National Uranium Resource Evaluation

BAKER QUADRANGLE OREGON AND IDAHO

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NATIONAL URANIUM RESOURCE EVALUATION
BAKER QUADRANGLE
OREGON AND IDAHO

M. L. Bernardi and J. W. Robins

BENDIX FIELD ENGINEERING CORPORATION
Grand Junction Operations
Grand Junction, Colorado 81502

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PREPARED FOR THE U. S. DEPARTMENT OF ENERGY
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This is the final version of the subject-quadrangle evaluation report to be placed on open file. This report has not been edited. In some instances, reductions in the size of favorable areas on Plate 1 are not reflected in the text.

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ABSTRACT

The Baker Quadrangle, Oregon and Idaho, was evaluated to identify areas containing geologic environments favorable for uranium deposits. The criteria used was developed for the National Uranium Resource Evaluation program. Stream-sediment reconnaissance and detailed surface studies were augmented by subsurface-data interpretation and an aerial radiometric survey.

Results indicate that lower Pliocene sedimentary rocks in the Lower Powder River Valley-Virtue Flat basin are favorable for sandstone uranium deposits. Although sandstones of mostly Tertiary age in the western Snake River basin area display some favorable characteristics, they remain unevaluated because of lack of subsurface data. Tertiary sandstones, possibly present at depth in the Long and Cascade Valleys, also remain unevaluated due to lack of subsurface data. All remaining environments in the Baker Quadrangle are unfavorable for all classes of uranium deposits.

INTRODUCTION

PURPOSE AND SCOPE OF STUDY

The Baker Quadrangle, in east-central Oregon and west-central Idaho (Fig. 1), was evaluated to identify geologic environments and delineate areas that exhibit characteristics favorable for the occurrence of uranium deposits. Favorable environments, as determined by surface and subsurface investigations, are those that could contain uranium deposits of at least 100 tons U_3O_8 in rocks with an average grade not less than 100 ppm U_3O_8 . Selection of a favorable environment is based on the similarity of its geologic characteristics to those found in close association with known uranium deposits (recognition criteria) as described in Mickle and Mathews (eds., 1978). The study was conducted by Bendix Field Engineering Corporation (BFEC) for the National Uranium Resource Evaluation (NURE) program, managed by the Grand Junction Office of the U.S. Department of Energy (DOE).

Approximately 1.75 man-years were spent on the project, which began March 1, 1980, and ended December 20, 1980. About 5 man-months were used to review the literature, to tabulate and plot reported uranium occurrences, and to prepare a land-status map, an index to geologic mapping, and a preliminary favorability map. Concurrently, a work plan was written describing the geologic environments potentially favorable for uranium deposits and determining the methods whereby they would be evaluated. Subsequently, 4 man-months were consumed by field studies, which included evaluating uranium occurrences, studying and geochemically sampling potentially favorable environments, collecting reconnaissance rock samples, and carrying out ground-followup studies on all airborne-defined radioactivity anomalies. Nine man-months were used to compile and evaluate data, write the report, and prepare the accompanying maps and illustrations.

ACKNOWLEDGMENTS

We wish to acknowledge the cooperation extended to us by Howard C. Brooks, resident geologist with the Oregon Department of Geology and Mineral Industries, Baker, Oregon, field office. Brooks supplied valuable information concerning the regional geologic aspects of the Oregon half of the quadrangle, and he also supplied representative rock samples of most major pre-Cenozoic units. Appreciation is extended to all property owners who allowed us to sample wells and springs on their property. All petrographic descriptions and analyses referred to in this report were made by or under the direction of Larry Fukui, BFEC petrologist, Grand Junction, Colorado.

PROCEDURES

To evaluate the uranium potential of the Baker Quadrangle as completely as time would permit, a preliminary literature study was conducted prior to field investigations to delineate and prioritize the potentially favorable environments and determine the methods and levels of effort needed to evaluate each area. As a result, detailed geochemical and radiometric sampling programs were carried out in areas tentatively considered favorable, whereas reconnaissance surface investigations were performed over the remainder of the quadrangle.

Figure 1. Baker Quadrangle location map.

Uranium-Occurrence Evaluation

Information on uranium occurrences was gathered to indicate the types of deposits that might be found in the quadrangle. Four occurrences were reported by previous investigators, and one new occurrence was discovered during reconnaissance field investigations (App. A; Pl. 2). Of the four reported occurrences, one could not be found, and two were void of any anomalous radioactivity. Where possible, occurrence evaluation included determination of grade and ore volume, deposit type and host-rock environment, ore controls, and collection of samples for chemical and petrographic analyses. A Mount Sopris Model SC-132 scintillometer was used to measure total and background radioactivity at each potential occurrence. The factors for converting cps to ur (International Atomic Energy Commission's unit of radioactivity) for BFEC scintillometer 11757 used on this project are: $ur_o = 0.259 \times \text{cps}$ for unshielded readings and $ur_s = 0.791 \times \text{cps}$ for the difference between shielded and unshielded readings.

Geochemical Sampling

During the field investigations, 156 rock and 32 water samples were collected for geochemical analyses (App. B; Pl. 5). All samples were analyzed by fluorometry for total U_3O_8 ; gamma-ray spectroscopic, semiquantitative emission spectroscopic, and major-oxide analyses were performed on selected samples. In addition, uranium or gamma-ray spectroscopic analyses of one water and 68 rock samples were taken from previous studies (App. B footnotes; Pl. 5).

Aerial Radiometric and Magnetic Survey

Data from the regional Aerial Radiometric and Magnetic Survey (ARMS) of the quadrangle, carried out by Geodata International, Inc. (1978), were interpreted by BFEC personnel. The results indicate five large preferred anomalies and four smaller ones, the locations of which are presented on Plate 3. All the anomalies were followed up during field investigations, and all could be attributed to either cultural effects or major lithologic changes and boundaries.

Hydrogeochemical and Stream Sediment Reconnaissance

Results of the multi-element Hydrogeochemical and Stream Sediment Reconnaissance (HSSR) study of the Baker Quadrangle, conducted by Savannah River Labs (SRL), did not become available in time to be incorporated into this study. As a result, no data are presented on Plate 4.

GEOLOGIC SETTING

The Baker Quadrangle, Oregon and Idaho (Fig. 1), contains parts of two geologically distinct physiographic provinces. The Columbia Intermontane Province of Ross and Savage (1967), formerly part of the Columbia Plateau Province as defined by Fenneman (1931), comprises about 90% of the quadrangle.

It includes parts of the Blue Mountains, Wallowa Mountains, Seven Devils Mountains, and western Snake River basin. The Northern Rocky Mountains Province encompasses the remaining 10% of the quadrangle and contains part of the western margin of the Idaho batholith (Fig. 2). For the purpose of most simply presenting the complex geologic, tectonic, and structural history of the rocks in the quadrangle, they are divided by age into two broad groups, pre-Cenozoic and Cenozoic, and are described as they occur in the above geologic-physiographic provinces.

Columbia Intermontane Province

Pre-Cenozoic Rocks. Adopting the nomenclature of Brooks and Vallier (1978) and Brooks (1979), the pre-Cenozoic rocks in that part of the Columbia Intermontane Province in the Baker Quadrangle (Fig. 2) are divided into four petrotectonic terranes and one intrusive episode: dismembered oceanic crust, Wallowa-Seven Devils volcanic-arc terrane, Huntington (Juniper Mountain-Cuddy Mountain) volcanic-arc terrane, forearc basin terrane (Jurassic flysch terrane), and late Mesozoic plutons (Fig. 3). Rocks in all these terranes formed as a result of broad-scale plate tectonics, which have far-reaching implications concerning the geologic development of the North American Cordillera. The volcanic-arc and dismembered oceanic-crust terranes are fragments of paleo-Pacific ocean floor that are believed to have accreted onto the North American craton sometime during the Mesozoic (Brooks and Vallier, 1978; Ave Lallemant and others, 1980).

