MASTER

**POCATELLO 1° x 2° NTMS AREA
IDAHO**

DATA REPORT

**NATIONAL URANIUM RESOURCE
EVALUATION PROGRAM**

**HYDROGEOCHEMICAL AND STREAM
SEDIMENT RECONNAISSANCE**

by

J. R. COOK

Approved by

M. L. Hyder
Analytical Chemistry Division

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**E. I. du Pont de Nemours & Co.
Savannah River Laboratory
Aiken, SC 29808**

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This report is released without standard editorial and technical review in order to make the information available as soon as possible to interested organizations and to assist the search for uranium resources.

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ABSTRACT

This data report presents results of ground water and stream/surface sediment reconnaissance in the National Topographic Map Series (NTMS) Pocatello 1° x 2° quadrangle. Surface samples (sediment) were collected from 1701 sites. The target sampling density was one site per 16 square kilometers (six square miles). Ground water samples were collected at 381 sites. Neutron activation analysis (NAA) results are given for uranium and 16 other elements in sediments, and for uranium and 9 other elements in ground water. Mass spectrometry results are given for helium in ground water. Field measurements and observations are reported for each site. Analytical data and field measurements are presented in tables and maps. Statistical summaries of data and a brief description of results are given. A generalized geologic map and a summary of the geology of the area are included.

Data from sediment sites (on microfiche in pocket) include (1) stream water chemistry measurements where applicable (pH, conductivity, and alkalinity), and (2) elemental analyses for sediment samples (U, Th, Hf, Al, Ce, Dy, Eu, Fe, La, Lu, Mn, Sc, Sm, Na, Ti, V, and Yb). Sample site descriptors (stream characteristics, vegetation, etc.) are also tabulated. Areal distribution maps, histograms, and cumulative frequency plots for most elements; U/Th, U/Hf, and U/La ratios; and scintillometer readings for sediment sample sites are included on the microfiche.

Data from ground water sites (on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity), (2) physical measurements where applicable (water temperature, well description, and scintillometer reading), and (3) elemental analyses (U, Al, Br, Cl, Dy, F, He, Mg, Mn, Na, and V).

Data from stream water sites (also on microfiche in pocket) include (1) water chemistry measurements (pH, conductivity, and alkalinity) and (2) elemental analyses (U, Al, Br, Cl, F, Mg, Mn, Na, and V).

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USER'S GUIDE

DATA REPORT: POCATELLO 1° x 2° NTMS QUADRANGLE:
IDAHO

INTRODUCTION

The National Uranium Resource Evaluation (NURE) program was established to evaluate domestic uranium resources in the continental United States and to identify areas favorable for uranium exploration. The Grand Junction Office (GJO) of the Department of Energy (DOE) is responsible for administering and coordinating NURE program efforts. The Savannah River Laboratory (SRL) has responsibility for hydrogeochemical and stream/surface sediment reconnaissance (HSSR) of 3.9 million square kilometers (1,500,000 square miles) in 37 eastern and western states. Other DOE laboratories are responsible for similar reconnaissance in the rest of the continental United States, including Alaska. The significance of the distribution of uranium in natural waters and sediments will be assessed as an indicator of areas favorable for the location of uranium deposits.

The principal objectives of the NURE program are:

- Increase geologic knowledge of U.S. uranium resources in regions where uranium ore bodies are known to exist and are candidate supplies under present and near-term market conditions.
- Complete assessment of lower cost potential uranium resources in the conterminous U.S. and Alaska.
- Improve reliability and validate resource estimates and increase confidence levels.
- Expand scope of uranium assessment to include higher cost and relatively unknown domestic resources that may be feasible uranium supply alternatives.
- Apply advanced technologies for detection and assessment of uranium resources.

DOE-GJO is responsible for administering and coordinating efforts to meet these objectives, including distribution of reports. Inputs to the NURE program come from DOE prime

contractors, DOE-sponsored research and development, the uranium industry, U.S. Geologic Survey, U.S. Bureau of Mines, other federal and state government agencies, and independent sources.

The NURE program consists of six parts:

1. Hydrogeochemical and Stream Sediment Reconnaissance Survey
2. Aerial Radiometric Survey
3. Intermediate-Grade Resource Studies
4. World-Class Geologic Studies
5. Subsurface Geologic Investigation
6. Technology Application

The data presented here are reconnaissance data intended for use in identifying broad areas for further study. While care has been taken to provide reliable sampling and analyses, verification of individual analyses is beyond the scope of this report. The data should be viewed statistically because "one-point anomalies" may be misleading. Regional trends, however, should be reliable. With careful consideration of regional geology, these data should provide reliable guides to areas warranting further study.

This report is one of a series presenting basic data obtained by SRL reconnaissance. In the interest of disseminating available data as soon as possible, only neutron activation analyses are reported here. Supplementary reports will be issued later. All data will be available on magnetic tape from:

GJOIS Project
UCC-ND Computer Applications Department
4500 North Building
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, TN 37830

A brief description of sampling and analytical procedures and a detailed description of the maps, tables, and figures contained in this report are presented in the SRL document **USER'S GUIDE** included on microfiche. A summary of the SRL development program in support of the reconnaissance is available in SRL-NURE progress reports (SRL-138). SRL data reports (SRL-146) have been open-filed for other western quadrangles (Figure 1).

FIGURE 1. Location Map for the Pocatello 1° x 2° NTMS Quadrangle

GEOLOGIC SUMMARY AND MINERAL OCCURRENCES

Principal Features

The geology of the Pocatello 1° x 2° NTMS quadrangle (hereafter referred to as the quadrangle or study area) is relatively complex (Plate 1) as it contains characteristics of two main physiographic provinces (Plate 2 and Figure 2). The northwestern part of the quadrangle lies within the Snake River Plain Province and is an area of flat rolling topography built on geologically recent basalt flows. The remainder of the quadrangle lies within the Basin and Range Province and consists of north-trending mountain ranges and intervening valleys. Range-front normal faults form the border between mountains and alluvial-filled valleys, and subsidiary faults cut the geology of the ranges into an intricate pattern. The principal ranges listed in order from west-to-east are: Albion Range, Sublett Range, Deep Creek Mountains, Bannock Range, Malad Range, and Portneuf Range.

Regional Geologic Setting

The Pocatello 1° x 2° NTMS quadrangle contains rocks ranging in age from 2.7 billion-year-old gneisses to recent volcanics and alluvium. Several major deformational, metamorphic, and plutonic events occurred at times throughout this history. Although published geologic reports date back 100 years to the Hayden survey, many aspects of the regional geology of the Pocatello quadrangle remain unclear, as details still need to be clarified in many areas.

The Precambrian gneisses and granites of the North American Cordillera are overlain by locally thick sequences of sediments, meta-sediments, and volcanics which are presumably related to a late Precambrian rifting in western North America (King, P. B., 1977; Burchfiel and Davis, 1975). By latest Precambrian and earliest Paleozoic Eras, a classical geosynclinal sequence was established with the basal unit reflecting a transgression from west-to-east and overlapping the craton (Burchfiel and Davis, 1975; Armstrong and Oriel, 1965). An unbroken Paleozoic wedge of sediments in southeastern Idaho thickens westward from a miogeosynclinal/continental platform facies where the pile is about 3,000 m (10,000 ft) thick (Armstrong and Oriel, 1965) over a west-dipping basement (Royse and others, 1975). Armstrong (1968) estimated a thickness of Paleozoic rocks over the Albion Range

FIGURE 2. Location Map of the Pocatello Quadrangle on a Physiographic Province Map

during peak Mesozoic metamorphism as 15,000 m (50,000 ft). West of this region, tectonism occurred during the latter part of the Paleozoic Era (Burchfiel and Davis, 1975). Marine phosphorites and associated chert blanketed the miogeosyncline during Permian time and are thickest in southeastern Idaho, southwestern Montana, and adjoining parts of Wyoming and Utah (McKelvey and Carswell, 1956).

The miogeosyncline began breaking up during the Mesozoic Era in a progression from west-to-east. A nearly continuous section from Jurassic shallow marine limestones to Cretaceous molasse exists in southeastern Idaho (Huntsman, 1978). West-to-east thrusting began during Jurassic-earliest Cretaceous (Oriel and Armstrong, 1966) within the Idaho-Wyoming thrust belt east of the Pocatello quadrangle. North and west of here, extensive batholith emplacement occurred during the late Cretaceous (Armstrong and others, 1977).

