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URANIUM FAVORABILITY OF CENOZOIC SEDIMENTARY ROCKS OF THE WESTERN SNAKE RIVER BASIN, IDAHO

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GRAND JUNCTION OFFICE, UNDER CONTRACT NO. E(05-1)-1664

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SUMMARY

Cenozoic sedimentary rocks in the western Snake River basin of Idaho were studied to determine their favorability for uranium resources. This project involved the review of published and unpublished reports, description and sampling of surface sections and isolated outcrops, chemical and mineralogical analyses of samples, and interpretation of data from petroleum test wells and deep water wells.

Effort was concentrated on formations that are widely exposed in the area and that contain thick sequences of consolidated or partially consolidated sedimentary rocks. These are the Payette, Sucker Creek, Poison Creek, Chalk Hills, and Glenns Ferry Formations and the undivided Idaho Group. Studies of the Payette, Sucker Creek, and Poison Creek Formations were mainly limited to the surface because these formations could not be identified in (and probably are not penetrated by) most wells utilized in the study. The Idaho Group was studied on the surface and in the subsurface.

To facilitate the analysis and description of uranium favorability, the project area was divided into 13 subareas based on the geology, availability of data, and relative favorability (Fig. 10). As an aid in describing the favorability, a relative favorability rating system was established. This system includes three favorability classes: greatest, moderate, and least.

The western Snake River basin of Idaho is judged to be favorable for potential uranium resources because (1) it is a large basin containing a thick sequence of Tertiary sedimentary rocks and (2) it is adjacent to the Idaho batholith that contains possible uranium source rocks. In addition, the dips of the sedimentary beds are gentle, there are unconformities in the sedimentary sequence, there is much faulting of the sedimentary beds, and the Tertiary sequence contains thick tuffaceous beds. Although no significant uranium deposits have been reported in the project area, occurrences are known in similar rocks in the westward continuation of the Snake River basin in Oregon.

The Payette Formation is rated least favorable because of the low percentage of medium- to coarse-grained sandstone, absence of sandstone beds more than 20 ft thick, and low mean equivalent uranium content. This formation crops out only in the Boise-Weiser subarea. Parts of this subarea that are mapped as Payette Formation or Columbia River Basalt (with which the Payette is interbedded) are, therefore, considered least favorable.

The Sucker Creek Formation is rated of greatest favorability because of the presence of thick sequences of medium- to coarse-grained sandstone and conglomerate in beds more than 20 ft thick, relative abundance of tuffaceous rocks above the potential host rocks, presence of carbonaceous material, relatively high mean equivalent uranium content, and anomalous chemical composition of samples from two localities. This formation crops out throughout

most of the Sucker Creek subarea and probably underlies volcanic rocks throughout the remainder of the subarea. The entire subarea is, therefore, rated of greatest favorability.

The Poison Creek Formation is rated moderately favorable because of a moderate percentage of medium- to coarse-grained sandstone or conglomerate and low mean uranium content. This formation crops out in the Boise-Weiser subarea and in the northern part of the Sucker Creek subarea.

The Idaho Group, which crops out and subcrops throughout most of the project area, is rated of least to greatest favorability depending on depth interval and location in the basin. The surface exposures and shallow subsurface interval (surface to 2,000 ft) are rated as follows:

1. Southeastern part of Boise-Weiser subarea - greatest favorability because of moderate to high sandstone percentage, presence of thick sequences (up to 600 ft thick) of permeable medium- to coarse-grained sandstone and conglomerate, in beds 20 to 50 ft thick, relative abundance of carbonaceous material, faulting, and anomalous trace-element composition of samples from three localities.

2. Northwestern part of Boise-Weiser subarea - moderate favorability because of low to moderate sandstone percentage and the fine-grained nature of rocks exposed at the surface.

3. Murphy-Chalk Hills subarea - moderate to greatest favorability, because of moderate to high percentage of sandstone in water wells, presence of thick sequences of sandstone containing thick beds of sandstone or conglomerate, high mean equivalent uranium content of samples, and anomalous trace-element composition of samples from three localities.

4. Castle Butte subarea - least favorability because of the low percentage of sandstone and absence of thick sandstone beds.

5. Reynolds Basin subarea - moderate favorability because of the presence of a thick sequence of medium- to coarse-grained arkosic sandstone more than 20 ft thick and the presence of tuffaceous rocks and lignite. Parts of the subarea that are underlain by granitic rock are rated least favorable because of the absence of more than 100 ft of sedimentary rocks, excluding unconsolidated rocks of Quaternary age.