Rocks of the dismembered oceanic-crust terrane form a broad northeast-trending belt, which underlies most of the northwestern fourth of the quadrangle, extending from the eastern flank of Elkhorn Ridge east to the Oxbow-Cuddy Mountain-Peck Mountain area (Fig. 3). The terrane comprises a tectonically chaotic assemblage of basement ophiolitic plutonic rocks and associated supracrustal cover (Fig. 4a). The supracrustal cover consists of volcanic and sedimentary rocks, all of which have undergone severe deformation and exhibit the structural disorder of melange and olistostrome. The ophiolitic plutonic rocks are of pre-Late Triassic age (Brooks, 1979) and are lithologically and tectonically correlative with the much publicized Canyon Mountain ophiolite complex to the west in the northeastern corner of the Canyon City Quadrangle. Rock types include mostly plagiogranite (quartz diorite and albite granite), ultramafic and gabbroic rocks, and diabase. Some of the largest exposures of ophiolite in the Baker Quadrangle crop out near Sparta and in the Virtue Hills just east of Baker (Fig. 3); smaller outcrops occur as fault slices and tectonic blocks mostly in the Elkhorn Ridge area and along the Connor Creek fault zone (Fig. 3). Rocks of the associated supracrustal assemblage range in age from Devonian to Middle Triassic (Brooks and Vallier, 1978; Brooks, 1979) and comprise the Elkhorn Ridge Argillite and Burnt River Schist of Gilluly (1937). Rock types composing the former are mostly chert, argillite, basalt, tuff, and limestone; whereas the latter is composed mainly of quartz phyllite, phyllitic quartzite, greenschist, greenstone, and marble. Both units exhibit two periods of folding (Ashley, 1966) and have been metamorphosed to the greenschist and epidote-amphibolite facies of regional metamorphism.

Rocks of the Wallowa-Seven Devils volcanic-arc terrane are north of the dismembered oceanic-crust terrane and underlie the northwestern and

Figure 2. Location of geologic-physiographic provinces in the Baker Quadrangle.

EXPLANATION

CENOZOIC
Volcanic and sedimentary rocks
PRE-CENOZOIC
Late Mesozoic plutons
Forearc Basin Terrane (Jurassic Flysch Terrane)
Huntington (Juniper Mtn. - Cuddy Mtn.) Volcanic-Arc Terrane
Wallowa-Seven Devils Volcanic-Arc Terrane
Dismembered Oceanic-Crust Terrane
terrane boundary
thrust fault

Figure 3. Generalized geologic map of the Baker Quadrangle showing areal distribution of pre-Cenozoic petroTECTONIC terranes, late Mesozoic plutons, and Cenozoic volcanic and sedimentary rocks.

Figure 4b. Lithologic symbols used in stratigraphic column.

north-central parts of the quadrangle (Fig. 3). Included in this terrane are volcanic rocks of Permian to Late Triassic age and younger sedimentary rocks of Late Triassic and Early Jurassic age. Published names for various parts of the volcanic-arc assemblage in the quadrangle include the Clover Creek Greenstone (Gilluly, 1937; Prostka, 1962), the Gold Creek Greenstone (Prostka, 1962), and the Lower Sedimentary Series (Prostka, 1962), all in the southern foothills of the Wallowa Mountains (Figs. 3 and 4a); also included is the Seven Devils Volcanics of Anderson (1930), renamed and defined by Vallier (1974; 1977) as the Seven Devils Group, which underlies most of the Seven Devils Mountains and forms extensive exposures in the Hells Canyon of the Snake River at and north of Oxbow (Figs. 3 and 4a). The Seven Devils Group comprises: the Lower Permian, or older(?), Windy Ridge Formation; the Lower Permian Hunsaker Creek Formation; the Middle and Upper Triassic Wild Sheep Creek Formation; and the Upper Triassic Doyle Creek Formation (Fig. 4a). The Windy Ridge and Hunsaker Creek Formations are just within the quadrangle, whereas the Wild Sheep Creek and Doyle Creek Formations crop out 3 to 7 km to the north (Vallier, 1974). Major rock types present include keratophyre, quartz keratophyre, tuff, flow breccia, spilite, and interbedded volcanoclastic rocks (Vallier, 1977; Brooks and Vallier, 1978). Major-element chemical data of these rocks indicate that they are sodium rich and follow a low-K₂O basalt-andesite-dacite-rhyolite differentiation trend (Vallier and Batiza, 1978). The total thickness of the Seven Devils Group has been estimated to be about 6000 m (Vallier, 1977). Younger sedimentary rocks overlying the Upper Triassic rocks in the Wallowa-Seven Devils volcanic-arc terrane are the Martin Bridge Limestone of Late Triassic age and the Hurwal Formation of Late Triassic and Early Jurassic age. The Hurwal is composed primarily of siltstone, shale, argillite, and limestone (Brooks and others, 1976; Brooks and Vallier, 1978).

Rocks of the Wallowa-Seven Devils volcanic-arc terrane are compositionally similar to those present in volcanic-arc terranes in the Wrangell Mountains of Alaska and on Vancouver Island, Canada; all are believed to be part of an arc, named Wrangellia, that formed near the equator during Permian-Triassic time (Jones and others, 1977). Subsequently, fragments of this arc were rafted northward and accreted to the northwestward-moving North American continent either during the Triassic (Hamilton, 1978), the Late Jurassic (Dickinson and Thayer, 1978; Dickinson, 1979; Ave Lallemant and others, 1980), or the Cretaceous (Jones and others, 1977; Davis and others, 1978).

The Huntington (Juniper Mountain-Cuddy Mountain) volcanic-arc terrane composes a northeast-southwest-trending belt of rocks that extends from the Cuddy Mountain-Peck Mountain area to at least Juniper Mountain, Oregon, and divides the quadrangle approximately in half (Fig. 3). Included in this terrane are metavolcanic and sedimentary rocks of Late Triassic age, which collectively have been named by Brooks and Vallier (1978) the Huntington Formation; excellent exposures of these rocks exist near Huntington, Oregon. Dominant rock types are metavolcanic flows (predominantly meta-andesite), tuffs, agglomerates, and intercalated coarse volcanoclastic breccia, conglomerate, and fossiliferous marine clastic beds (Brooks and Vallier, 1978). Also within the Huntington volcanic-arc terrane are granitic intrusive bodies that have been dated by K/Ar methods at 200 to 217 m.y. (Henricksen and others, 1972; Armstrong and others, 1977). Examples of these plutons are found at Cuddy Mountain and Sturgill Peak. Although direct evidence is

lacking, indirect evidence detailed in Brooks and Vallier (1978) indicates that the Wallowa-Seven Devils and Huntington volcanic-arc terranes may be part of the same arc or parts of different arcs of similar origin.

The forearc basin terrane (Jurassic flysch terrane), situated between the dismembered oceanic-crust terrane and the Huntington volcanic-arc terrane (Fig. 3), contains up to 15,000 m of clastic sedimentary rocks. These sediments are composed of the detritus formed from the erosion of an adjacent landmass during the Jurassic (Brooks and Vallier, 1978). These rocks comprise the "flysch terrane" of Brooks and Vallier (1978), the "Jurassic flysch" of Brooks (1979), and conceal the contact between the oceanic-crust and the Huntington volcanic-arc terranes (Fig. 3). The flysch is composed mainly of volcanic wacke, siltstone, shale, and tuff, and lesser amounts of lava flows, limestone, and conglomerate. A distinctive red and green conglomerate marker unit occurs at the base of the flysch section and is unconformable on the Huntington Formation (Fig. 4a) (Brooks, 1967). Along their northern boundary, rocks of the flysch terrane are in contact with rocks of the dismembered oceanic-crust terrane along the Connor Creek fault zone (Fig. 3). The Connor Creek Fault zone is a high-angle reverse fault along which, according to Brooks (1979), "rocks of the oceanic-crust terrane have been uplifted and shoved southeastward over part of the flysch."

Upper Mesozoic plutons in that part of the Columbia Intermontane Province in the Baker Quadrangle are mainly of hornblende, biotite-quartz diorite, and biotite-quartz granodiorite and mostly cut the dismembered oceanic-crust terrane (Fig. 3). Some of these plutons, typified by the Pedro Mountain stock in the west-central part of the quadrangle, are associated with gold-bearing fissure veins and replacement masses (Gilluly and others, 1933).

Cenozoic Volcanic and Sedimentary Rocks. Cenozoic volcanic and sedimentary rocks, mostly of Miocene and Pliocene age, underlie approximately 70 percent of that part of the Columbia Intermontane Province in the Baker Quadrangle (Fig. 3). In general, volcanic rock compositions range from rhyolite to basalt; the rocks occur mostly as flows, tuffs, and breccias. Extensive Tertiary volcanic units present include: the Miocene Columbia River Basalt Group (Griggs, 1976), which fills in structural depressions in the Blue Mountains, covers a large part of the area north and northeast of the Snake River basin, and forms north-trending ridges that lie just west of the western margin of the Idaho batholith; glassy rhyolite crystal-vitric tuff, vitric-lithic tuff, and vitrophyre of the Dinner Creek welded ash-flow tuff of Fouch (1968), which occur in and around the Cottonwood Mountain area in the southwestern corner of the quadrangle; and the Miocene Dooley Rhyolite Breccia of Gilluly (1937), which contains much platy flow-banded rhyolite, welded vitric tuff, vitric-crystal tuff, tuff breccia, dacite, and andesite, and which is named for excellent exposures on and near Dooley Mountain in the west-central part of the quadrangle (Brooks and others, 1976). Although mostly in the Oregon half of the quadrangle, additional unnamed volcanic units and interfingering flows occur throughout the quadrangle and complicate the Tertiary rock stratigraphy (Brooks and others, 1976; Mitchell and Bennett, 1979).