Extensive volcanism affected Idaho and parts of adjacent states during early Tertiary time, producing the Challis volcanics (Armstrong, 1974; Huntsman, 1978). Mineralization accompanied this volcanism. By mid-Tertiary times, erosion removed part of the Challis sequence, and block-faulting and volcanism began during the Miocene epoch (Armstrong and others, 1975; Proffett, 1977). During the latter part of the Cenozoic, the Snake River Plain became the locus of multiple sequences of thin lava flows which eventually developed into the broad features of today (King, J. S., 1977). Protska and others (1976) propose that much of the Cenozoic tectonism of the Cordillera resulted from interaction between a rising mantle plume of uranium- and thorium-rich material and oceanic crust subducted during the late Mesozoic Era.

Description of Map Units

Precambrian

The oldest rocks exposed in the Pocatello 1° x 2° NTMS quadrangle belong to the Green Creek Complex [2700 million years before the present (Myr BP)], an area of mantled gneiss domes located in the Albion Range. The most widespread rock is a porphyroblastic granitic gneiss with layers, lenses, and pods of schist, quartzite, and amphibolite (metamorphosed Paleozoic sediments) mantling the gneiss (Armstrong, 1968; 1976). Later granitic intrusions are either concordant, strongly deformed, mylonitic flaser gneisses or completely undeformed discordant stocks and pegmatite dikes (Armstrong, 1976). Metamorphic grade in the Green Creek Complex decreases towards the east and corresponds to a decrease in stratigraphic depth (Armstrong, 1968; 1976).

Thick quartzites, mica schists, graphitic schists with interbedded carbonates, and calcareous schists mantle the gneiss domes (Armstrong, 1968; Anderson, 1931). Metamorphic grade, structural complexity, and lack of useful fossils inhibit correlation with other Paleozoic strata in the Pocatello quadrangle (Armstrong, 1970).

Available isotopic data reveal three main thermal events during the history of the Albion Range (Armstrong, 1976):

- 1) 2.45 to 2.7 Myr BP: emplacement of granites into sediments (now granitic gneiss);
- 2) 2.0 Myr BP: mafic intrusion, high grade metamorphism, and metamorphic differentiation;
- 3) 100 Myr BP: low-grade metamorphism.

Initial Sr-87/Sr-86 ratios range from 0.7055 for a biotite adamellite gneiss, to 0.930 for a granitic gneiss. Pegmatites (whole-rock Rb/Sr age of 60 ± 4 million years) in the highest-grade metamorphic rocks have Rb/Sr ratios of 2.17 to 11.8, and initial Sr-87/Sr-86 ratios of 0.7244 to 0.7350. Rb/Sr ratios in the Paleozoic schists are 0.61 to 4.8; initial Sr-87/Sr-86 ratios are 0.717 to 0.8115. Anomalous values could be explained by ingestion of Paleozoic sediments by the intruding Mesozoic granite (initial Sr-87/Sr-86 ratio equals 0.704; Armstrong, 1976).

Other Precambrian metasedimentary rocks in the Pocatello quadrangle comprise a thick sequence of quartzite with interbedded argillite, minor diamictite, greenstone, and slate which grades into overlying Lower Paleozoic strata with apparent conformity (Crittenden and others, 1971; Armstrong and Oriel, 1965). The lower part of this sequence locally contains 300 m (1000 ft) of meta-volcanic flows and breccias with relict porphyritic textures, vesicles, and amygdules (Crittenden and others, 1971). Although Crittenden and others recognize six different Precambrian formations in the Pocatello study area, Oriel (1971) does not recognize these same formations east of the Portneuf Range because of complex lateral facies changes and lack of definite marker units.

Lower Paleozoic

Quartzites, limestones, shales, and dolomites of Cambrian and younger age conformably overlie the Precambrian quartzites (Trimble, 1976; Trimble and Carr, 1976; Oriel, 1971). A distinctive quartzite/sandstone, containing detrital potassium feldspar, marks the youngest Cambrian unit in the region. Ordovician through Devonian strata consist mainly of limestones and dolomites containing stringers or nodules of chert that are interbedded with minor quartzite sandstone and quartzite.

Upper Paleozoic

Basal Mississippian strata in the Pocatello quadrangle locally overlie Devonian or older strata unconformably (Trimble and Carr, 1976). Limestones with chert nodules interbedded with calcareous sandstones, shales, and dolomites characterize Mississippian strata in this region (Platt, 1977; Trimble, 1976; Trimble and Carr, 1976). The Mississippian/Pennsylvanian boundary lies within the Manning Canyon shale, a series of shales and argillites interbedded with limestone, siltstone, sandstone, and quartzite. A limited phosphatic layer locally containing up to 30% phosphorus pentoxide equivalent occurs above and below the quartzite (Trimble and Carr, 1976). The Pennsylvanian/Permian boundary occurs in a series of cherty and sandy limestones interbedded with sandstones and minor marine-chert pebble conglomerate (Platt, 1977; Trimble, 1976; Trimble and Carr, 1976).

Permian strata in the Pocatello quadrangle belong to the Phosphoria Formation, a series of carbonaceous phosphatic shales and overlying cherts. The Phosphoria Formation is only exposed in a few areas in the study area.

Triassic

The only Mesozoic strata reported in the Pocatello 1° x 2° NTMS quadrangle are scattered patches of the Dinwoody Formation of Triassic age (Rember and Bennett, 1979). The Dinwoody Formation is a series of marine shales, limestones, and sandstones.

Tertiary

The oldest Tertiary rock unit is an Eocene-Oligocene granitic intrusive in the southern Albion Range. This unit is composed of granodiorite, adamellite, and associated pegmatites (Armstrong, 1976; Anderson, 1931). Unfoliated except along its westernmost satellitic exposure, this discordant stock yields an isotopic age of 28.3 Myr BP (Armstrong, 1976). Whole rock Rb/Sr ratios are 0.178 to 47.5 for biotite adamellite and muscovite adamellite, respectively (Armstrong, 1976). Whole rock initial Sr-87/Sr-86 ratios are between 0.7082 and 0.765 for the pluton (Armstrong, 1976).

The oldest Tertiary strata in the Pocatello quadrangle belong to the Salt Lake Formation, a sequence of white calcareous to tuffaceous conglomerates, sandstones, and siltstones (Platt, 1977). The Salt Lake Formation, believed to be Pliocene and Miocene in age, contains a diamictite near exposures of older rock (Platt, 1977).

Scattered basalts, rhyolitic ash-flow tuffs, vitrophyres, and rhyolite flows (collectively mapped as Tertiary volcanics) occur in the central and western parts of the Pocatello quadrangle. Correlation of these volcanics with the Salt Lake Formation is difficult (Carr and Trimble, 1963). These Tertiary volcanics may even correlate with the Payette Formation exposed west of the Pocatello quadrangle (Anderson, 1931).

A middle Pliocene sequence of volcanics, the Starlight Formation (Carr and Trimble, 1963), in the American Falls area is divided into three members: A lower rhyolitic tuff with local marl and basalt; a widespread rhyolitic vitric-crystal/ash-flow tuff; and an upper friable rhyolitic tuff and massive pumiceous tuff, breccia, and marl (Trimble and Carr, 1976). The upper member can only be distinguished from the lower member when the intervening ash-fall tuff is present. Locally, on the west side of the Bannock Range, a diamictite unit composed of poorly sorted, angular fragments of quartzite up to 8 m (25 ft) in diameter intertongues with the lower rhyolite flows and represents an alluvial fan deposit contemporaneous with the rhyolite flows (Trimble, 1976).

Tertiary and Quaternary

A series of tuffaceous sandstones, tuffs, basalts, and siltstones overlies the Starlight Formation with slight angular discordance (Carr and Trimble, 1963). Basal tuffaceous clayey sandstones and tuff are successively overlain by an unbedded friable tuff and a sequence of friable rhyolitic tuffs and welded tuffs. These tuffs have uniform perfect bedding and contain freshwater sponge spicules. Carr and Trimble (1963) suggest accumulation of volcanic ash in a quiet lake or pond for the origin of this unit. Overlying the friable tuffs is a thin gravel deposit which in turn is overlain by interbedded basaltic and rhyolitic tuffs that also represent freshwater deposition (Trimble and Carr, 1976; Carr and Trimble, 1963). Basaltic tuffs, flows, and breccias appear above the freshwater tuffs with slight angular discordance. The youngest unit in the Tertiary-Quaternary sequence consists of largely fluviatile silts and sands with local cross-bedding, a few rhyolites, and calcareous nodules and thick caliche within the upper units (Trimble and Carr, 1976; Carr and Trimble, 1963).