6. Nampa and Glenns Ferry-Hagerman subareas - moderately favorable because of the overall moderate percentage of sandstone and presence of medium- to coarse-grained sandstone in beds more than 20 ft thick.

7. Mountain Home and Gooding subareas - possibly moderate favorability because of the probable presence of rock units correlative with moderately favorable strata in the adjacent Glenns Ferry-Hagerman subarea.

8. Camas Prairie, Mount Bennett Hills, and Winter Camp subareas - least favorability because of the absence of more than 100 ft of sedimentary rocks, excluding unconsolidated sediments of Quaternary age.

The deep subsurface interval (below 2,000 ft) of the Idaho Group is rated only in those parts of the project area for which information is available. These ratings, based solely on sand percentage, are as follows:

1. Boise-Weiser and Nampa subareas - least to greatest favorability depending on location.

2. Castle Butte subarea - least favorability.

3. Central part of Glenns Ferry-Hagerman subarea - least to greatest favorability depending on location.

INTRODUCTION

This report presents the results of a study of Cenozoic sedimentary rocks in the western Snake River basin of Idaho, conducted on behalf of the Grand Junction Office of the U.S. Energy Research and Development Administration (ERDA). The study was started in December 1974 and completed in June 1975.

This area was selected for a uranium favorability study because of the large size of the Tertiary basin, the thickness and depth of sandstone units, the proximity to uraniferous source rocks of the Idaho batholith, and the lack of past uranium exploration. The western Snake River basin in Idaho has had no uranium production and lacks significant uranium occurrences, but similar Tertiary strata in adjacent Malheur County, Oregon, do contain minor uranium occurrences.

OBJECTIVES AND SCOPE

The primary objective of the project was to assess the favorability of Cenozoic rocks for uranium resources. This objective was accomplished through (1) review of published and unpublished maps and reports; (2) analysis of all available subsurface data; (3) field work, including radiometric reconnaissance, outcrop studies, and collection of samples; (4) petrographic and chemical analyses of samples; and (5) interpretation of the data.

A secondary objective was to synthesize geologic information gathered in the course of the study to provide ERDA with a basis for estimating the uranium potential of Cenozoic sedimentary rocks in the area.

PROJECT AREA

The project area includes parts of 16 counties in southwestern Idaho (Fig. 1). Its north-south extent is approximately 45 miles; its east-west extent, 150 miles. The total area encompassed is approximately 9,000 square miles.

ACKNOWLEDGMENTS

The authors acknowledge Lewis S. Prater, Idaho Bureau of Mines, Moscow, for assistance in obtaining data on petroleum test wells; Margaret C. Roth, Idaho Department of Water Resources, Boise, for assistance in obtaining copies of water well drillers' reports; and the U.S. Geological Survey personnel of the Public Information Office in Spokane.