Cenozoic sedimentary rocks, mostly of Tertiary age, occur mainly as fill in basins and as interbeds between volcanic units. Extensive rock units are

mainly in the western Snake River basin area, the Lower Powder River Valley-Virtue Flat basin, the Durkee and Richland basins, and the Rye Valley area. Rock types include mostly lacustrine and fluvial sandstone, shale, and siltstone, some of which are tuffaceous and (or) diatomaceous, and lesser amounts of conglomerate, claystone, diatomite, ash, and fine gravel. Recognized Cenozoic sedimentary rock units in the quadrangle are: the Miocene Payette and Latah Formations, which occur as interbeds in the Columbia River Basalt Group, are contemporaneous and commonly consist of sandstone, carbonaceous shale, well-consolidated ash, siltstone, and claystone (Kirkham, 1931; Marjaniemi and others, 1976); the late Miocene Deer Butte Formation (Kittleman and others, 1965), which occurs in the western Snake River basin area (Fig. 4a) (Marjaniemi and others, 1976), and consists mostly of soft tuffaceous siltstone and shale, volcanic carbonaceous shale, tuffaceous and arkosic sandstone, and conglomerate; the Poison Creek Formation of probable early Pliocene age (Kittleman and others, 1965), which also occurs in the western Snake River basin area, and contains clay, silt, ash, arkose, conglomerate, silicified and iron-stained sandstone, and orthoquartzite (Savage, 1961); and the Pliocene and younger (Kirkham, 1931) and lower-to-middle Pliocene Idaho Group (Corcoran and others, 1962), also in the western Snake River basin and consists of unconsolidated to semiconsolidated clay, silt, sand, ash, diatomite, limestone, and conglomerate (Newton and Corcoran, 1963) (Fig. 4a). Unnamed tuffaceous sedimentary rocks of Miocene and Pliocene age are in the previously mentioned Cottonwood Mountain and Dooley Mountain areas, and lignite-bearing fluvial deposits and uraniferous tuffaceous and diatomaceous arenites are in the Lower Powder River Valley area northeast of Baker.

Quaternary surficial deposits include sand, terrace gravels, stream alluvium, alluvial fans, landslide debris, and other less important deposits that cover the floors of most of the basins and fill in stream valleys in the quadrangle. Glacial debris, consisting mainly of moraine and glaciofluvial deposits, occurs in the Blue and Wallowa Mountains where glaciation was extensive during the Pleistocene.

Northern Rocky Mountains Province

Pre-Cenozoic Rocks. Pre-Cenozoic rocks in that part of the Northern Rocky Mountain Province in the Baker Quadrangle are exclusively those composing the western margin of the Cretaceous Idaho batholith (Figs. 2 and 3). In general, the rocks are mostly highly foliated metasedimentary rocks and migmatitic gneisses that grade eastward into quartz diorite and granodiorite. All the rocks fall into Swanberg and Blackwell's (1973) "main group", which composes the bulk of the batholith and yields average K/Ar and Pb/ ages of 91 m.y. and 108 m.y., respectively. In the quadrangle, the "main group" comprises from west to east the gneiss of Council Mountain, the migmatite of McCall, the quartz diorite gneiss of Donnelly, the leucocratic quartz diorite of Little Valley, and the granodiorite of Gold Fork (Schmidt, 1964).

Cenozoic Rocks. Except for some outcrops of the Miocene Columbia River Basalt Group and the interbedded Latah Formation, the remainder of the Cenozoic rocks in that part of the Northern Rocky Mountains Province in the Baker Quadrangle fall into two groups: Quaternary-Tertiary fluvial and

lacustrine deposits, and Quaternary alluvium, terrace deposits, basin-fill detritus, glacial deposits, alluvial fans, colluvium, and landslide debris (Mitchell and Bennett, 1979). The fault-bounded Long and Cascade Valleys, which occupy most of the eastern edge of the quadrangle, are filled with Quaternary alluvium and possibly Tertiary sedimentary rocks at depth and are the location of radioactive fluvial black-sand placer deposits.

ENVIRONMENTS FAVORABLE FOR URANIUM DEPOSITS

SUMMARY

Tertiary sedimentary rocks in the Lower Powder River Valley-Virtue Flat basin are considered favorable for the occurrence of sandstone uranium deposits (Subclass 241, Austin and D'Andrea, 1978). Although sandstones of mostly Tertiary age in the western Snake River basin area display some favorability characteristics, they remain largely unevaluated because subsurface data are lacking. Tertiary sandstones possibly present at depth in the Long and Cascade Valleys also remain unevaluated due to lack of subsurface data. All remaining environments in the quadrangle tentatively considered favorable from our literature studies were evaluated; none were found to be favorable for the occurrence of uranium deposits. All remaining Tertiary sedimentary rocks and all Tertiary volcanic rocks lack important favorability characteristics, and there are no recognized uranium concentrations in bed rock that begin to approach minimum tonnage and grade requirements. Although Quaternary radioactive fluvial black-sand placer deposits in the Long and Cascade Valleys, Idaho, area meet tonnage requirements, they do not meet minimum grade requirements.

AREA A (LOWER POWDER RIVER VALLEY-VIRTUE FLAT BASIN)

The Lower Powder River Valley-Virtue Flat basin (Pl. 1a) is favorable for "Wyoming" roll-type sandstone uranium deposits (Subclass 241, Austin and D'Andrea, 1978) in unnamed lower Pliocene sedimentary rocks. This favorable designation is based upon the presence of favorable host lithologies, reductants, well waters high in uranium, a newly discovered uranium occurrence, and the close match with recognition criteria from known deposits of Subclass 241. Although source rocks for the uranium are unknown and, at best, can only be speculated upon, the fact that uranium is present in some of the favorable rocks indicates that a source either existed in the past (and subsequently was removed), or that one, as yet unrecognized, presently exists.

The favorable area includes a structural and topographic basin of about 340 km² (Pl. 1a) made up of the northwest-southeast-trending Lower Powder River Valley and the adjacent Virtue Flat basin; the latter adjoins the former on the southwest. The basin is bounded on the west by probable Miocene Columbia River Basalt Group rocks, on the north mostly by pre-Cenozoic rocks of the Wallowa-Seven Devils volcanic-arc terrane, and on the south and east mostly by pre-Cenozoic rocks of the dismembered oceanic-crust terrane (Brooks and others, 1976). Although the thickness of the favorable rocks in the basin is unknown, Gilluly (1937) estimated the minimum thickness of the favorable rocks in the Ritter Creek area, in the southern part of the basin, to be not

less than 244 m (800 ft) and possibly 610 m (2,000 ft). Drill-hole data from a water well, drilled to 209 m (685 ft) in the SE1/4 NW1/4 NE1/4 sec. 14, T. 8 S., R. 41 E., and mapping by Brooks and others (1976) indicate that a thick section of the Miocene(?) Columbia River Basalt Group underlies a thick section of the favorable sedimentary rocks along the western edge of the basin. Dips of both the favorable rocks and the underlying basalt are basinward and low, commonly between 5° and 10°.

Very little published information is available on the favorable sedimentary rocks of the basin. Early studies by Gilluly (1937) reported tuffaceous sedimentary rocks, and less abundant but fairly widespread lake beds, that contain interbeds of diatomite as much as 12 m (40 ft) thick in the Lower Powder River Valley. Also mentioned are pumiceous interbeds and rare lapilli, locally present in the diatomite, and leaf casts, snail shells, and lignite. The lignite, of poor grade, forms beds up to 70 cm (2 ft) thick. Subsequent studies by Brooks and others (1976) showed the favorable basin to be underlain mostly by tuffaceous sedimentary rocks (their map unit, Tst). These rocks are principally composed of a lower lacustrine facies and an upper fluvial facies, the contact between which is gradational where exposed in the Ritter Creek area (NE1/4 T. 9 S., R. 42 E.). Although Gilluly (1937) believed these rocks to be contemporaneous or interbedded with the probable Columbia River Basalt Group, data from water wells and from surface mapping by Brooks and others (1976) indicate that the favorable unit overlies and is younger than the basalt. Ages of vertebrate fossils from near the top of the lacustrine part of the section point to an early Pliocene age for the favorable rocks (Brooks and others, 1976).