Quaternary-Tertiary

The youngest volcanic rocks mapped in the Pocatello 1° x 2° NTMS quadrangle were found in the Snake River Plain. These consist of olivine-bearing basaltic cinder cones, flows, and craters

with characteristic ropy surfaces (pahoehoe) and many pressure ridges. These volcanics are slightly discordant to the underlying fluvial deposits. The age of the volcanics is from Pliocene to Recent; some yield Carbon-14 ages of 33,000 $\pm$ 1600 years or less (Greeley, 1977; Trimble, 1976). Overall, the Snake River Plain basalts consist of multiple, typically thin, flows from either fissures or low-shield volcanoes (Greeley, 1977).

Quaternary

The oldest non-volcaniclastic sediments of Quaternary age in the Pocatello quadrangle are the silts of pluvial Lake Bonneville. Silts and sands with an irregular veneer of loess grade into colluvium and beach gravels along valley margins (Platt, 1977). This unit only occurs in the southeastern part of the quadrangle.

The flood deposits of Lake Bonneville consist of pebbly silt, sand, and gravel that are part of a deltaic sequence deposited during a catastrophic flood during the middle or late Quaternary (Carr and Trimble, 1963). The deposits become coarser-grained eastward from the area around American Falls to the town of Pocatello along the Snake River.

Units mapped as colluvium include colluvium, gravels, terrace deposits, range-front deposits, travertine, fill, and boulder deposits. Gravels are of mixed lithologies and contain boulders up to 2-1/2 m (8 ft) in diameter. Terrace deposits include silt, pebbly sand, and gravel reworked from older deposits. Travertine-cemented conglomerates, breccia, and travertine occur near Tertiary volcanics and along fault scarps. Anderson (1931) described till, moraines, and other outwash partly buried by younger deposits, and younger till found at elevations greater than 2300 m (7500 ft). Other evidence of local mountain glaciation and periglacial activity is widespread (Trimble, 1976; Trimble and Carr, 1976; Armstrong, 1968; Carr and Trimble, 1963).

Units mapped as alluvium include all alluvium younger than recognized terrace deposits and consist of pebbly gravels, sands, and reworked gravels. Alluvium also covers small valley floors. Holocene dune sand of local provenance is included as alluvium and is still active. Loess (consisting of poorly indurated, very well-sorted, uniform silt that caps recent basalts as well as older rocks) also is mapped as alluvium. Loess thins close to mountain fronts and generally is absent above 1800 m (5800 ft) elevation (Trimble, 1976; Trimble and Carr, 1976; Carr and Trimble, 1963).

Structure and Tectonics

The structures of the Pocatello 1° x 2° NTMS quadrangle are numerous and complex. Folding is not pervasive. East-dipping thrust faults characterize the earlier faults in the region, although west-dipping thrusts also occur (Rember and Bennett, 1979; Corbett, 1978; Platt, 1977; Trimble, 1976; Trimble and Carr, 1976). Trimble and Carr suggest that areas of Paleozoic rock east of the Deep Creek Mountains and extending to the eastern border of the Pocatello quadrangle are part of a large [15,500 km² (6000 mi²)] klippe bounded on the east by the Idaho-Wyoming thrust belt and on the south by the Willard Thrust in Utah. Within this klippe are at least three subsidiary thrust faults (Trimble, 1976). The times of movement of the klippe and subsidiary thrusts can not be determined, except that thrusting here is probably equivalent to late Mesozoic thrusting further east in the thrust belt (Oriel and Armstrong, 1966).

High-angle normal faults cut across earlier thrust faults. Paleozoic, Tertiary, and Quaternary rocks and deposits border steep mountain fronts. These faults attain stratigraphic displacement up to 1500 m (5000 ft) or more (Trimble, 1976). As these faults are characteristic Basin and Range faults, their age is probably Miocene or younger based on regional relationships (Proffett, 1977). Trimble (1976) cites evidence of rhyolite flows interbedded with very coarse-grained alluvial fan deposits at the western edge of the Bannock Range. The Pliocene age of the rhyolite flows documents Basin and Range faulting in this region at that time. Not all normal faults are late Cenozoic in age; Mesozoic normal faults may have formed contemporaneously with (or independent of) thrusting (Loring, 1976; Royse and others, 1975). Trimble (1976) cites evidence for contemporaneous normal and thrust faults near Pocatello, Idaho. Recent earthquakes throughout the region indicate faulting is still active (Lucian Platt, 1976, personal communication).

Recent work strongly suggests that the Snake River Plain is a graben and not a structural downwarp as advocated by Kirkham (1931). Fissure-type volcanic activity within the Snake River Plain corresponds with that found in other grabens (King, J. S., 1977). Northeast-trending faults in Tertiary rocks, springs, and aligned outcrops of vitrophyre and brecciated rocks occur along the southern margin of the Snake River Plain near Pocatello (Trimble and Carr, 1976). An underlying positive gravity anomaly and pronounced magnetic anomaly support an interpretation of a fault zone along the southeastern Snake River Plain (Smith and others, 1976; Mabey, 1976; Carr and Trimble, 1963). Movement of magma related to volcanism in the Snake River Plain has greatly warped the beds of the Starlight Formation which now have a structural relief of about 6100 m (20,000 ft) (Trimble and Carr, 1976).

The structure of the Albion Range is a series of gneiss domes (Armstrong, 1968; 1970). Northwest- to west-northwest-trending folds and lineations most prominent west of, but also present east of, the domes indicate formation contemporaneously with (or later than) emplacement of the gneiss domes. Some of the northwest-trending fabric yields isotopic dates of 80 My BP (Armstrong, 1976). Thus, emplacement of the gneiss domes is not earlier than Jurassic (Armstrong, 1976), and the Albion Range represents one of the few locales in the Cordillera where metamorphism and deformation are contemporaneous (Compton and others, 1977). Younger metamorphism and associated low-angle thrust-faulting immediately south of the Albion Range (Compton and others, 1977) may be associated with the emplacement of the Almo Pluton in the southern Albion Range (Armstrong, 1976).

Geologic History

Tectonic activity formed the basement rocks of the Pocatello quadrangle some 2 to 2.6 billion years ago. After a period of erosion and planation, sedimentation began during late Precambrian time with quartzites, argillites, and siltstones. Local volcanism and glaciation briefly interrupted this cycle. The uppermost Precambrian deposits mark initial deposition of geosynclinal sedimentation in this region. Sandstones, limestones, shales, and dolomites form a continuous stratigraphic sequence through the Triassic period. Deposition of phosphatic shales and associated rocks record a slight lowering of sea level during the late Paleozoic era which possibly reflects ongoing tectonic activity to the west of this region.

Little remains of the Mesozoic section in the Pocatello quadrangle, but regions further east record continuous miogeosynclinal sedimentation through Jurassic time. Final break-up of the miogeosyncline, with the development of large-scale thrust-faulting established intra-cratonic deposition during Cretaceous time. Jurassic metamorphism and deformation affected the Albion Range.

Granodiorites in the Albion Range reflect early Cenozoic magmatic activity in the southwestern part of the Pocatello quadrangle. Cenozoic volcanic and volcanoclastic deposits are scattered throughout the map area and consist of basaltic and rhyolitic material. The middle and late Tertiary material is predominantly rhyolitic, whereas younger volcanics are mostly basaltic in composition. Extensive block-faulting which began during middle Tertiary time created north-trending mountain ranges and broad intervening valleys; seismic activity continues along many of these normal faults. The Snake River Plain is the youngest large-scale feature to form in this region.