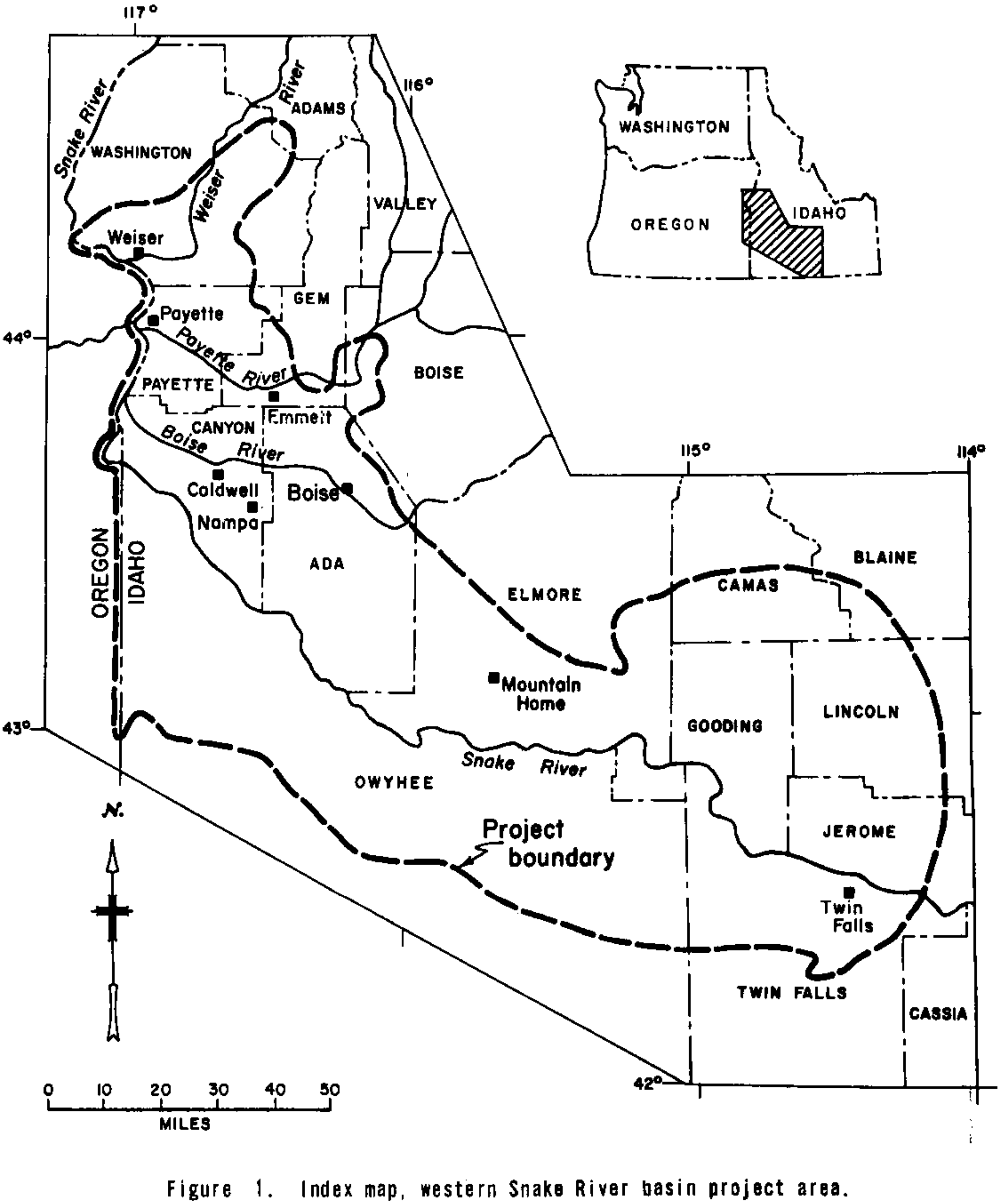

Figure 1. Index map, western Snake River basin project area.

URANIUM FAVORABILITY CRITERIA AND RATING SYSTEM

The uranium favorability of a sedimentary rock sequence is determined from a comparison of its observed characteristics with those of similar sequences in areas of known uranium deposits. Reviews and discussions of uranium favorability criteria are found in the literature (see, for example, Grutt, 1972).

PERTINENT CRITERIA

Criteria pertinent to the present study include:

Total Thickness of Sedimentary Rock. Large areas of the western Snake River basin are characterized by (1) absence of major sedimentary formations with thicknesses in excess of 100 ft, and (2) either shallow granitic basement rock with less than 100 ft of overlying sediments, or volcanic formations that contain less than 100 ft of interbedded sedimentary rock. Because the probability that a sequence contains potential host rocks is related to the overall thickness of the sequence, the presence of a sedimentary formation more than 100 ft thick is considered more favorable in an area than the presence of a sequence less than 100 ft thick.

Age. Tertiary sedimentary rocks are more favorable than Quaternary rocks. Unconsolidated Pleistocene rocks are unfavorable.

Depositional Environment. The two sedimentary environments most widely represented in the study area are fluvial and lacustrine. The fluvial environment is the more favorable.

Sand Percent. A value between 50 and 80 percent is favorable (range of sand/shale ratio considered favorable by Grutt, 1972, p. 53).

Thickness of Beds. A favorable sequence should contain one or more sandstone beds that are at least 20 ft thick.

Grain Size, Sorting, and Permeability. Poorly sorted, medium- to coarse-grained or conglomeratic rocks and permeable rocks are most favorable. Low permeability due to cementation (that is, carbonate, silica) or presence of clay minerals is indicative of low favorability only if there is evidence that this condition has existed since time of lithification.

Presence of a Reductant. The presence of carbonaceous material or pyrite in or adjacent to the potential host rock is favorable. The presence of carbonaceous material or pyrite in beds separated from the host rock is favorable but of less importance. The detection of gas in a well is favorable.

Association with Tuffaceous Rocks. The presence of tuffaceous rocks lying above the potential host rock is favorable.