Results of our detailed studies of the newly discovered J. R. occurrence in the southern part of the basin (App. A, U. Occur. Rept. 2; Pl. 2) shed some light on favorable sedimentary host rock lithologies and possible uranium source rocks. In particular, field and petrographic studies reveal that favorable host lithologies at the occurrence include permeable and loosely consolidated tuffaceous and diatomaceous lithic arenite (Sample MKU 017) and light gray-brown siltstone. The former shows medium-scale cross-bedding, scour and fill structures, and contains fossil vertebrate (camel) bone material (H. Brooks, geologist, Oregon Department of Geology and Mineral Industries, oral comm., 1980) and carbonaceous trash, and is stained with limonite. The latter is tuffaceous and has minor amounts of carbonaceous trash. Thin-section studies of the lithic arenite indicate that the rock is moderately well sorted with sand-sized angular to subangular clasts of the following materials: 18 percent glass, occurring mostly as shards; 18 percent fresh to totally vermiculized or chloritized biotite; 14 percent iron-stained clay clasts; 14 percent volcanic rock fragments, predominantly of devitrified and (or) altered tuff; 7 percent quartz; 5 percent plagioclase, having moderate to strong sericitic alteration; 4 percent K-feldspar, having minor argillic alteration and some corrosion; 2 percent hornblende; 2 percent diatoms; 2 percent opaques (limonite, in part as clasts and as patchy cement, pyrite, chromite, and ilmenite); a trace of epidote, zircon, and sphene; and a trace of plutonic rock fragments.

Anomalous radioactivity of the arenite is associated with secondary coatings of calcium phosphate (up to 13 percent was identified in thin section) on clasts and occurring locally as cement. Select sample MKU 017 of the lithic arenite contains 57 ppm of leachable U₃O₈ (App. B) and

anomalous concentrations of calcium, magnesium, phosphorous, and tungsten (App. D). Representative sample MKU 018 of (airfall?) vitric tuff, which overlies the lithic arenite and could be a potential source, contains 10 ppm U_3O_8 but less than 1 ppm leachable U_3O_8 (App. B).

Results of our studies of the J. R. occurrence and of well-water (Pl. 5; MKU 174-181) samples indicate that known concentrations of uranium in the basin are associated with organic materials and that uranium is currently in solution. Specifically, the presence of fossil bone material and carbonaceous matter associated with anomalous radioactivity in the field, and anomalous concentrations of calcium, magnesium, and phosphorous associated with an anomalous concentration of uranium in lithic arenite, point to an intimate relationship between organic material and the localization and concentration of uranium. Secondary coatings of calcium phosphate and their contained uranium indicate that fossil bone material has gone into solution and has coprecipitated with the uranium. The presence of uranium moving in ground water in the basin is supported by well-water samples taken from four wells with bottom depths from 21 to 61 m (70 to 200 ft) (App. B; Pl. 5). Anomalous concentrations of uranium in these waters ranged from 52 to 9 ppb (average 28 ppb). These water samples indicate concentrations of labile uranium at relatively shallow depths. On the other hand, samples from four wells drilled to greater depths, 77 to 209 m (254 to 685 ft), are void of anomalous concentrations of uranium and have from 2 to less than 1 ppb; (average was less than 1.3 ppb) (App. B; Pl. 5). However, some of the latter samples are from wells that are known to have been drilled into rocks of the Miocene(?) Columbia River Basalt Group.

Characteristics of the favorable rocks in the Lower Powder River Valley-Virtue Flat basin have all the following favorable characteristics for Wyoming roll-type sandstone uranium deposits. These include most recognition criteria for that deposit subclass as discussed by Austin and D'Andrea (1978) and as outlined in Mathews and others (1979): tectonically, the favorable area occurs as an intermontane basin with adjacent uplands; favorable host rocks contain important fluvial structures, which include medium-scale cross-bedding indicative of meandering stream channel-bar and point-bar deposits, possibly similar to those containing uranium in the southern Powder River basin, Wyoming (see also Dahl and Hagmaier, 1974); favorable host-rock lithologies present include permeable and loosely consolidated lithic arenite and siltstone, some of which contain disseminated carbonaceous matter, fossil bone material, limonite staining, pyrite, and an abundance of tuffaceous material and glass shards; favorable depositional environments include fluvial, having moderately well-sorted channel-fill sediments, and flood plain, having backswamps that accumulated finer grained and locally organic-rich siltstones and claystones, and lignite; structurally, most of the favorable rocks comprise gently dipping layered sequences of channel-fill sands and silts overlain and underlain by less permeable, finer grained vitric tuff, claystone, siltstone, ash, and diatomite; other associated rock types include abundant tuffaceous siltstone and sand-sized or larger tuffaceous, glassy, and granitic rock fragments that may themselves be important as possible sources of uranium; alteration includes oxidation of iron-bearing minerals, sericitization of plagioclase, and argillization and some corrosion of K-feldspar. In addition to the above criteria, well waters high in uranium and the presence of a newly discovered uranium occurrence help support the favorability of the area.

Approximately 40 percent of the favorable land in the basin is administered under the jurisdiction of the Bureau of Land Management, and the remaining 60 percent is patented (private) land (Bureau of Land Management, 1978), which is inhabited and used mostly for grazing and agricultural purposes. A network of paved and dirt roads covers most of the area, and much of the private land is posted.

ENVIRONMENTS UNFAVORABLE FOR URANIUM DEPOSITS

SUMMARY

All pre-Cenozoic ophiolitic and associated supracrustal rocks and volcanic-arc and flysch-terrane rocks fail to meet the favorability criteria of any of the classes of uranium deposits as described in Mickle and Mathews (eds., 1978). All Mesozoic plutonic rocks are poor sources of uranium for all classes of deposits and are poor hosts for all pertinent classes of uranium deposits in igneous rocks. All Tertiary volcanic rocks in the quadrangle fail to match the recognition criteria for uranium deposits in volcanic environments, and all Tertiary sedimentary rocks (excluding those underlying the favorable and unevaluated basins) and Quaternary deposits are unfavorable for all classes of uranium deposits in sedimentary environments.

PRE-CENOZOIC OPHIOLITIC, VOLCANIC-ARC, AND FLYSCH-TERRANE ROCKS

All areas underlain by pre-Cenozoic ophiolite and associated supracrustal volcanic-arc and flysch-terrane rocks are unfavorable for all classes of uranium deposits. All these rocks are believed to have been either formed in, or derived from rocks that formed in, an oceanic environment (Brooks and Vallier, 1978; Ave Lallemand and others, 1980). Uranium is generally not known to be concentrated in oceanic environments, except in submarine hydrothermal Fe-Mn deposits (Rydell and Bonatti, 1973; Gabelman, 1977). In general, rock types comprising the unfavorable units are mostly ultramafic and low-K₂O intrusives (plagiogranite, quartz diorite, gabbro, and serpentinite), argillite, phyllite, greenstone, chert, graywacke, and spilite and keratophyre flows. None commonly serve as suitable sources or hosts for uranium deposits.

Uranium values of representative reconnaissance rock samples of these pre-Cenozoic units indicate that none are enriched in uranium; eight samples of associated supracrustal rocks have a mean U₃O₈ content of 2.6 ppm; 18 samples of volcanic-arc terrane rocks have a mean U₃O₈ content of 2.3 ppm; and 14 samples of flysch-terrane rocks have a mean U₃O₈ of 2.4 ppm (App. B; Pl. 5). There are no ARMS-defined radioactivity anomalies or known uranium occurrences associated with any of these rocks. Background radioactivity of all of these units, as measured by scintillometer, is low (ur_o ranges from 9 to 25, and ur_s ranges from 4 to 12).

MESOZOIC INTRUSIVE ROCKS

All the rocks of the Cretaceous Idaho batholith, and all other Mesozoic intrusive rocks in the Baker Quadrangle, are considered unfavorable for all

classes of uranium deposits in igneous rocks. The majority of the rocks of the batholith in the quadrangle (western-margin "main group" rocks as described in Swanberg and Blackwell [1973]) are biotite quartz monzonite and granodiorite, quartz diorite and quartz diorite gneiss, migmatite and gneiss, and older included blocks of metasedimentary schist and gneiss. All of these rocks contain low radioactivity and are not enriched in uranium. Mean equivalent-uranium content of 40 representative rock samples of the batholith is only 1.2 ppm, and three samples have a mean U_3O_8 content of 2.7 ppm (App. B; Pl. 5). In addition, data presented in Swanberg and Blackwell (1973) indicate that the migmatite of McCall (Kmcm) and the quartz diorite gneiss of Donnelly (Kqdg), both of which compose the majority of the batholith in the quadrangle, have mean equivalent-uranium values below 1.0 ppm. All other Mesozoic intrusives in the quadrangle also contain low radioactivity, low uranium content, and do not appear to be favorable sources; five representative rock samples from scattered Mesozoic plutons (Pedro Mountain stock, intrusives in the Cuddy Mountains) had less than 2.0 ppm, and six samples had a mean equivalent-uranium content of only 1.0 ppm. Although most Mesozoic intrusive rocks are slightly to moderately sericitized and (or) argillized and within a mobile-belt tectonic setting, their remaining characteristics do not closely match any of the recognition criteria for any of the classes of igneous uranium deposits as outlined in Mickle and Mathews (eds., 1978). There are no ARMS-defined radioactivity anomalies or reported uranium occurrences associated with any of the Mesozoic intrusive rocks within the Baker Quadrangle.