Several intermittent basalt flows and changes in base level during the Pleistocene epoch dammed streams and rivers causing the formation of a few large lakes. Some volcanic matter accumulated in these fresh-water environments. Terrace gravels and fluvial deposits record transitory base levels. Pluvial Lake Bonneville, part of which occupied the extreme southeastern corner of the Pocatello quadrangle, overflowed in a catastrophic flood some 20,000 to 30,000 years ago causing deposition of a widespread deltaic sequence of sand and gravel and carving out the present channel of the Snake River. Downcutting of the Snake River continues through the present.

Mineral Resources

Mineral resources in the Pocatello 1° x 2° NTMS quadrangle include several noble metal, base metal, pegmatite, phosphate, barite, and uranium deposits (Mardirosian, 1976). Gold placers occur in a few localities in the Albion Range, Sublett Range, Bannock Range, Portneuf Range, and along the Snake River. Mineralization type and character varies with geographic/geologic setting.

The base metal deposits in the Albion Range are not of very high tenor nor of large size, but local mining resulted in some production early in this century (Ross, 1941). The deposits are fissure fillings and replacements in Precambrian and younger quartzites, limestones, schists, and granites, and are related to the Almo Pluton (Ross, 1941; Anderson, 1931). Veins and fissure fillings are either well-defined or are tabular with variable pinch-and-swell; thickness is about 2 m (6 ft) maximum in quartzites to over 15 m (50 ft) in limestones (Anderson, 1931). The fissures generally follow the trend of major structures, but no offsets occur suggesting vein formation is later than the Jurassic deformation. Quartz, pyrite, and sphalerite probably formed early in the veins; while chalcopyrite, galena (argentiferous), and gold formed last (Anderson, 1931). Also, veins and fissures in granodiorite indicate mineralization occurred after consolidation of the Almo Pluton which is Eocene-Oligocene in age (Armstrong, 1976). Therefore, mineralization in the Albion Range represents probable late-stage hydrothermal activity associated with the emplacement of the Almo Pluton during the early/middle Tertiary.

Mineralization in the southern part of the Sublett Range consists of irregular replacement deposits of sulfides, barite, and some arsenate in upper Paleozoic limestones (Ross, 1941; Anderson, 1931). A nearby major thrust-fault apparently controlled location of these closely-spaced deposits; no igneous

rocks crop out in the area (Anderson, 1931). The shattered veins containing ore show evidence of later movement suggesting a mid-Tertiary origin of these deposits (Anderson, 1931). This limestone-lead-zinc association may represent Mississippi Valley-type base-metal deposits related to the widespread Cenozoic volcanism in this region (Callahan, 1977). Other base-metal deposits in the Pocatello quadrangle of uncertain age or affinity may also be Mississippi Valley-type deposits.

Small patches of the Phosphoria Formation are few and widely scattered between the Albion Range and the Portneuf Range. Production of phosphate is low because this region lies west of the rich phosphates of the main Phosphoria Formation (McKelvey and others, 1959). Trimble and Carr (1976), however, report some phosphate containing up to 30% phosphorus as phosphorus pentoxide in the Manning Canyon Shale. McKelvey (1956) and McKelvey and Carswell (1956) point out that if a phosphate contains 30% phosphorus pentoxide equivalent, then significant uranium might be recovered as a by-product.

The only reported occurrences of uranium in the Pocatello 1° x 2° NTMS quadrangle occur in the southern part of the Albion Range. Pegmatite deposits associated with the Almo Pluton contain columbite, a rare-earth oxide mineral (Fryklund, 1951). The pegmatites strike N°55-60°W and dip steeply southwest. Anderson (1931) described these pegmatites as several hundred meters long and fifteen meters wide. Tertiary volcanoclastic deposits in the Goose Creek district are slightly radioactive; and uranium enrichment in interbedded carbonaceous shale, lignite, and ash is particularly noticeable (Mapel and Hail, 1959). The uranium-enriched rocks follow the axial trend of a small, northwest-striking syncline, but no geological source for the uranium has been found, as no uranium minerals are present. Four different localities yield uranium contents of 0.034%, 0.045%, 0.101%, and 0.12%. Local rhyolites contain some uranium (0.006%). Mapel and Hail (1959) suggest that ground water leached uranium from the volcanic rocks and deposited uranium-enriched material, while flowing along an impervious shale in a syncline. Interestingly, these volcanic rocks correlate with the Starlight Formation exposed elsewhere in the Pocatello quadrangle. Protska and others (1976) speculate that a rising mantle plume enriched in uranium and thorium caused basaltic and rhyolitic volcanism in the Basin and Range during the Cenozoic. The presence of uranium-bearing volcanoclastic rocks in the southern Albion Range may support their idea; if so, all of the Cenozoic volcanic and volcanoclastic rocks of this region (especially the Starlight Formation) may be important sources of low-grade uranium deposits.

Placer gold deposits along the Snake River have produced significant amounts of very fine-grained gold (Koschmann and Bergendahl, 1968; Ross, 1941). Associated heavy minerals might contain uranium. The source of the gold in the placers may or may not be local and is enigmatic (Huntsman, 1978; Ross, 1941).

Current Research

Several parties currently are engaged in research in the Pocatello 1° x 2° NTMS quadrangle. The U.S. Geological Survey (USGS) team headed by Steven S. Oriel is mapping the quadrangle in more detail than has been done previously. Students from several colleges and universities including Idaho State University, Pocatello, Idaho (under the direction of Prof. M. K. Corbett) and Bryn Mawr College, Bryn Mawr, Pennsylvania (under the direction of Prof. L. B. Platt) are also mapping parts of this large area. R. L. Armstrong continues his work on isotopic dating and mapping of the igneous and metamorphic rocks in this region. The 1979 geologic map of the Pocatello quadrangle contains a list of important recent works in this region. Steven Oriel (personal communication, 1979) hopes to produce a completed, detailed, geologic map of the Pocatello 1° x 2° NTMS quadrangle in the near future. Bendix Field Engineering Corporation recently issued an aerial radiometric and magnetic survey report for an area including the Pocatello quadrangle (Texas Instruments, 1979).

HYDROLOGY

Climate

The Pocatello 1° x 2° NTMS quadrangle has a variable climate with cold winters and relatively mild summers. The average July temperature is about 22°C, and the average January temperature is about -4°C. The annual rainfall is fairly evenly distributed throughout the area ranging from about 250 mm in the west to about 350 mm in the east (NOAA, 1977). Most precipitation is during the winter months and occurs as snowfall in the higher areas. Precipitation data for the months in which field sampling took place are presented in Table 1.

Geography

The Pocatello quadrangle lies almost completely in the Snake River Plain section of the Columbia Plateau Province. The southeastern corner of the area lies in the Great Basin section of the Basin and Range Province. North of the Snake River, which flows west southwestward through the area, a lava plain occurs slightly

TABLE 1

Precipitation Totals for 1979 at Selected Weather Stations in the Pocatello Quadrangle

Weather Station and Elevation (m)	Average Monthly Precipitation, mm											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Burley FAA AP (1267)	27.7	20.3	20.1	23.6	30.2	25.9	7.37	12.2	12.2	15.5	25.4	26.9
Pocatello WSO AP (1355)	25.7	20.3	23.9	26.9	32.8	32.5	9.14	15.7	15.5	19.0	26.7	25.1
Malad (1433)	35.3	31.2	26.4	30.0	38.6	41.4	16.8	23.4	22.6	24.4	34.3	38.4

above an altitude of 1400 m. The topography of the Snake River Plain is rather simple; the lava surface is so new that weathering and erosion have made little progress (Fenneman, 1931, p. 238). The basaltic flows extended southward into Raft River Valley and other low places south of Snake River. A series of mountain ranges, having a general northerly trend, rise above the nearly flat lava surface of the Snake River Plain in the south-central and southwestern parts of the study area. These mountains, mostly residual fault blocks, are composed of complex igneous and metamorphic rocks that have very little soil cover. Some of the lava is swept bare; whereas in other areas, windblown silt covers the plain and reaches thicknesses of tens of meters (Nace, 1961, p. 22). Alluvium covers much of the basalt along the Snake River.

In the northeastern part of the study area, the valleys leading northward to the Snake River are mantled by older lava flows and alluvium. The adjacent mountains, rising to altitudes as great as 2100 m above sea level and several hundred meters above the adjacent valleys, are composed chiefly of resistant Paleozoic rocks.