Iron Staining. Pre-Holocene, postlithification iron staining is favorable.

Structure. A gentle dip of the potential host rock is favorable. An unconformity or erosional surface above or below the potential host rock is favorable. Faulting of the potential host rock is favorable.

Provenance. Source rocks with high uranium content are favorable.

Feldspar Content. Feldspar is a favorable mineralogic component of the potential host rock.

Color. Light colors in a potential host rock are favorable where they are suggestive of a reducing environment.

Subsurface Radioactivity. High natural gamma radiation (as recorded on a gamma-ray log) from a potential host rock or adjacent claystone or siltstone bed is favorable.

Chemical Composition. High concentrations of certain elements or ratios in the potential host rock, in argillaceous sedimentary rocks interbedded with or adjacent to the potential host rock or in water that may have passed through the potential host rock, are evidence of favorability. These elements and ratios include eU, eU/eTh, eU/eK, eTh/eK, As, B, Cr, Cu, Ga, Li, Mn, Mo, Nb, P, Se, Sn, V, and Zn (Marjaniemi and Robins, 1975a, 1975c; Grutt, 1972, p. 53). Of these, equivalent uranium is the most important indicator. The amounts of the possible chemical indicators in individual samples were determined to be "high" or "not high" by comparison with the respective mean amounts of a control group of samples (for example, all samples in the same formation).

The information available relative to structure and provenance were sufficient to determine overall relative favorability of the project area but were not useful in determining relative favorability of individual formations or geographic subdivisions of the project area.

In any one formation or subdivision of the project area, only some of the favorability criteria apply, depending on available data. The largest number of criteria applies to formations and areas in which surface studies were conducted and samples of potential host rocks were collected and analyzed. The smallest number of criteria applies to formations and areas in which the only pertinent information available is from regional geologic maps.

RATING SYSTEM

On the basis of the criteria listed above, the following relative rating system was developed to aid in describing the uranium favorability of the western Snake River basin of Idaho.

Greatest Favorability. The sequence of sedimentary rocks is more than 100 ft thick. The age of the sequence is Miocene to Pliocene. Sandstone composes more than 30 percent of the sequence. Potential host rocks in the sequence have the following characteristics: (1) fluvial; (2) more than 20 ft but less than 200 ft thick; (3) medium to coarse grained or conglomeratic;

and (4) poorly to moderately sorted. The sequence generally includes some tuffaceous rocks and a reductant (carbonaceous material or natural gas) or evidence of reducing conditions (pyrite). The mean concentration of uranium in samples of potential host rock and adjacent fine-grained beds is close to or above the mean for all project samples. A few samples contain anomalously high (two or more standard deviations above the mean) concentrations of uranium and one or more of the other possible chemical indicators of favorability.

Moderate Favorability. The sequence of sedimentary rocks is more than 100 ft thick. The age of the rocks is Pliocene to Pleistocene. The overall percentage of sandstone is between 10 and 30 percent. Potential host rocks with the following characteristics are generally present in the sequence: (1) fluvial in origin; (2) more than 20 ft but less than 200 ft thick; (3) medium to coarse grained or conglomeratic; (4) moderately sorted; and (5) poorly consolidated. The sequence includes some tuffaceous rocks; possible reductants or evidence of reducing conditions are scarce.

Least Favorability. The sequence of sedimentary rocks is less than 100 ft thick or the overall percentage of sandstone is generally less than 10 percent. The age of the rocks is Miocene to Pleistocene. Beds of medium- to coarse-grained sandstone or conglomerate are less than 20 ft thick.

USE OF THE RATING SYSTEM

As a rule, when different favorability ratings were obtained for different localities in an area or for different stratigraphic intervals in a formation, the area or formation was assigned the highest of the ratings except when the number of localities or intervals so rated was minor.

For example, if data from 10 localities was consistent with a greatest favorability rating and data from 15 was consistent with a moderate rating, the area was rated of greatest favorability. If, on the other hand, data from two localities was consistent with a greatest favorability rating and data from 20 was consistent with a moderate rating, then the area was rated of moderate favorability, and the exceptions are noted as evidence that parts of the area may be of greatest favorability.

METHODS OF INVESTIGATION

The study involved (1) a review of the literature, (2) an analysis of subsurface data, (3) field work, (4) petrographic and chemical analyses of surface samples, and (5) interpretation of the data. Subsurface work was given priority over field and laboratory work because Cenozoic formations with the most overall favorable characteristics are deeply buried throughout much of the basin (R. D. Miller, oral commun., 1974). Discussions of data from the field work and sample analyses generally precede discussions of subsurface aspects in the present report because they were generally more useful in determining relative favorability.

