990.0	5.0	< 10.0	< 2.0
PU85-10C	B37	88.2	Mucky Inorg. Txt.	2-3	8.9	34.9	6.40	0.64	1.40	2.30	0.39	1.10	0.05	0.26	150.0	< 2.0	< 10.0	< 8.0	940.0	5.0	< 10.0	< 2.0
PU85-11A	B38	67.6	Inorg. Txt. Muck	0-1	46.1	95.8	5.90	0.59	1.90	1.80	0.28	1.10	0.10	0.25	260.0	< 2.0	< 10.0	< 8.0	410.0	18.0	< 10.0	< 2.0
PU85-11B	B38	40.5	Peaty Muck	1-2	3.9	21.3	4.20	0.74	1.20	0.55	0.36	0.15	0.10	0.12	86.0	< 2.0	< 10.0	< 8.0	360.0	2.0	< 10.0	< 2.0
PU85-12A	B38	85.0	Inorg. Txt. Muck	0-1	26.2	90.1	7.20	0.50	2.80	3.00	0.28	1.90	0.07	0.30	640.0	< 2.0	< 10.0	< 8.0	630.0	13.0	< 10.0	< 2.0
PU85-12B	B38	61.2	Muck	1-2	23.1	60.0	4.70	0.42	1.80	1.70	0.20	0.99	0.12	0.15	250.0	< 2.0	< 10.0	< 8.0	260.0	15.0	< 10.0	< 2.0
PU86-12A	B39	62.6	Muck	0-1	5.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12B	B39	53.3	Muck	1-2	5.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12C	B39	46.2	Muck	2-3	6.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12D	B39	56.0	Muck	3-4	5.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12E	B39	66.0	Inorg. Txt. Muck	4-5	7.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12F	B39	80.6	Inorg. Txt. Muck	5-6	9.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
PU85-1A	130.0	2.0	15.0	8.0	< 2.0	19.0	< 4.0	78.0	27.0	3.0	---	58.0	6.0	26.0	6.0	< 20.0	86.0	< 40.0	22.0	39.0	4.0	79.0
PU85-2A	130.0	2.0	14.0	13.0	< 2.0	7.0	< 4.0	64.0	12.0	< 2.0	---	64.0	8.0	16.0	4.0	< 20.0	57.0	< 40.0	19.0	39.0	4.0	45.0
PU85-2B	160.0	1.0	14.0	8.0	< 2.0	9.0	< 4.0	81.0	9.0	< 2.0	---	77.0	8.0	16.0	4.0	< 20.0	68.0	< 40.0	16.0	46.0	5.0	26.0
PU85-2C	140.0	2.0	10.0	6.0	< 2.0	17.0	< 4.0	96.0	21.0	< 2.0	---	86.0	6.0	29.0	5.0	< 20.0	100.0	< 40.0	11.0	47.0	5.0	60.0
PU85-3A	210.0	2.0	18.0	12.0	2.0	17.0	9.0	100.0	27.0	9.0	---	130.0	7.0	110.0	7.0	< 20.0	57.0	< 40.0	35.0	320.0	35.0	410.0
PU85-4A	260.0	2.0	14.0	15.0	4.0	11.0	16.0	200.0	41.0	5.0	---	260.0	9.0	37.0	6.0	< 20.0	51.0	< 40.0	19.0	530.0	49.0	480.0
PU85-4B	380.0	3.0	16.0	13.0	5.0	16.0	21.0	290.0	74.0	4.0	---	350.0	10.0	38.0	9.0	< 20.0	64.0	< 40.0	25.0	690.0	65.0	590.0
PU85-4C	380.0	3.0	18.0	13.0	5.0	16.0	21.0	290.0	77.0	4.0	---	350.0	10.0	36.0	9.0	< 20.0	64.0	< 40.0	27.0	680.0	64.0	560.0
PU85-4D	360.0	4.0	14.0	12.0	5.0	15.0	24.0	290.0	74.0	8.0	---	380.0	12.0	33.0	9.0	< 20.0	56.0	< 40.0	26.0	780.0	76.0	680.0
PU85-4E	340.0	4.0	17.0	13.0	5.0	14.0	22.0	260.0	79.0	5.0	---	340.0	12.0	33.0	9.0	< 20.0	63.0	< 40.0	28.0	730.0	70.0	670.0