TERTIARY VOLCANIC ROCKS

All Tertiary volcanic rocks in the Baker Quadrangle are unfavorable for all classes of volcanogenic uranium deposits because they lack important favorable characteristics as outlined in Mickle and Mathews (eds., 1978). There are no uranium concentrations that begin to approach minimum tonnage and grade requirements in these rocks. Results of our studies indicate that two areas, Cottonwood Mountain in the southwestern corner of the quadrangle and Dooley Mountain in the west-central part of the quadrangle, both the sites of large ARMS-defined radioactivity anomalies (Pl. 3), are unfavorable. The results also indicate that these anomalies, and all other ARMS anomalies associated with Tertiary volcanic rocks in the quadrangle, reflect relatively broad areas that are mostly underlain by glassy silicic volcanics. That is, the anomalies delineate areas underlain by more highly siliceous lithologies than associated basalts and sedimentary rocks with relatively lower background radioactivity.

Although the Cottonwood Mountain area is the largest, most intense, and most continuous ARMS-defined bismuth-214 anomaly in the quadrangle (eU values up to 6 ppm with an average of about 3.5 ppm) (Pl. 3), rocks underlying the area do not appear to be favorable sources or hosts for potential deposits. Rock types present include mostly rhyolite crystal-vitric tuff, vitrophyre, and lithic tuff of the Miocene Dinner Creek welded ash-flow tuff of Fouch (1968), Miocene and Pliocene-Pleistocene basalt, and lesser amounts of interbedded sedimentary rocks of lacustrine origin. Followup studies of the strongest parts of the anomaly indicate their association with glassy silicic volcanic rocks and dark-gray to greenish-black vitrophyre. All of these approximate the average chemical composition of rhyolite (Table 1; Carmichael

TABLE 1. MAJOR-OXIDE ANALYSES OF SELECTED SAMPLES OF TERTIARY
VOLCANIC ROCKS FROM THE COTTONWOOD MOUNTAIN AND DOOLEY
MOUNTAIN AREAS

	Cottonwood Mountain			Dooley Mountain		
	MKU 033	MKU 034	MKU 037	MKU 005	MKU 010	MKU 013
SiO ₂	74.28	72.45	72.84	77.48	75.33	74.54
TiO ₂	.82	.83	.88	.12	.12	.09
Al ₂ O ₃	13.68	13.36	12.68	13.35	13.31	15.47
Fe ₂ O ₃	2.54	1.87	3.17	.55	.55	.61
FeO	.37	1.96	.72	.01	.06	.18
MnO	.03	.07	.05	<.01	<.01	<.01
MgO	.08	.39	.34	.02	.02	.04
CaO	1.25	1.58	1.25	.71	.78	.70
Na ₂ O	3.84	3.12	2.68	3.94	3.73	2.54
K ₂ O	4.40	4.90	4.21	4.03	3.90	4.15
P ₂ O ₅	.09	.09	.12	<.01	<.01	.02
CO ₂	<.10	.10	<.10	<.10	<.10	<.10
TOTALS	101.48	100.72	100.04	100.33	97.92	98.45

and others, 1974) and are not enriched in uranium. Ten representative rock samples, mostly from the strongest parts of the anomaly, have a mean U_3O_8 content of 5.0 ppm (range 2 to 9 ppm). This is the same as the average abundance of uranium in rhyolites worldwide (Rogers and Adams, 1969; Gabelman, 1977). Four samples of rhyolite vitrophyre from the above 10 samples are only more slightly enriched in uranium with a mean U_3O_8 content of 5.5 ppm (App. B; Pl. 5). Thin-section analyses reveal that all the rocks contain a high percentage of glass (average 75 percent) in the groundmass and, for the most part, are fresh to only partially devitrified. Because the above rocks are relatively fresh, the glassy silicic volcanics having only average uranium content, and because studies have shown that uranium is immobile in rocks of this type (Rosholt and others, 1971), these rocks are considered to be unfavorable as a source. The rocks also do not appear to be favorable hosts because of their low permeability and low porosity as glass, their general lack of reductants, and their lack of structural avenues for concentrating any uranium which might be in solution. In addition to and concerning the latter point, low mean values for leachable U_3O_8 (less than 1.3 ppm for the above 10 samples) indicate the highly insoluble nature of uranium in these rocks and its probable uniform distribution in the noncrystalline glassy matrix.

Tertiary rhyolitic rocks in the Dooley Mountain area also appear to be unfavorable for uranium deposits, based on their peraluminous chemistry (Table 1), relatively low background radioactivity, and low mean U_3O_8 content. Seven representative rock samples average only 3.4 ppm U_3O_8 , which is well below the 5-ppm average abundance of uranium in rhyolites (Rogers and Adams, 1969; Gabelman, 1977); and they have low mean leachable U_3O_8 contents of less than 1.1 ppm. There are no proven uranium occurrences associated with any of the unfavorable rocks (App. A).

The middle Miocene Columbia River Basalt Group, which underlies approximately 40 percent of the Baker Quadrangle (Pls. 7a, b, and c), is also considered unfavorable for uranium deposits, based on its basic composition and low background radioactivity; nine reconnaissance rock samples averaged 2.2 ppm U_3O_8 . In addition, silica-deficient rocks are typically deficient in uranium worldwide and commonly serve neither as sources nor as hosts for uranium deposits. Neither our reconnaissance field studies nor the ARMS program delineated any uranium anomalies within the basaltic units that could not be attributed to change in rock type to more siliceous lithologies.

TERTIARY SEDIMENTARY ROCKS

All Tertiary sedimentary rocks, except those in the favorable Lower Powder River Valley-Virtue Flat basin and the unevaluated western Snake River basin and Long and Cascade Valleys area, are unfavorable for all classes of sedimentary uranium deposits. Although most of the unfavorable rocks occur in favorable tectonic and regional structural settings (mobile belt, basins, and adjacent uplands) and are partially composed of favorable lithologies (sandstones and lithic wackes), their remaining characteristics do not closely match any of the recognition criteria of any of the classes of sedimentary uranium deposits as outlined in Mickle and Mathews (eds., 1978). In addition to and most importantly, results of our field studies indicate that most of the unfavorable sedimentary rocks have been derived from unfavorable pre-Cenozoic oceanic, Mesozoic plutonic, and Tertiary volcanic source rocks.

Specifically, water-laid tuffs and tuffaceous siltstones in the Richland basin in the north-central part of the quadrangle have unfavorable rocks of the Columbia River Basalt Group as one of their sources and also contain clasts of phyllitic quartzite and black quartzite, which indicates unfavorable material derived from the MzPzsv map unit (Paleozoic and Mesozoic sedimentary, volcanic, and intrusive rocks) of Brooks (1978) to the south and east. Sandy siltstones in the Durkee basin in the west-central part of the quadrangle contain numerous clasts of unfavorable greenschist, gabbro, and quartz diorite (Pls. 7a and b). Similarly, clasts of unfavorable Tertiary volcanic (flow-banded rocks, devitrified porphyries, basalt) and metamorphic rocks (schist, quartzite, hornfels, argillite) are in Tertiary sedimentary rocks south of Baker and north of Dooley Mountain in the northwest quarter of the quadrangle. Tertiary sedimentary rocks in the Rye Valley area in the west-central part of the quadrangle contain fragments of unfavorable intrusive rocks of the Pedro Mountain stock. Lower Pliocene sedimentary rocks in the Cottonwood Mountain and Dooley Mountain areas (Brooks and others, 1976) are also considered to be unfavorable because of their intimate association with and partial derivation from unfavorable Tertiary silicic volcanic rocks which underlie both areas.

All the unfavorable Tertiary sedimentary rocks in the Baker Quadrangle contain low background radioactivity as measured by scintillometer, commonly lack reductants, and are void of any ARMS-defined radioactivity anomalies or reported or proved uranium occurrences.