LITERATURE REVIEW

Published and unpublished reports were reviewed and utilized in the study. The pertinent published reports are cited as references in the present report. Unpublished reports utilized in the study include U.S. Geological Survey open-file reports; theses from several colleges and universities; U.S. Atomic Energy Commission preliminary reconnaissance reports; data from petroleum test wells obtained from files of the Idaho Bureau of Mines, Moscow, Idaho; well logs for petroleum test wells obtained from the Rocky Mountain Well Log Service, Denver, Colorado; and water well drillers' reports obtained from the Idaho State Department of Water Resources, Boise.

FIELD WORK

Field work consisted of gathering stratigraphic and lithologic data, collecting samples, and conducting radiometric reconnaissances using a hand-held scintillometer. Effort was concentrated on formations considered to have the most favorable overall characteristics identified in the section "Uranium Favorability Discussions" (below), on the basis of information in the literature and field reconnaissance by R. D. Miller (oral commun., 1974). The stratigraphic and lithologic data (App. A) consist of general characteristics and thickness estimates of representative sections and detailed characteristics of parts of sections containing possible host rocks. As a rule, samples were collected of the most favorable potential host rock (considering stratigraphic, lithologic, and radiometric characteristics) in the section. Whenever possible, samples were also collected of fine-grained argillaceous beds adjacent to the potential host rock so that it could be determined if the argillaceous beds were enriched in uranium or other possible trace element indicators relative to the potential host rock (such as would be expected from movement of uraniferous solutions through the potential host rock).

For conglomeratic rock units, the sample for chemical analysis included fragments of both clasts and matrix and was representative of the total rock. Because of the limited area that can be represented on a thin section, the petrographic sample was collected from the matrix or finest conglomeratic material.

All rock samples were examined through a binocular microscope to determine color, texture, and overall composition for subsequent incorporation in the stratigraphic and lithologic descriptions of individual localities.

The field work was completed during a one-month period. Sections were examined in more than 100 localities (Pl. 2), most of them near the margins of the basin. Stratigraphic and lithologic data are recorded in Appendix A. In addition, 118 rock samples were collected for petrographic and chemical analyses, and 10 water samples were collected for uranium analyses.

CHEMICAL ANALYSES

All rock samples were analyzed by gamma-ray spectrometry for uranium, thorium, and potassium (App. B); the results are reported as radiometric equivalents, eU, eTh, and eK, and as the ratios eU/eTh and eU/eK. Water samples (App. F) were analyzed for uranium by the fluorimetric method. The precision of the gamma-ray spectrometric analyses is similar to that reported by Marjaniemi and Robins (1975a, Table 1, p. 7).

Thirty-eight rock samples were analyzed for 69 elements by emission spectroscopy. Appendix C contains the results of these analyses for 31 elements; 38 elements were not found in any sample. The samples were selected for emission spectroscopic analysis from localities characterized by (1) higher-than-average radioactivity, and (or) (2) highly favorable stratigraphic and lithologic characteristics (App. A).

PETROGRAPHIC WORK

Thin-section studies (App. E) of 20 samples include rock identification, semiquantitative modal analysis, textural description, and description of alteration. The precision of the modal analysis, based on repeated analysis of samples, is about ±5 percent at a 10 percent concentration level and ±10 percent at a 50 percent concentration level. Thin-section studies were made where there were (1) questions of origin, classification, or composition and (2) higher-than-average radioactivity readings.

The rock names used in this study and those heading the thin-section reports (App. E) were assigned following a review of the thin-section reports and field data. Where the assigned rock name and its descriptors conflict with the modal analysis, the rock name should be considered correct as such disparitites arise primarily because the thin section does not represent the total rock, as in conglomerates.

SUBSURFACE STUDY

Petroleum Test Wells

Twenty-seven petroleum test wells were identified in the project area; the study utilized data from 14 of these wells (Pl. 2) and from 3 additional wells just outside of the project area in Oregon. Wells were selected on the basis of total depth, type and quality of well logs available, and location. Most of the rejected wells have only poor quality lithologic logs and no electric logs, and are less than 2,000 ft. Identification data and information on log availability and quality for the selected wells are in Appendix H.