The southeastern part of the map area is in the Basin and Range Province. Curlew Valley, Pocatello Valley, and Malad River Valley extend southward toward Great Salt Lake. Locally the valleys appear to have open drainage, but only Malad River has perennial flow.

Native grasses and sagebrush occur in many places, and greasewood and rabbitbrush are plentiful in some bottomlands and sheltered mountains (Nace, 1961, p. 16). Many mountain slopes have no soil. In many lowlands, the contemporary erosion and deposition coupled with the arid climate, have prevented the development of mature soil profiles.

Much of the area around streams and lakes is irrigated and used for agriculture. Special crops, such as potatoes, are grown. Grain crops are grown in support of livestock grazing.

The Pocatello quadrangle area has population of 55,000. There are four major towns in the area - Burley, Rupert, American Falls, and Pocatello, Idaho. Pocatello, with 40,000 people, accounts for most of the population (U.S. Bureau of Census, 1970).

Drainage and Hydrology

The drainage divide (between the Snake River basin to the north and the arid Basin and Range Province to the south) passes through the southeastern part of the study area.

The Snake River is the only major river and flows west-southwest, leaving the area near Burley, Idaho. From the southern intermontane valleys, several streams flow north to join the Snake River. The largest are Raft River in the west and Portneuf River in the east. So much of the water from these north-flowing streams is diverted for irrigation, that only a part of the normal flow reaches Snake River. No significant streams flow over or are incised in the lavas of the Snake River Plain north of Snake River. However, there is large underground drainage southward to the Snake River as ground-water "sheetflow" through the permeable lava to seepage places in the river.

In the southeast section of the quadrangle, southward flow of water in the arid alluviated intermontane valleys is not great, and much water is lost to processes of evapotranspiration and to seepage into the underlying alluvium in its downstream part.

A great range in water-yielding capacities of wells characterizes the various rocks of the area. The Snake River basalt underlying the region north of Snake River and part of Raft River Valley is very permeable and yields large quantities to wells. An unbroken unit of basalt is practically impermeable, but the basalt is intensively jointed and creviced (Nace, 1961, p. 22). Sands and gravels along Snake River and Raft River tend to be permeable and are a good source of high-yielding wells. In many parts of the intermontane valleys, the unconsolidated materials are poorly sorted and have low permeabilities. An assortment of alluvium, hill wash, and glacial deposits compose these unconsolidated materials, and their short downslope movement has prevented the sorting of sands and gravels into discrete permeable beds. Wind-blown silty materials compose the soils in many places; these silty materials generally lie above the water table and are poorly permeable.

No intensive study has been made of the rocks composing the mountains. Many of the rocks are fractured and faulted sufficiently to yield as much as 100 liters of water per minute to wells. The carbonate rocks are considered to be among the better rock aquifers south of Snake River (Eakin and others, 1976).

Some artesian water occurs in deeper parts of the Snake River Plain and in Raft River Valley, but a water-table circulation system is predominant. The water table is as deep as 100 m beneath some mountainous areas and is near land-surface along perennial streams. The normal movement of ground water is from upland areas to valleys as underflow; additional recharge to the valleys is by direct penetration of precipitation, by infiltration from a surface stream, and by infiltration of irrigation water.

Many small perennial and ephemeral springs emerge from coves in the mountain slopes, but springs are nearly absent from the lava beds of the Snake River Plain. Several significant thermal springs flow from faulted limestones and quartzites in the southern part of the quadrangle (Waring, 1965, p. 31).

Most of the ground water is of good quality, containing less than 1000 mg/L of total solids. Some of the more arid valleys, especially in the Great Basin area of the southeastern portion of the quadrangle, contain some ground waters that are more mineralized.

Many areas are irrigated by both surface water and ground water. The quality of the water is good and is not greatly affected by the irrigation return flow. Most surface waters have a dissolved solids content of less than 400 mg/L.

FACTORS AFFECTING THE DATA

Stream sediment, stream water, and ground water samples were collected during the fall of 1979. Very few stream water samples were available at this time due to very dry conditions.

QUALITY ASSURANCE

Sample Collection

Sampling teams marked each sampling site on an SRL-approved map and completed a Field Data Form (Figure 3) for every sample. 108 sediment and 12 ground-water sampling sites were field-checked by an SRL subcontractor during November and December 1979. No evidence has been discovered of deliberate malfeasance by the sampling teams. Ninety-seven percent of the sites checked were found to be located within 800 m (0.5 mi) of the locations plotted on sample maps. Thus, the goals of a regional reconnaissance have not been compromised by map errors. Details of the quality assurance program are given elsewhere (SRL-138).

SRL FIELD DATA FORM

SITE CODE								DATE								TEAM NO.		SURFACE SITE DATA																FORMATION		ODOR			
Sheet	Map Code	Site Number			Mo.	Day	Yr.	Hr.	Sample Type	Rock Type	Sed Size	Width	Depth	Flow	Level	Veg Type	Veg Density	Relief	No. of Sample Composites	Activities Contaminants (List up to four)																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
HAVE A GOOD DAY																																							
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
pH		SPECIFIC CONDUCTANCE $\mu\text{mhos/cm}$		WATER TEMP. °C		ALKALINITY Drops H_2SO_4 ml Water		ml OF WATER ION-EXCHANGED		WELL DEPTH		CONDENS. Well Class.		Where Sample Taken		SCINTILLOMETER READING																							
ADDRESS (use / to separate lines)																																							
Sheet	Map Code	Site Number																																					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
IN THE CASE OF EACH CIRCLED ENTRY SPACE, ENTER MOST APPROPRIATE DESIGNATORS LISTED BELOW																																							
(20) A Other sediment (8) B Other resin (9) C Well water (9) D Spring water (9) E Stream sediment + water (8) F Stream sediment only (8) G Soil (8) H Talus (8)										(21) 1 Other (explain) 2 Volcanic - Felsic 3 Volcanic - Mafic 4 Plutonic - Felsic 5 Metamorphic 6 Clastics - coarse 7 Sandstone 8 Shale 9 Carbonate										(22) 1 Other (explain) 2 Pebbles & coarser 3 Sand 4 Silt & clay 5 Organic muck										(23 and 24) 1 Dry 2 < 1/2' 3 1/2 - 1' 4 1 - 2' 5 2 - 4' 6 4 - 8' 7 8 - 16'									
(25) 1 Dry 2 Slow 3 Moderate 4 Fast 5 Torrent										(26) 1 Dry 2 Low 3 Normal 4 High										(27) 1 Other 2 Forest 3 Desert scrub 4 Grassland 5 Saltbush 6 Marsh										(28) 1 Sparse 2 Moderate 3 Dense									
(29) 1 0 - 10' 2 10 - 50' 3 60 - 200' 4 > 200'										(32 thru 35) 1 Other 2 None 3 Chemical 4 Smelting 5 Mining 6 Garbage 7 Farming 8 Grazing 9 Oil Field										(40) 1 Other 2 None 3 H_2S 4 Oil										(62) 1 Certain 2 Probable 3 Possible 4 Educated guess 5 Unknown									
(63) 1 Other 2 Domestic 3 Municipal 4 Livestock 5 Irrigation 6 Industrial - commercial																				(64) 1 Others 2 Immediately after storage tank 3 Before storage tank 4 Direct from pump 5 Direct from well or spring 6 From municipal system										(77) Enter "X" when analysis information is requested									
																				(80) Enter number in parentheses ( ) for column 20 options																			
Sampler(s) Signature(s) Field Supervisor (initials)																																							
Standard Letters and Numbers A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9																																							

FIGURE 3. SRL Field Data Form for Western Quadrangles

Analytical Standards

Sediment Standards SRL 2.2, 3.1, and 4.1 were analyzed along with NURE sediment samples. Analyses of the standards provide routine checks of the analytical equipment and software. Tables 2a, 2b, and 2c contain the results from the standards run during the same time period as the Pocatello sediment samples. These results give a good estimate of the precision of the analyses and can be used in estimating bias between this and other SRL reports.

Periodically, DOE intersite comparison standards are analyzed. An independent quality assurance program based on these standards is conducted for DOE by Ames (Iowa) Laboratory (D'Silva, et al.).