QUATERNARY DEPOSITS

Most Quaternary deposits in the Baker Quadrangle are unfavorable for uranium deposits because they do not match recognition criteria for favorable environments and do not contain favorable tonnages or grades. Fluvial placer deposits in streams draining the Idaho batholith contain anomalous concentrations of radioactive heavy minerals and meet all of the recognition criteria for fluvial placer uranium deposits (Subclass 111, Jones, 1978). Although the placer deposits probably meet favorable tonnage requirements, they do not contain favorable grades and, as a result, are unfavorable. The highest potential grade calculated for fluvial placers in the Baker Quadrangle is only 0.002 percent U_3O_8 from the Gold Fork placer deposit (App. A, U. Occur. Rept. 1) in Long Valley along the eastern edge of the quadrangle. This value was calculated using the maximum concentration of black sand from drill-hole data and its percent eU content from analyses listed in Storch (1958). Similar coeval fluvial placers having higher grades and tonnages, which also do not meet grade requirements for favorability, are in the adjacent Challis Quadrangle (Wopat and others, 1980).

Pleistocene sediments, particularly those in the western Snake River basin area, are unfavorable for uranium deposits because of their poorly consolidated to unconsolidated nature and low background radioactivity as measured by scintillometer. Pleistocene glacial deposits in the quadrangle are poor hosts for uranium deposits because their organic content is low and because they have low porosity and permeability due to high clay content. Recent alluvial deposits in the Baker Quadrangle are considered to be unfavorable for uranium deposits based on their low background radioactivity, as measured by scintillometer, and their lack of ARMS-defined radioactivity anomalies and uranium occurrences.

UNEVALUATED ENVIRONMENTS

Time constraints of the project in conjunction with the lack of subsurface data precluded the evaluation of two areas in the Baker Quadrangle that could possibly be favorable for the occurrence of uranium deposits. The two areas are the western Snake River basin area in the south-central part of the quadrangle and the Long and Cascade Valleys along the eastern edge of the quadrangle (Pl. 1b). Potentially favorable environments in both areas are thought to be of the sandstone type.

SNAKE RIVER BASIN

Sedimentary rocks of mostly Tertiary age, in that part of the western Snake River basin area that occupies most of the south-central part of the Baker Quadrangle (Pl. 1b), are unevaluated for sandstone uranium deposits (Class 240, Austin and D'Andrea, 1978). This unevaluated designation is based on the general lack of subsurface data, the lack of detailed mapping and the corresponding relative uncertainty of the geology of the area, the presence of few favorable characteristics in the potential sedimentary host rocks for the above deposit class, and the mostly unfavorable aspects of possible source rocks. The area is currently classified by DOE geologists as containing speculative potential uranium resources (DOE, 1979).

The western Snake River basin area is a part of a broad depression, probably a rift feature (Warner, 1975), which extends across southern Idaho and trends northwestward into southeastern and central-eastern Oregon. That part of the basin in the Oregon half of the Baker Quadrangle occupies most of the region between the city of Ontario and the Willow Creek area (Pls. 6 and 10). In the Idaho half of the quadrangle, the basin comprises the northwestern part of the Boise-Weiser subarea as defined by Marjaniemi and others (1976) that includes the general area of Payette, Weiser, and the Weiser River Valley (Pls. 6 and 10).

Most of the unevaluated area is underlain by Cenozoic sedimentary rocks composed of mostly semiconsolidated to loosely consolidated basin-fill material. Recognized rock units in the quadrangle are: the Miocene Payette Formation, the upper Miocene Deer Butte Formation, the lower Pliocene Poison Creek Formation, and the Pliocene and younger Idaho Group. Results of reconnaissance studies of these units indicate that they are stratigraphically complex and show wide lithologic variation over relatively short distances. For general unit descriptions and a synopsis of the geology of the western Snake River basin area, see Marjaniemi and others (1976) and the "Geologic Setting" section of this report.

In general, results of this study and those of Marjaniemi and others (1976) indicate that the mostly lower to middle Pliocene Idaho Group in the Payette and Weiser River Valley, Idaho, areas displays favorable recognition criteria as hosts for sandstone uranium deposits. The chief criteria are thick beds and sequences of medium- to coarse-grained sandstone, some of which are permeable and arkosic and have limonite staining and carbonaceous matter. Although the above Idaho Group rocks appear potentially favorable as hosts, other Cenozoic sedimentary host rocks in the remaining part of the Idaho half of the basin in the quadrangle do not display these favorable

characteristics, and potentially favorable source rocks in the immediate area are lacking. Concerning the latter point, results of the above studies indicate an absence of tuffaceous source rocks above the potential host rocks (Marjanemi and others, 1976, p. 47); other possible uranium sources in the immediate area, the Cretaceous Idaho batholith, the Miocene Columbia River Basalt Group, and glassy Tertiary silicic volcanic rocks in the Cottonwood Mountain area, all contain low to average mean U_3O_8 and (or) eU contents (App. B; Pl. 5) and do not display favorable characteristics. However, tuffs and tuffaceous materials mostly south of the quadrangle and immediate to and within the confines of the Snake River drainage are speculated by geologists to be additional possible sources of uranium (R. D. Miller, DOE geologist, Spokane District Office, oral comm., 1980).

The western Snake River basin area in the Baker Quadrangle contains no known uranium occurrences. Results of field studies and analyses of rock samples of all of the potentially favorable Cenozoic sedimentary host-rock units collected on a regional reconnaissance basis show no indication of anomalously uraniferous surface exposures; 24 rock samples contain a mean U_3O_8 content of 3.6 ppm, and 18 samples have a mean eU content of only 2.3 ppm (App. B; Pl. 5). In addition, eight ground-water samples from wells up to 425 m (1,294 ft) deep contain from 4 to less than 1 ppb U_3O_8 and average less than 1.8 ppb U_3O_8 . Although large ARMS-defined radioactivity anomalies are present in the Ontario, Oregon, and Weiser, Idaho, parts of the basin, they are associated with agricultural fields that have probably been treated with commercial uraniferous phosphate fertilizers (Pl. 3).

Finally, because of the limited amount and varying quality of subsurface data available for the unevaluated area, any subsurface stratigraphic correlations presently put forth are tentative at best. Specifically, although some data are available in the form of lithologic logs of water wells and lithologic and electrical logs of a few petroleum test wells, the information is mostly general (simple rock type and basic color descriptions); and most of the drill holes are so scattered geographically that specific correlations are extremely difficult or impossible to make. These points, in conjunction with the fact that part of the western Snake River basin which lies between long 116° W. and the Willow Creek, Oregon, area has not been mapped in any detail, greatly underscore the unevaluated classification of the area.

LONG AND CASCADE VALLEYS

Tertiary sedimentary rocks possibly present at depth in the Long and Cascade Valleys, adjoined and located along the eastern edge of the Baker Quadrangle (Fig. 3; Pl. 1b), are unevaluated for uranium deposits. Although these rocks could be potentially favorable for sandstone-type deposits, no subsurface information is currently available to confirm their presence at depth within either valley. Because of the potentially favorable geology of the unevaluated area despite the lack of subsurface drill-hole data, the area is considered by DOE geologists to be favorable for uranium resources but with insufficient basis for the estimation of potential uranium resources (DOE, 1979).

Long Valley occupies all of the unevaluated area roughly west and north of Cascade, Idaho; and Cascade Valley (includes Round Valley to the south) occupies the remainder of the unevaluated area to the south of Cascade. Quaternary and Quaternary-Tertiary basin-fill deposits cover most of the area; the only surface exposures of potentially favorable Tertiary sedimentary rocks are those of the Miocene Latah Formation, which crop out in two places along the eastern edge of Long Valley (Mackin, 1970; Mitchell and Bennett, 1979). Whether additional amounts of Latah and other possibly favorable Tertiary sedimentary host rocks occur at depth is unknown. Outcrops of the Latah are not anomalously radioactive, and there are no uranium occurrences or ARMS-defined radioactivity anomalies associated with them.

Structural favorability of the unevaluated area is indicated by the results of a gravity survey (Kinoshita, 1962). This survey shows the Long and Cascade Valleys to be asymmetrical basins that are bounded on all sides by steeply dipping normal faults, with the deepest parts of the basins being along the west sides. Analysis of an east-west profile of Long Valley in the Donnelly, Idaho, area indicates that about 2134 m (7,000 ft) of sedimentary deposits fill the basin and are in fault contact with granitic bed rock (rocks of the Cretaceous Idaho batholith) near the base of West Mountain, and about 610 m (2,000 ft) of sedimentary deposits are in fault contact with granitic bed rock at the east edge of the valley. Similarly, analysis of a nearly east-west profile of Cascade Valley from about 4 km (2.5 mi) south of Cascade indicates about 914 m (3,000 ft) of basin-fill sedimentary deposits at the west edge of the valley and about 762 m (2,500 ft) of sedimentary deposits at the east edge, all in fault contact with granitic basement material. According to Kinoshita (1962), the position of the faults and the westward dipping of the basins suggest that they are tilted fault blocks.