Pikes Peak Quadrangle (continued)

Sample No.	Ce (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Eu (ppm)	Ga (ppm)	Ho (ppm)	La (ppm)	Li (ppm)	Mo (ppm)	Nb (ppm)	Nd (ppm)	Ni (ppm)	Pb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ta (ppm)	V (ppm)	Y (ppm)	Yb (ppm)	Zn (ppm)
PU85-4F	380.0	4.0	16.0	14.0	6.0	15.0	30.0	310.0	87.0	5.0	---	440.0	13.0	34.0	10.0	< 20.0	61.0	< 40.0	30.0	960.0	96.0	830.0
PU85-4G	380.0	4.0	12.0	16.0	7.0	15.0	34.0	340.0	90.0	6.0	---	490.0	15.0	40.0	11.0	< 20.0	64.0	< 40.0	31.0	1100.0	110.0	870.0
PU85-4H	370.0	4.0	14.0	17.0	8.0	14.0	39.0	330.0	92.0	8.0	---	510.0	15.0	33.0	10.0	< 20.0	55.0	< 40.0	28.0	1200.0	130.0	930.0
PU85-4I	420.0	4.0	14.0	18.0	8.0	15.0	41.0	360.0	98.0	7.0	---	550.0	15.0	41.0	11.0	< 20.0	55.0	< 40.0	28.0	1300.0	130.0	920.0
PU85-4J	340.0	4.0	14.0	16.0	7.0	13.0	33.0	290.0	75.0	9.0	---	440.0	13.0	31.0	9.0	< 20.0	49.0	< 40.0	25.0	1000.0	110.0	800.0
PU85-4K	400.0	4.0	14.0	18.0	9.0	14.0	43.0	360.0	87.0	18.0	---	570.0	15.0	36.0	11.0	< 20.0	49.0	< 40.0	25.0	1300.0	140.0	1000.0
PU85-4L	360.0	4.0	13.0	18.0	6.0	17.0	30.0	310.0	93.0	9.0	---	420.0	12.0	38.0	10.0	< 20.0	58.0	< 40.0	26.0	940.0	98.0	900.0
PU85-4M	380.0	5.0	13.0	18.0	5.0	23.0	20.0	270.0	99.0	10.0	---	320.0	13.0	45.0	12.0	< 20.0	86.0	< 40.0	33.0	640.0	64.0	710.0
PU85-4N	340.0	5.0	10.0	16.0	4.0	22.0	13.0	230.0	93.0	14.0	---	250.0	14.0	42.0	10.0	< 20.0	67.0	< 40.0	30.0	430.0	43.0	820.0
PU85-4O	330.0	6.0	13.0	17.0	4.0	20.0	16.0	240.0	92.0	17.0	---	290.0	13.0	40.0	11.0	< 20.0	79.0	< 40.0	33.0	530.0	52.0	760.0
PU85-4P	330.0	7.0	13.0	18.0	4.0	20.0	15.0	240.0	89.0	23.0	---	280.0	14.0	39.0	11.0	< 20.0	77.0	< 40.0	35.0	480.0	45.0	670.0
PU85-10A	150.0	5.0	17.0	24.0	< 2.0	15.0	< 4.0	110.0	34.0	< 2.0	---	99.0	14.0	29.0	9.0	< 20.0	96.0	< 40.0	46.0	72.0	7.0	140.0
PU85-10B	180.0	4.0	19.0	14.0	< 2.0	17.0	< 4.0	130.0	37.0	< 2.0	---	120.0	12.0	21.0	10.0	< 20.0	120.0	< 40.0	44.0	89.0	9.0	110.0
PU85-10C	220.0	3.0	19.0	13.0	< 2.0	18.0	< 4.0	150.0	35.0	< 2.0	---	130.0	9.0	22.0	10.0	< 20.0	120.0	< 40.0	46.0	100.0	11.0	91.0
PU85-11A	830.0	3.0	20.0	19.0	2.0	24.0	16.0	500.0	70.0	7.0	---	470.0	9.0	43.0	17.0	< 20.0	81.0	< 40.0	26.0	460.0	49.0	240.0
PU85-11B	130.0	3.0	27.0	23.0	< 2.0	12.0	< 4.0	120.0	20.0	2.0	---	120.0	11.0	20.0	10.0	< 20.0	72.0	< 40.0	40.0	50.0	4.0	77.0
PU85-12A	590.0	3.0	15.0	11.0	< 2.0	30.0	9.0	350.0	110.0	5.0	---	300.0	6.0	44.0	14.0	< 20.0	280.0	< 40.0	25.0	240.0	29.0	220.0
PU85-12B	580.0	2.0	13.0	13.0	< 2.0	17.0	10.0	310.0	53.0	8.0	---	300.0	7.0	26.0	9.0	< 20.0	97.0	< 40.0	20.0	310.0	34.0	140.0
PU86-12A	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12B	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12C	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12D	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12E	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
PU86-12F	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Pitchpine Mountain Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-3A	C46	88.3	Mucky Inorg. Txt.	0-1	56.7	< 13.0
NP85-3B	C46	96.3	Inorg. Txt.	1-2	25.2	27.4
NP85-4A	C45	61.6	Muck	0-1	11.2	< 6.9
NP85-4B	C45	90.6	Mucky Inorg. Txt.	1-2	9.8	16.9
NP85-5A	C45	89.2	Mucky Inorg. Txt.	0-1	12.0	< 5.2
NP85-5B	C45	83.1	Inorg. Txt. Muck	1-2	17.6	< 7.2
NP85-6A	C44	70.7	Inorg. Txt. Muck	0-1	27.8	< 9.0
NP85-6B	C44	92.6	Mucky Inorg. Txt.	1-2	18.4	< 5.8
NP85-7A	C43	70.3	Inorg. Txt. Muck	0-1	16.3	< 6.6
NP85-7B	C43	81.6	Inorg. Txt. Muck	1-2	25.4	< 7.7
NP85-7C	C43	96.8	Inorg. Txt.	2-3	8.4	< 3.7
NP85-7D	C43	98.3	Inorg. Txt.	3-4	6.2	< 3.0
NP85-8A	C42	93.4	Mucky Inorg. Txt.	0-1	4.8	7.9