DESCRIPTION OF DATA TABLES

This section of the report summarizes the types of data tabulated on microfiche. Detailed descriptions of the tables and definitions of abbreviations can be found on the microfiche labeled **USER'S GUIDE**. Ground-water analyses and site descriptions are tabulated in Tables A-1 and A-2, both of which can be found on the microfiche titled **POCATELLO GW TABLES**. Sediment analyses and site descriptions are tabulated on Tables B-1, B-2, and B-3, which are on the microfiche titled **POCATELLO SS TABLES**. Surface water analyses are tabulated in Table C-1, on the microfiche titled **POCATELLO SW TABLES**.

Table A-1 begins with the sample's SRL identification number, which is composed of four letters and a three-digit number. The first two letters identify the quadrangle. PC is the two-letter designator for the Pocatello 1° x 2° NTMS quadrangle. The third and fourth letters define which 15-minute quadrangle contains the sampling site (see chart below).

	A	B	C	D	E	F	G	H
A	AA	AB	AC	AD	AE	AF	AG	AH
B	BA	BB	BC	BD	BE	BF	BG	BH
C	CA	CB	CC	CD	CE	CF	CG	CH
D	DA	DB	DC	DD	DE	DF	DG	DH

TABLE 2

Accuracy and Precision of Analyses of SRL Standards

a. Sediment Standard SRL 2.2

<u>Element</u>	<u>Number</u>	<u>Mean, ppm</u>	<u>Coefficient of Variation, %</u>	<u>Accepted Value, ppm</u>
U	30	19.7	16.2	22.2
Th	30	108	17.7	125
Hf	26	109	23.9	173
Al	30	6350	20.1	6500
Ce	24	531	21.5	614
Fe	29	7750	34.6	6700
Mn	26	314	85.6	300
Sc	30	2.58	37.4	3.9
Na	26	127	24.6	145
Ti	29	10,600	23.8	13,200
V	30	31.5	19.9	34.7
Dy	29	17	38.4	<22
Eu	24	2.9	109	2.5
La	30	325	25.3	301
Lu	25	2.4	22.0	2.9
Gm	27	47.1	37.8	51.3
Yb	24	15.9	22.3	18.2

TABLE 2 (Continued)

b. Sediment Standard SRL 3.1

<u>Element</u>	<u>Number</u>	<u>Mean, ppm</u>	<u>Coefficient of Variation, %</u>	<u>Accepted Value, ppm</u>
U	28	39.3	22.3	41.3
Th	28	145	22.4	162
Hf	16	4.8	57.4	7.4
Al	27	35,200	22.9	30,600
Ce	23	791	24.5	903
Fe	28	15,600	28.3	15,200
Mn	27	399	115	289
Sc	28	4.0	30.8	4.19
Na	25	1450	184	901
Ti	17	4820	18.9	6100
V	27	46.7	24.8	54.4
Dy	24	42.3	50.8	50*
Eu	27	3.5	41.2	3.86
La	28	406	23.7	443
Lu	23	4.1	25.4	4.4
Sm	23	71.7	73.0	69.2
Yb	25	28.7	26.0	29.9

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* Only one laboratory reported values for dysprosium.

TABLE 2 (Continued)

c. Sediment Standard SRL 4.1

<u>Element</u>	<u>Number</u>	<u>Mean, ppm</u>	<u>Coefficient of Variation, %</u>	<u>Accepted Value, ppm</u>
U	28	0.5	14.7	0.58
Th	13	2.9	31.0	2.1
Hf	25	2.9	31.1	4.4
Al	28	59,700	25.9	66,700
Ce	15	51.1	27.1	44
Fe	28	77,200	13.6	87,300
Mn	24	1,520	21.9	1970
Sc	28	13.2	36.1	21
Na	27	15,500	21.6	16,100
Ti	23	19,700	24.1	25,200
V	27	217	20.6	273
Dy	3	4.4	97.4	<22
Eu	20	1.2	49.6	1.16
La	23	15.2	22.2	18.6
Lu	16	0.2	36.6	0.28
Sm	22	2.9	30.6	4.2
Yb	7	1.6	24.3	1.6

Numbers from 001 to 499 designate surface sites. Numbers from 501 to 999 designate ground water sites. The first sediment sample, therefore, taken from the extreme northeastern portion of the Pocatello 1° x 2° NTMS quadrangle would be PCAH001.

Other entries on Table A-1 include a DOE identification number; pH, conductivity, alkalinity, and scintillometer readings; analyses for U, Br, Cl, F, He, Mn, Na, and V; and the ratio of uranium-to-conductivity (multiplied by 1000 for convenience; $U \times 1000/\text{cond.}$). All entries are self-explanatory except those noted below.

DOE ID is a 28-digit number that includes the following parts:

Digit Number

1-2	State (See Table 1 in the USER'S GUIDE)
4-10	Latitude of site
12-19	Longitude of site
21	Laboratory code (4 = ERL)
23-24	Sample type (See Table 2 in the USER'S GUIDE)
26-28	Replication code. Generally only original samples (-000) are reported in the Data Reports.

Table A-2 shows SRL identification number; concentrations of Al, Dy, and Mg; sampling date; sample collection team number; and the following characteristics of the well or spring that was sampled:

WATRTEMP	Water Temperature, in °C.
WELDEPTH	Depth of well in feet.
DPTHCONF	Confidence in depth measurement (see p. 14 in USER'S GUIDE).
WELCLASS	Classification of well use (see p. 15 in USER'S GUIDE).

SMPPPOINT   Point in plumbing system where water was taken
                  (see p. 14 in **USER'S GUIDE**).

WELLODOR   Presence or strength of hydrogen sulfide or
                  other odor.

Sediment analyses and site descriptions are tabulated in
Tables B-1, B-2, and B-3, which are on the microfiche labeled
POCATELLO TABLES..

Table B-1 includes SRL and DOE identification numbers similar
to those described above for ground-water sites. Table B-1 also
includes scintillometer readings, pH, conductivity, and alkalinity
of stream water, plus elemental concentrations of U, Th, Hf, Ce,
Fe, Mn, Na, Sc, Ti, and V.

Table B-2 (Supplementary Data - Sediments) includes the SRL
identification number and concentrations of Al, Dy, Eu, La, Sm,
Yb, and Lu.

Table B-3 (Supplementary Data - Sediments) includes the SRL
identification number and the following entries:

SAMPTYPE   Type of soil, sediment, etc., sampled (see
                  Table 2 in the **USER'S GUIDE**).

ROCKTYPE   Type of rock underlying sampling site
                  (see p. 16 in the **USER'S GUIDE**).

SEDSIZE   Dominant size of particles in sediment at
                  site (see p. 17 in **USER'S GUIDE**).

STRWIDTH   Size and flow rate of stream at sampling
STRDEPTH   site (see p. 17 in **USER'S GUIDE**).
STRFLOW
STRLEVEL

VEGTYPE   Dominant type of vegetation at site (see
                  p. 17 in **USER'S GUIDE**).

VEGDENS   Vegetation density at site (see p. 17 in
                  USER'S GUIDE).

RELIEF   Local relief at site (see p. 18 in **USER'S**
                  GUIDE).

COMPOSIT   Number of subsamples blended into sample.

CONTAMN1	Activities or contaminants that may affect the material sampled (see p. 18 in the USER'S GUIDE).
CONTAMN2	
CONTAMN3	
CONTAMN4	
FORMATION	The rock formation that underlies the site (see FORM on p. 13 of the USER'S GUIDE).
ODOR	Odors detected in sampled material (see p. 15 in the USER'S GUIDE).
WATERTEMP	Water temperature in °C.
SAMPDATE	Date sample was collected.
TEAM	Numerical designator of sample collection team.

Surface water analyses are tabulated in Table C-1, on the microfiche labeled **Pocatello SW Tables**. Table C-1 includes SRL and DOE identification numbers similar to those described above. Table C-1 also includes pH, conductivity, and alkalinity of stream water, plus elemental concentrations of U, Br, Cl, F, Mn, Na, and V; and the ratio of uranium-to-conductivity (multiplied by 1000 for convenience; $U \times 1000/\text{cond.}$).