In summary, the great depth of Long and Cascade Valleys, in conjunction with the possibility of the presence of potentially favorable Tertiary sedimentary host rocks at depth, supports the unevaluated classification of the area. Although source rocks surrounding the immediate area do not look promising (Cretaceous Idaho batholith, Miocene Columbia River Basalt Group), additional possible sources, e.g., tuffaceous materials, can be speculated to have been present in the past or to be present at depth in the basins.

RECOMMENDATIONS TO IMPROVE EVALUATION

Proposed additional studies for the favorable lower Pliocene sedimentary rocks of the Lower Powder River Valley-Virtue Flat basin include detailed geochemical and scintillometer surveys, surface and photogeologic mapping, a high-resolution airborne radiometric survey, geophysical logging, additional sampling of water wells, and stratigraphic drilling. Because most of the surface investigations of the basin have been of a reconnaissance nature, rock sampling in conjunction with surface mapping, augmented by scintillometer studies, should be carried out in detail in an attempt to define and delineate favorable fluvial host-rock units and potential sources. Previous to and concurrent with the surface mapping, mapping by interpretation of aerial photographs taken at relatively low altitude, if available, should be carried out. Interpretation of low-altitude infrared aerial photographs should also be implemented in order to identify any fault or fracture trends present. A

low-level, high-resolution, rotary-wing airborne radiometric survey at 0.25-km line spacing should be flown perpendicular to the trends. The survey could aid in mapping additional trends and could reveal anomalous radioactivity along structures, which might signify the leakage of decay products from subsurface uranium occurrences or deposits. Important information, pertaining to uranium favorability in the subsurface, could be gained by logging all the water wells in the basin with tools such as spontaneous potential, resistivity, natural gamma, neutron-neutron, and neutron-gamma. Concurrently, additional sampling of the wells should be carried out, and all samples should be analyzed for uranium and helium and tested for radon. As a final step, drill holes should be placed in areas where results of the above studies indicate favorable stratigraphy and (or) uranium enrichment.

Proposed additional studies for the unevaluated Snake River basin and Long and Cascade Valley areas include mostly subsurface and some surface investigations. As a first step, because potentially favorable host rocks in the western Snake River basin area in the quadrangle have not been mapped in any detail, photogeologic mapping in combination with surface mapping is recommended in order to build an adequate geologic base map and break out subdivisions of individual units, particularly those of the Idaho Group. As described above for the favorable area, in-depth water-well and geophysical well-logging programs should be carried out in both unevaluated areas. The data from these programs could be used to further delineate relative favorability of individual units and subdivisions and to identify any uranium enrichment at depth. Finally, an initial phase of stratigraphic drilling carried out to a depth of 1524 m (5,000 ft) is recommended for the most potentially favorable areas of the western Snake River basin area. This drilling could be followed by drilling less-favorable areas to gain increased stratigraphic control and to support correlations of units. At least one drill hole should be placed in each of the Long and Cascade Valleys to check for the presence of possible Tertiary sedimentary host rocks and tuffaceous source materials at depth. Both holes should be drilled in the deepest parts (along the western edges) of the basins where maximum subsurface information could be realized.

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BAKER, OREGON/ IDAHO

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

BASE MAP CONTROL FROM USGS

Plate IA. AREAS FAVORABLE FOR URANIUM DEPOSITS

BAKER, OREGON/ IDAHO

Plate IB. AREAS UNEVALUATED FOR URANIUM DEPOSITS

BAKER, OREGON/ IDAHO

EXPLANATION		
URANIUM OCCURRENCES		
	CLASSIFICATION	
	Sedimentary	Volcanic
Minor prospect or mineral occurrence	□	
Could not locate		⊗

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 2. URANIUM OCCURRENCES

BAKER, OREGON/ IDAHO

Plate 3. INTERPRETATION OF AERIAL RADIOMETRIC DATA

BAKER, OREGON/ IDAHO

Plate 4. INTERPRETATION OF DATA FROM HYDROGEOCHEMICAL
AND STREAM-SEDIMENT RECONNAISSANCE

Map of Eastern Oregon showing uranium resource evaluation. The map displays numerous labeled points (MKU, W, C, BL) across a geographic area defined by latitude and longitude. A scale bar at the bottom indicates distances in miles (0 to 25) and kilometers (0 to 25).

All sample numbers having the prefix MKU were collected during this study, and all other sample numbers were collected during previous studies

Plate 5.

Plate 6. DRAINAGE

[illegible]

URANUM RADIUM POLONIUM
COEFFICIENT OF THERMAL EXPANSION

Plate 7A.

EXPLANATION

Qal	Alluvium: Mainly valley fill and stream channel deposits consisting of unconsolidated silt, sand, and gravel.
Qls	Landslide debris
Qtg	Terrace and fan deposits: Unconsolidated gravel, cobbles, and boulders with intermixed clay, silt, and sand.
Qgm	Glaciofluvial deposits: Unsorted bouldery gravel, sand, and silt of terminal and lateral moraines.
Tob	Basalt: Mostly thin, gently dipping flows of gray to black olivine-bearing basalt and basaltic andesite.
Tobc	Small mafic volcanic centers: probably the source of (Tob) flows.
Tst	Tuffaceous sedimentary rocks: Poorly consolidated, water-laid silts and clays, ash, tuffaceous clay, siltstone, sandstone, minor diatomite, mud-flow deposits, air-fall and ash-flow tuffs, and some coarse epiclastic deposits. Chiefly lacustrine except in the northern part of the map area where the upper part of the sequence includes gravelly fluvialite deposits.
Tpb	Basalt: Thin basalt flows and small eruptive centers. Locally covered by welded tuff of unit (Twt) and some sedimentary rocks of unit (Tst).
Twt	Silicic welded and non-welded tuff: Some tuffaceous sedimentary rocks included.
Tab	Andesite and basalt: Platy-jointed flows of hypersphere andesite and basalt. The unit is exposed only in the northern part of the map area. Stratigraphic relations are uncertain.
Tabc	Mafic shield volcano: probably the source of (Tab) flows.
Tss	Tuffaceous sedimentary rocks: Semi-consolidated to well-consolidated, welded, fine-grained tuffaceous sediments and water-laid tuff: lesser amounts of arkosic sandstone and siltstone, impure diatomite, pumice and palagonite tuff.
Tat	Ash flow tuffs and tuffaceous sedimentary rocks: Partly to densely welded silicic, ash-flow tuff, includes some non-welded tuff and tuffaceous sedimentary rocks.
Tb	Basalt and andesite: Chiefly flow on flow basalt. Includes some andesite flows, basaltic and andesitic flow breccias, palagonite tuff and breccia, and minor silicic tuff and tuffaceous sedimentary rocks. In southwest part of area includes some silicic flows at top of section.
Tr	Rhyolite and andesite: Rhyolitic and subordinate andesitic flows, flow breccia, welded and non-welded tuff, tuff breccia and small intrusive masses, commonly flow banded and locally perlitic. Includes part of Dooley Rhyolite Breccia of Gilluly (1937).
Tos	Volcaniclastic sedimentary rocks: Poorly sorted andesite and dacite pebble and boulder conglomerate, breccia and water-laid tuff.
ToV	Andesite and dacite: Flows, breccia, tuff, and intrusive rocks consisting of porphyritic hornblende andesite and dacite.
JLI	Limestone: Massive and thin-bedded limestone. Minor wacke, siltstone and arkosic sandstone.
JTs	Sedimentary rocks: Volcanic wacke and siltstone. Some conglomeratic wacke and thin limestone lenses.
Th	Sedimentary rocks: Graywacke and laminated siltstone; minor chert, thin-bedded limestone and conglomerate. Mapped as Hurval Formation by Prostka (1962).
Tmb	Limestone: Massive conglomeratic and coralline limestone and thin-bedded with thin-bedded pyritic and carbonaceous limestone and calcareous shale. Named Martin Bridge Formation by Ross (1938).
TV	Volcanic and sedimentary rocks: Lava flows, flow breccia, agglomerate, tuff, volcaniclastic conglomerate, breccia, sandstone, and siltstone. Chiefly andesite, some basaltic and rhyolitic rocks. Minor limestone.
mr	Mixed sedimentary, volcanic and intrusive rocks: Windowous and fault slices of older rocks in (JL) terrain. Includes rocks typical of units (R, gb), (MzPz) and (MzPz).
PPV	Volcanic and sedimentary rocks: Lava flows, flow breccia, and agglomerate; pyroclastic rocks; subordinate epiclastic conglomerate, sandstone, and argillite; minor chert and limestone. Volcanic rocks include split and keratophyre. Includes Clower Creek Greenstone of Gilluly (1937).
MzPzs	Foliated sedimentary and volcanic rocks and marble: Includes Port River Schist of Gilluly (1937). Phyllitic, talciferous, quartz, phyllite, pelitic phyllite, minor slate, conglomerate and marble (MzPz-s). Mostly greenstone and greenschist (MzPz-g). Marble with interlayered phyllite and slate (MzPz-l); includes Nelson Marble of Prostka (1967).
MzPzg	
MzPzl	
MzPza	Sedimentary and volcanic rocks: Argillite, chert and tuff; subordinate lava flows, conglomerate, and limestone. Includes Elkhorn Ridge Argillite of Gilluly (1937).
Kul	Upper Jurassic-Lower Cretaceous plutons: Medium-grained hornblende and biotite quartz diorite and granodiorite. Some trondhjemite and gabbro.
JNl	Upper Triassic — Lower Jurassic quartz diorite.
Rgb	Pre-Upper Triassic intrusive complex: Chiefly quartz diorite and "abite granite" (Rgd); gabbro and altered gabbro, minor peridotite, pyroxenite, and serpentinite (Rsg).