Red Feather Lakes Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
RF83-6A	C12	---	Peaty Muck	0-1	22.8	< 8.3
RF83-6B	C12	---	Muck	1-2	19.8	< 7.0
RF83-8A	C11	---	Peaty Muck	0-1	104.0	< 27.0
RF83-9A	C10	---	Peaty Muck	0-1	42.8	84.0
RF83-9B	C10	---	Muck	1-2	70.5	84.5
RF83-10A	C8	---	Mucky Inorg. Txt.	0-1	192.0	< 40.0
RF83-10B	C8	---	Inorg. Txt.	1-2	65.5	< 16.0
RF83-11A	C9	---	Inorg. Txt. Muck	0-1	12.8	27.4
RF83-11B	C9	---	Inorg. Txt.	1-2	25.8	48.7
RF83-12A	C6	---	Peaty Muck	0-1	70.1	< 22.0
RF83-13A	C6	---	Peaty Muck	0-1	57.7	74.1
RF83-14A	C7	---	Muck	0-1	28.6	49.0
RF83-15A	C13	---	Muck	0-1	7.5	22.6
RF83-16A	C13	---	Mucky Inorg. Txt.	0-1	36.2	< 14.0
RF83-17A	C14	---	Muck	0-1	25.5	53.4

Red Feather Lakes Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
RF83-18A	C15	---	Peaty Muck	0-1	49.9	107.0
RF83-18B	C15	---	Mucky Inorg. Txt.	1-2	22.5	41.2
RF83-19A	C16	---	Peaty Muck	0-1	50.1	87.6
RF83-19B	C16	---	Peaty Muck	1-2	77.0	145.0
RF83-19C	C16	---	Muck	2-3	46.9	60.9
RF83-20A	C16	---	Peaty Muck	0-1	89.0	133.0
RF83-21A	C16	---	Inorg. Txt. Muck	0-1	87.0	111.0
RF83-21B	C16	---	Inorg. Txt. Muck	1-2	50.4	87.4
RF83-21C	C16	---	Inorg. Txt.	2-3	20.1	< 8.5
RF83-22A	C5	---	Inorg. Txt.	0-1	7.0	19.6
RF83-23A	C1	---	Inorg. Txt.	0-1	9.9	16.4
RF83-24A	C2	---	Peaty Muck	0-1	83.9	< 25.0
RF83-25A	C3	---	Peaty Muck	0-1	106.0	129.0
RF83-26A	C4	---	Inorg. Txt. Muck	0-1	19.4	77.3
RF83-27A	C4	---	Mucky Inorg. Txt.	0-1	66.6	< 18.0
RF83-28A	C4	---	Muck	0-1	238.0	< 55.0