Site descriptions and field measurements are recorded on the SRL Field Data Form (Figure 3). Data are recorded in the spaces numbered 1 through 80. The spaces have self-explanatory labels. Spaces whose numbers are circled are filled with one of the choices listed beneath the appropriate number on the Field Data Form. Some data are listed differently on the Field Data Form and in the data tables on microfiche. For example, well water samples are coded as Sample Type "C" on the Field Data Form and are reported as Sample Type "52" in Table A-1. Details of how the Field Data Form is used can be found in the **USER'S GUIDE** and in SRL's **Training Manual for Water and Sediment Geochemical Reconnaissance** (Price and Jones, 1979, Du Pont SRL Internal Doc. DPST-79-219).

Elemental Analyses

Concentrations of each element are reported in parts per million (ppm) by weight for sediment and parts per billion (ppb) for water. Values have been rounded to appropriate significant figures. Note that elemental (not oxide) concentrations are quoted in this table. Values below detection limits are indicated

by a minus (-). For example, -3 means that the sample contains less than 3 ppm of that element. A period (.) is used to indicate not only that the element was not detected, but that the detection limit is not estimated for that element. Missing data are indicated by "M". All analytical results are missing when there was insufficient sample for analysis.

RESULTS AND DISCUSSION OF THE DATA

Surface Sediment Samples

Sediment samples were collected from 1701 surface sites in the Pocatello 1° x 2° NTMS quadrangle. Basic statistical data for uranium and 16 other elements in these sediments are given in Table 3. Log histograms, cumulative frequency plots, and areal distribution maps for these 17 elements as well as elemental ratios (log U/Th, log U/Hf, and log Th/La) are shown on the microfiche sediment plots.

SRL experience suggests that most uranium in surface sediment samples is present in resistate minerals. Interpretation of the areal distribution of uranium (Plate 5) is best done by studying the areal distributions of the ratio of uranium to geochemically associated elements such as Th, Hf(Zr), Ce, etc. Elemental associations suggested here should be considered speculative pending detailed mineralogical investigations.

An areal distribution map of uranium concentrations in a given stream sediment sample may be more dependent on stream gradient or sampling conditions than on any proximity to a commercial uranium deposit. For example, if uranium were uniformly present in the mineral zircon at a concentration of 5000 ppm, then a uranium distribution map for stream sediment samples comprised of particles of less than 149 micrometers would have highs and lows which were functions of many factors. These include: (1) the areal distribution of zircon, (2) the areal distribution of zircon grain size, (3) the effectiveness of sampled streams in sorting and concentrating zircon relative to diluent minerals such as quartz or micas, and (4) the effectiveness of the sampling method in obtaining "representative" samples.

On the other hand, comparison of a map showing the distribution of uranium with a map showing the distribution of the U/Hf (or U/Zr) ratio should show where zircon is an important contributor to the amount of uranium. The areal distribution of this ratio is presented on microfiche. The ratio of U/Hf should be low

TABLE 3

Statistical Summary of Field Measurements and Elemental Analyses -
Sediment

Field Measurement or Element	n*	Measured Values		Mean††	Log Mean‡	Log Std.‡ Deviation	Standard Deviation
		Maximum**	Minimum†				
Scintillometer Reading	1701	440	1	39			17
U	1701	14.1	0.8		0.37	0.13	
Th	1648	97.0	5.0		1.02	0.14	
Hf	1670	33	1.0		0.87	0.20	
Al	1695	83,600	100		4.59	0.16	
Ce	1612	372	21.0		1.77	0.14	
Fe	1666	237,000	7500		4.33	0.14	
Mn	1665	1940	110		2.63	0.13	
Na	1345	10,000	700		3.87	0.12	
Sc	1671	19.5	1.0		0.64	0.18	
Ti	1414	14,500	900		3.48	0.14	
V	1693	270	10		1.65	0.13	
Dy	768	52.1	1.1		0.59	0.25	
Eu	1007	6.2	0.3		0.05	0.21	
La	1662	411	10.0		1.47	0.16	
Lu	1343	1.1	0.1		-0.50	0.17	
Sm	1633	63	1.0		0.60	0.25	
Yb	505	13.3	0.9		0.51	0.19	

* Number of observations

** Elemental concentrations in ppm.

† Minimum or detection limit.

†† Mean of values above detection limit.

‡ Log units; $[(\sum \log_{10} x)/n]$.

where zircon is the primary mineral host of uranium in sediment samples. High values of the ratio indicate areas where uranium is present in minerals other than zircon or where zircon is particularly enriched in uranium.

Using the same logic, areas where values of the U/Th ratio (on microfiche) are high show either that uranium is present in minerals other than resistates (such as monazite) or that these resistates are particularly enriched in uranium. Anomalous areas which persist on several ratio figures may be areas where uranium is present in some mineral other than common resistate minerals. If these anomalous areas are supported by other considerations (such as radioactivity highs, geologic conditions, or high values of dissolved uranium in natural waters), then they may warrant a detailed field examination or detailed geochemical sampling.

Uranium concentrations in sediment samples from the Pocatello 1° x 2° NTMS quadrangle are comparatively low, with a maximum uranium content of 14.1 ppm. Most of the higher uranium concentrations are associated with Precambrian granitic rocks. The largest exposure of these rocks is in the southwestern part of the quadrangle, where two uranium occurrences are reported (Plate 1B).

Stream and Ground Water Samples

Water samples were collected from 381 ground water sites in the Pocatello quadrangle. Statistical summaries of key field measurements and elemental analyses for ground water sites and stream water sites are given in Tables 4 and 5, respectively. Log histograms, cumulative frequency plots, and areal distribution plots for uranium and ten other elements (Al, Br, Cl, Dy, F, He, Mg, Mn, Na, and V) in ground waters are shown on microfiche. Helium concentrations were determined by mass spectrographic analyses.

Uranium concentrations in stream and ground water samples are dependent on several factors: (1) the concentration of uranium in the rocks and soils through which the ground water passes, (2) the rate at which uranium-bearing minerals in the rocks (soils) release uranium, (3) the hydrologic character of the rocks (soils), and (4) the chemistry of the water (especially Eh, pH, and alkalinity).

The interpretation of uranium analyses in natural waters is not straightforward. In active roll-front deposits, solubility of uranium may be low. Concentrations of uranium in natural waters may be very low near areas of active uranium deposition or very high in oxidizing zones near dissolving ore bodies.

TABLE 4

Statistical Summary of Field Measurements and Elemental Analyses -
Ground Water

Variable	n*	Measured Values		Mean††	Log Mean†	Log Std.‡	Standard Deviation
		Maximum**	Minimum†				
Scintillator Reading	381	175	2.0	3.8			20
pH	381	9.0	4.6	7.8			0.5
Conductivity	381	6500	40.0		2.6	0.2	
Alkalinity	381	10.4	0.32		0.48	0.20	
U	376	31.1	0.03		0.03	0.5	
Al	346	9940	87		2.50	0.3	
Dy	22	1.7	0.038		-0.92	0.3	
Br	180	6280	8.6		1.90	0.5	
Cl	373	736,000	8600		4.6	0.3	
F	192	1350	15.0		2.1	0.4	
He¶¶	349	394	3.0		0.8	0.2	
Mn	72	1400	4.1		2.0	0.4	
Na	375	838,000	4520		4.3	0.3	
V	292	18	0.9		0.4	0.3	

* Number of observations. Some values are missing for reasons other than being below detection limit.

** Elemental concentrations in ppb; conductivity in $\mu\text{mhos/cm}$; alkalinity in meq/L .

† Minimum or detection limit.

†† Mean of values above detection limit.

‡ Log units, $[(\sum \text{Log}_{10} x)/n]$.

¶¶ Helium in ppm by volume in 2 mL air gap over 300 mL of water.

TABLE 5

Statistical Summary of Field Measurements and Elemental Analyses -
Stream Water

Field Measurement or Element	n [*]	Measured Values		Mean ^{††}	Log Mean [‡]	Log Std. [‡] Deviation	Standard Deviation
		Maximum ^{**}	Minimum [†]				
pH	37	8.8	5.6	8.0			0.6
Conductivity	37	600	30.0		2.4	0.3	
Alkalinity	37	4.8	0.20		0.3	0.3	
U	38	3.34	0.01		-0.5	0.5	
Al	38	950	17.0		2.4	0.3	
Rr	14	66	3.71		1.5	0.3	
Cl	37	213,000	7600		4.3	0.3	
Dy	3	0.2	0.05		-1.1	0.3	
F	22	935	14.0		1.7	0.4	
Mg	32	41,800	380		3.8	0.4	
Mn	15	109	0.1		1.7	0.1	
Na	38	47,100	290		4.0	0.3	
V	27	5.8	0.3		0.1	0.3	

* Number of observations. Some values are missing for reasons other than being below detection limit.