PLUTONIC ROCKS

GEOLOGIC SYMBOLS

—	Contact (dashed where gradational or inferred)
- - -	Fault showing downthrown side (dashed where inferred)
- - -	Fault, High-angle reverse
+	Anticline (showing trace of axial plane and bearing and plunge of axis. Dashed where approximately located)
+	Syncline (showing trace of axial plane and bearing and plunge of axis)
-	Strike and dip of beds or flows

7B. EXPLANATION FOR WEST HALF (OREGON PART) OF GEOLOGIC MAP

BAKER, OREGON; IDAHO

7C. EXPLANATION FOR EAST HALF (IDAHO PART) OF GEOLOGIC MAP

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1. Anderson and Wagner, 1952, fig. 2, scale 1:10,619.*
2. Ashley, 1966, pl. 1, scale 1:21,100.
3. Beeson, 1955, fig. 30, scale 1:62,500.
4. Berry, 1956, pl. 16, scale 1:62,500.
5. Breese, 1972, pl. 1, scale 1:63,360.
6. Brooks, 1977, scale 1:24,000.
7. Brooks, 1979, scale 1:62,500.
8. Brooks, in preparation, scale 1:24,000.
9. Brooks, in preparation, scale 1:62,500.
10. Brooks, in preparation, scale 1:24,000.
11. Brooks, in preparation, scale 1:62,500.
12. Brooks, in preparation, scale 1:62,500.
13. Brooks, in preparation, scale 1:24,000.
14. Brooks, in preparation, scale 1:62,500.
15. Brooks, in preparation, scale 1:24,000.
16. Brooks and others, 1977, scale 1:24,000.
17. Brooks and McIntyre, 1977, scale 1:24,000.
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19. Brooks and McIntyre, 1977, scale 1:24,000.
20. Brooks, McIntyre, and Walker, 1976, scale 1:250,000.
21. Brooks, McIntyre, and Walker, in preparation, scale 1:62,500.
22. Brooks and Vallier, 1967, pl. 1 through 6, scale 1:89,339.*
23. Brown and Newcomb, 1962, pl. 1, scale 1:126,720.
24. Bruce, 1971, pl. 1, scale 1:32,659.*
25. Calkins, 1954, pl. 1, scale 1:62,500.
26. Carlat, 1954, pl. 1, scale 1:62,500.
27. Fankhauser, 1969, pl. 1, scale 1:2,000.
28. Fitzsimmons, 1949, pl. 1, scale 1:62,500.
29. Fouch, 1968, pl. 1, scale 1:24,000.
30. Gilluly, 1933, pl. 1, scale 1:31,680.
31. Gilluly, 1937, pl. 1, scale 1:125,000.
32. Henriksen, 1975, pl. 1, scale 1:11,625.*
33. Hoover, unpublished manuscript map, scale 1:31,250.
34. Juras, 1973, pl. 1, scale 1:24,000.
35. Kennedy, 1956, pl. 1, scale 1:62,500.
36. Kiilsgaard, 1947, scale 1:190,000.
37. King, 1970, pl. 1, scale 1:24,000.
38. Kirkham, 1931, fig. 6, scale 1:422,400.
39. Livingston, 1923, (a) pl. 1, scale 1:63,360, (b) pl. 2, scale 1:63,360.
40. Lystrom, Nees, and Hampton, 1967, scale 1:96,000.
41. Mackin, 1953, pl. 13, scale 1:6,000.
42. Marjanemi, Curry, and Robins, 1976, pl. 1, scale 1:500,000.
43. Mitchell and Bennett, 1979, scale 1:250,000.
44. McIntyre, 1976, scale 1:62,500.
45. McIntyre, 1976, scale 1:62,500.
46. Newton and Corcoran, 1963, pl. 1, scale 1:250,000.
47. Palmer, 1963, pl. 1, scale 1:20,178.*
48. Paris, 1969, pl. 1, scale 1:21,120.*
49. Patterson, 1969, pl. 1, scale 1:48,000.
50. Price, 1967, pl. 1, scale 1:250,000.
51. Prostka, 1962, scale 1:62,500.
52. Prostka, 1967, scale 1:62,500.
53. Ross, 1938, pl. 1, scale 1:55,578.*
54. Savage, 1961, fig. 4, scale 1:126,720.
55. Schmidt, 1964, pl. 1, scale 1:250,000.
56. Schmidt and Mackin, 1979, pl. 1, scale 1:62,500.
57. Skurla, 1974, pl. 1, scale 1:24,000.
58. Slater, 1969, pl. 1, scale 1:12,184.*
59. Smiley, Shah, and Jones, 1975, fig. 2, scale 1:158,400.
60. Spiller, 1958, pl. 1, scale 1:33,600.
61. Stearns and Anderson, 1966, fig. 2, scale 1:14,400.
62. Storch, 1958, fig. 2, scale 1:46,452.*
63. Vallier, 1967, pl. 3, scale 1:36,624.*
64. Vallier, 1974, scale 1:125,000.
65. Wagner, Brooks, and Imlay, 1963, fig. 2, scale 1:150,857.*
66. Wolff, 1965, pl. 1, scale 1:62,500.
67. Wracher, 1970, pl. 1, scale 1:24,000.
68. Young, Harenberg, and Seitz, 1977, fig. 4, scale 1:258,612.*
69. Young and Whitehead, 1975, fig. 4, scale 1:126,720.

*Scale determined from xerox copy

Plate 8. GEOLOGIC-MAP INDEX

BAKER, OREGON/ IDAHO

INDEX

C. Forest Service RARE II (Roadless Area Review and Evaluation, Phase II) and Other Restricted Areas*

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- C-2 Boulder Park (6282) Nonwilderness
- C-3 Little Eagle Meadows (6283) Nonwilderness
- C-4 Lake Fork (6290) Further Planning
- C-5 Homestead (6291) Further Planning
- C-6 Indian Creek (4-462) Nonwilderness
- C-7 Flat Creek (4-463) Nonwilderness
- C-8 Cuddy Mountain (4-464) Nonwilderness
- C-9 Sheep Gulch (4-465) Nonwilderness
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- C-11 Snowbank (4-062) Nonwilderness
- C-12 Lick Creek West (W4-455) Nonwilderness
- C-13 Phillips Reservoir Protective Area
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- E-1 Washington Gulch
- E-2 Snake River
- E-3 Wildhorse Rapids
- E-4 Weiser River—Crane Creek
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G. Government Installations

- G-1 Beaver Mountain Radar Station
- G-2 Blue Mountain Seismological Station

J. National Wildlife Reserves and Refuges

- J-1 Snake River Islands (Deer Flat National Wildlife Refuge)

M. State Withdrawals

- M-1 Rattlesnake Springs Wayside Park
- M-2 Farewell Bend State Park
- M-3 Mann Creek State Park
- M-4 Ontario State Park
- M-5 Packer John Cabin State Park
- M-6 Ponderosa State Park

*The Forest Service identification code for each area appears in parentheses. The terms "Wilderness," "Nonwilderness," and "Further Planning" are allocations recommended by the Forest Service as of January 1979.

Plate 9. GENERALIZED LAND STATUS

BAKER, OREGON/ IDAHO

Plate IO. CULTURE

Figure 4a. Generalized stratigraphy of the Baker Quadrangle.