Teal Lake Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
NP85-2A	C47	92.5	Mucky Inorg. Txt.	0-1	5.3	11.2
NP85-2B	C47	96.6	Inorg. Txt.	1-2	5.6	13.9

Ward Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)
WD86-1A	A7	91.7	Mucky Inorg. Txt.	0-1	3.8
WD86-1B	A7	94.0	Mucky Inorg. Txt.	1-2	3.7
WD86-1C	A7	95.0	Mucky Inorg. Txt.	2-3	4.1
WD86-2A	A6	64.4	Muck	0-1	3.2
WD86-2B	A6	71.2	Inorg. Txt. Muck	1-2	3.1
WD86-3A	A6	82.2	Inorg. Txt. Muck	0-1	3.6
WD86-4A	A5	87.2	Mucky Inorg. Txt.	0-1	5.3
WD86-4B	A5	95.6	Inorg. Txt.	1-2	4.1
WD86-5A	A5	85.0	Inorg. Txt. Muck	0-1	3.5
WD86-6A	A4	20.3	Peat	0-1	5.0
WD86-6B	A4	20.5	Peat	1-2	0.7
WD86-6C	A4	18.9	Peat	2-3	1.0
WD86-6D	A4	35.8	Peaty Muck	3-4	2.9
WD86-6E	A4	25.7	Peaty Muck	4-5	3.6
WD86-6F	A4	79.6	Inorg. Txt. Muck	5-6	0.8

Rustic Quadrangle

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)	Th (ppm)
RF83-1A	C23	---	Inorg. Txt.	0-1	21.0	31.3
RF83-1B	C23	---	Inorg. Txt.	1-2	10.3	13.6
RF83-2A	C23	---	Inorg. Txt. Muck	0-1	28.7	32.3
RF83-3A	C22	---	Peaty Muck	0-1	15.5	47.8
RF83-3B	C22	---	Inorg. Txt.	1-2	15.3	52.4
RF83-4A	C21	---	Peaty Muck	0-1	87.1	< 21.0
RF83-4B	C21	---	Muck	1-2	51.6	< 13.0
RF83-5A	C20	---	Mucky Inorg. Txt.	0-1	18.8	19.3
RF83-7A	C19	---	Muck	0-1	19.4	21.0
RF83-7B	C19	---	Peaty Muck	1-2	19.7	< 8.9
RF83-7C	C19	---	Peaty Muck	2-3	18.4	< 7.2
RF83-7D	C19	---	Muck	3-4	17.4	18.8
NP85-34A	C24	59.1	Muck	0-1	15.4	< 34.0
NP85-34B	C24	46.8	Muck	1-2	14.6	< 37.0
NP85-34C	C24	68.8	Inorg. Txt. Muck	2-3	16.3	< 33.0
NP85-34D	C24	87.7	Mucky Inorg. Txt.	3-4	12.6	< 23.0
NP85-34E	C24	92.6	Mucky Inorg. Txt.	4-5	16.7	< 23.0
NP85-35A	C25	93.8	Mucky Inorg. Txt.	0-1	5.0	< 22.0
NP85-35B	C25	95.0	Mucky Inorg. Txt.	1-2	8.7	< 20.0
NP85-35C	C25	93.9	Mucky Inorg. Txt.	2-3	13.0	< 21.0

Ward Quadrangle (continued)

Sample No.	Map No.	% ash	Sample description	Sample depth	U (ppm)
WD86-7A	A2	49.9	Muck	0-1	4.6
WD86-7B	A2	33.0	Peaty Muck	1-2	3.0
WD86-7C	A2	15.6	Peat	2-3	1.8
WD86-7D	A2	17.2	Peat	3-4	3.7
WD86-7E	A2	40.2	Peaty Muck	4-5	8.9
WD86-8A	A3	52.7	Muck	0-1	10.3
WD86-9A	A3	68.9	Inorg. Txt. Muck	0-1	10.7
WD86-9B	A3	70.7	Inorg. Txt. Muck	1-2	10.4

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