** Elemental concentrations in ppb; conductivity in $\mu\text{mhos/cm}$; alkalinity in meq/L .

† Minimum or detection limit.

†† Mean of values above detection limit.

‡ Log units, $[(\sum \text{Log}_{10} x)/n]$.

Uranium concentrations in water can be expected to vary with total dissolved solids in the water. Because conductivity of water increases with increasing total dissolved solids, the ratio of uranium concentration to conductivity gives an approximation of the proportion of uranium in natural waters. The areal distribution of uranium concentration/conductivity ratios for ground water and stream water are shown on the plots of ground water and stream water (on microfiche).

There are several samples in the Pocatello quadrangle where the uranium concentration in ground water is low, but the helium concentration is anomalously high. The areas possibly represent reduced, immobile uranium accumulations in the subsurface. Several clusters of such samples are apparent in the DD, AH, BA, and BG map units. A group of high uranium values appear near 42° 30' N latitude and 113° 45' W longitude.

Too few stream water samples (Table 5) were collected to allow any interpretation.

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<u>No.</u>	<u>Quadrangle</u>	<u>SRL Doc. No.</u>	<u>DOE-GJO Doc. No.*</u>
1	January-March 1975	DPST-75-138-1	GJBX-5(76)
2	April-June 1975	DPST-75-138-2	GJBX-6(76)
3	July-September 1975	DPST-75-138-3	GJBX-7(76)
4	October-December 1975	DPST-75-138-4	GJBX-8(76)
5	January-March 1976	DPST-76-138-1	GJBX-17(76)
6	April-June 1976	DPST-76-138-2	GJBX-27(76)
7	July-September 1976	DPST-76-138-3	GJBX-63(76)
8	October-December 1976	DPST-76-138-4	GJBX-6(77)
9	January-March 1977	DPST-77-138-1	GJBX-35(77)
10	April-June 1977	DPST-77-138-2	GJBX-55(77)
11	July-September 1977	DPST-77-138-3	GJBX-90(77)
12	October-December 1977	DPST-77-138-4	GJBX-37(78)
13	January-March 1978	DPST-78-138-1	GJBX-66(78)
14	April-September 1978	DPST-78-138-2	GJBX-13(79)
15	October 1978-March 1979	DPST-79-138-1	GJBX-86(79)
16	April-September 1979	DPST-79-138-2	GJBX-160(79)
17	October 1979-March 1980	DPST-80-138-1	(in process)

SRL-146, SRL-NURE Data Reports, E. I. du Pont de Nemours & Co., Savannah River Laboratory, Aiken, South Carolina.

<u>No.</u>	<u>NTMS 1° x 2° Quadrangle</u>	<u>SRL Doc. No.</u>	<u>DOE-GJO Doc. No.*</u>
1	Winston-Salem†	DPST-77-146-1	GJBX-66(77)
2	Spartanburg	DPST-77-146-2	GJBX-09(78)
3	Charlotte	DPST-78-146-1	GJBX-40(78)
4	Greenville	DPST-78-146-2	GJBX-47(78)
5	Winston-Salem††	DPST-78-146-3	GJBX-58(78)
6	Greensboro	DPST-78-146-4	GJBX-74(78)
7	Knoxville	DPST-78-146-5	GJBX-75(79)
8	Scranton	DPST-78-146-6	GJBX-02(79)
9	Athens	DPST-79-146-1	GJBX-20(79)
10	Harrisburg	DPST-79-146-2	GJBX-31(79)
11	Portland	DPST-79-146-2	GJBX-28(79)
12	Glens Falls	DPST-79-146-3	GJBX-44(79)
13	Augusta	DPST-79-146-4	GJBX-45(79)
14	Dyersburg	DPST-79-146-5	GJBX-58(79)
15	Poplar Bluff	DPST-79-146-6	GJBX-63(79)
16	Hartford	DPST-79-146-7	GJBX-94(79)

No.	NTMS 1° x 2° Quadrangle	SRL Doc. No.	DOE-GJO Doc. No.*
17	Williamsport	DPST-79-146-8	GJBX-152(79)
18	Newark	DPST-79-146-9	(in process)
19	Albany	DPST-79-146-10	GJBX-140(79)
20	Atlanta	DPST-79-146-11	GJBX-129(79)
21	Delta, Richfield†††	DPST-79-146-12	GJBX-161(79)
22	Walker Lake	DPST-79-146-13	GJBX-107(80)
23	McDermitt, Wells†††	DPST-79-146-14	GJBX-117(80)
24	Reno	DPST-79-146-15	GJBX-108(80)
25	Death Valley	DPST-79-146-16	(in process)
26	Flagstaff	DPST-79-146-17	(in process)
27	Marble Canyon	DPST-79-146-18	(in process)
28	Grand Canyon	DPST-79-146-19	(in process)
29	Pocatello	DPST-79-146-20	(this report)

† Sediment only.
 †† Ground water only
 ††† SRL analyses of samples collected by Lawrence Livermore
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* DOE-GJO reports are available on microfiche from the Grand Junction Office, DOE, for \$6.00. Prepaid orders should be sent to: Bendix Field Engineering Corporation, Technical Library, P.O. Box 1569, Grand Junction, CO 81501. Checks or money orders should be made out to Bendix Field Engineering Corporation, the operations contractor for DOE's Grand Junction Office.

EXPLANATION

Sedimentary	Igneous	Metamorphic
Qal Alluvium	Qtr basalt and rhyolite	
Qc Colluvium		
Qd Bonneville flood deposits		
Qe silts of Lake Bonneville		
Qf silts, sands, boulders (fluvial)		
Qg Salt Lake Formation	Qst Starlight Formation	
	Qv flows and tuffs	
	Qw intrusive rocks	
	Qx granodiorite	
Qy Dinwoody Formation		
Qz Phosphoria Formation		
Qaa Quirrh Formation		
Qab Manning Canyon Shale		
Qac limestone, shale		
Qad dolomite		
Qae dolomite, limestone, quartzite		
Qaf Cambrian, Ordovician, undifferentiated		
Qag limestone, shale, quartzite		
	Qba Pogonip Group (marble)	
	Qbb schists and quartzites	
	Qbc quartzite, phyllite, limestone, argillite, metadiorite, greenschist	
	Qba Green Creek Complex	

UNITS OF UNKNOWN AGE AND CORRELATION

Qcd Cassia County Dolomite	Qmm quartzite
Qde Daley Creek Quartzite	Qns Harrison Summit Quartzite
Qef marble, schist, quartzite	
Qem marble, schist, quartzite	
Qgn pegmatite and granitic gneiss	

- geologic contact
- fault- dashed where approximate, dotted where concealed
- thrust fault- teeth on upper plate, dashed where approximate, dotted where concealed

GEOLOGIC MAP OF THE POCATELLO 1°x2° QUADRANGLE

BY
John R. Huntsman

PLATE 1A

1960 MAGNETIC DECLINATION:
17°30' E (center of west edge)
16°45' E (center of east edge)
MEAN ANNUAL CHANGE 0°02' W

SOURCE MATERIAL

This map is modified from:
Rember, W.C., and E.H. Bennett, 1979, GEOLOGIC MAP OF THE POCATELLO QUADRANGLE, IDAHO: Geologic Map Series, Id. Bu. Mines and Geology

PLATE 1A

- EXPLANATION**
- ✕ reported mineral occurrence
  - Ag silver
  - Au gold
  - Au(p) gold placers
  - Ba barite
  - Ca calcite
  - Cu copper
  - Hg mercury
  - Mn manganese
  - Pb lead
  - peg pegmatite minerals
  - phos phosphate
  - Sb antimony
  - U uranium
  - Zn zinc
  - - - physiographic province boundary

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MINERAL RESOURCES OF THE POCATELLO 1°x2° QUADRANGLE

BY
John R. Huntsman

PLATE 1B

1980 MAGNETIC DECLINATION
17°30' (center of west edge)
16°45' (center of east edge)
MEAN ANNUAL CHANGE 0°02'W

PLATE 1B