The total depth of the petroleum test wells utilized in the study ranges from 758 ft (well 32) to 11,963 ft (well 35). Lithologic logs are available for all of the wells; electric logs are available for 8 wells; and gamma-ray neutron logs for 2 wells (Pls. 3, 4, 5, and 6).

Water Wells

Lithologic logs for 74 water wells utilized in the study were obtained from well drillers' reports on file with the Idaho Department of Water Resources, Boise, and from Littleton and Crosthwaite (1957). The wells were selected from several thousand in the area on the basis of total depth, log quality, formations penetrated, and usefulness in the favorability evaluation of that subdivision of the project area in which the well is located. The lithologic logs for the selected wells, most of which are unpublished, are in Appendix G. Locations of these wells are shown on Plate 2.

The depth of the water wells used ranges from 300 ft (well 107) to 4,000 ft (well 37). The amount of information on the lithologic logs varies considerably. For most of the wells the information is limited to simple rock type and basic color. For a few wells, the logs contain more definitive rock names and colors in addition to information on hardness and grain size.

Structure Cross Sections

Four subsurface cross sections were constructed from lithologic logs for the 17 petroleum test wells and 2 deep water wells selected for use in the study. The water wells were selected on the basis of total depth, quality of lithologic log, and location with respect to the lines of section (Pl. 2). The sections A-A', B-B', C-C', and D-D' are shown on Plates 3 through 6, respectively. The cross sections consist of (1) symbolized lithologic columns; (2) electric logs, where available; (3) gamma-ray logs, where available; (4) lithologic information relating to the uranium favorability of sand intervals (such as grain size, degree of consolidation, feldspar content); and (5) information to further define generalized intervals on the lithologic column (for example, interbedded sandstone and claystone).

Where the electric log is of good quality, the top and bottom elevations of units shown on the lithologic column are based on the electric rather than on the lithologic log.

It was not possible to construct stratigraphic cross sections for the following reasons:

1. Lithologic logs of the quality needed for correlating formations or rock-stratigraphic units were not available for all wells.

2. Electric logs were available for less than half of the wells.

3. The overall density of wells was low. The wells were spaced on the average of 5 to 10 miles apart.

4. There were few good markers on the available electric logs, and because of possible faults and facies changes, these could not reliably be carried throughout the cross sections.

Because two of the recent petroleum test wells (nos. 34 and 35) were much deeper than the others (9,678 and 11,963 ft, respectively), the lower parts of these logs are shown on cross section D-D' (Pl. 6).

TERMINOLOGY

The purpose of this section is to define terms used in this report which are variously defined in the literature.

The term "feldspathic" indicates that the rock contains between 10 and 25 percent feldspar. "Arkosic" indicates that it contains more than 25 percent feldspar.

Rock modifiers relating to crystal or lithic content indicate that the rock is composed of more than 50 percent of that mineral or rock type (for example, "quartz" sandstone and "granite" conglomerate).

The terms "tuff" and "tuffaceous" are used as defined in the "Glossary of Geology" (Gary and others, 1972). The following characteristics were used to distinguish between tuffs and tuffaceous sedimentary rocks:

1. Tuffs have a higher percentage of glass shards (generally more than 50 percent) than do tuffaceous sedimentary rocks.

2. Tuffs have a lower percentage of rounded to subrounded crystal or rock fragments than do tuffaceous sedimentary rocks.

3. The composition of rock fragments in tuffs is less varied than in sedimentary rocks.

4. In tuffs there is generally no evidence of epiclastic origin (bedding, sorting, cross bedding) while in tuffaceous sedimentary rocks there may be such evidence.

Where it was not possible to distinguish between pyroclastic or epiclastic origin, both terms are used as follows: "tuffaceous siltstone/tuff" (the first is considered most probable). Use of the term tuffaceous does not imply any particular origin or mode or transport of the pyroclastic material. The pyroclastic material of a tuffaceous sandstone may have been blown into the sedimentary basin directly from its source area or may have washed in from a nearby deposit.

REGIONAL SETTING

PHYSIOGRAPHY

The project area lies within the Columbia Plateau province of Fenneman (1931) and more recently has been called the Columbia Intermontane province (Ross and Savage, 1967, p. 150). The project area includes most of the Malheur-Boise-King Hill section and parts of the adjoining Seven Devils, Owyhee Uplands, and eastern Snake River Plain sections of this province (Fig. 2), as defined by Ross and Savage (1967). The following summary of the characteristics of these physiographic sections is based largely on Ross and Savage (1967, p. 151-154).

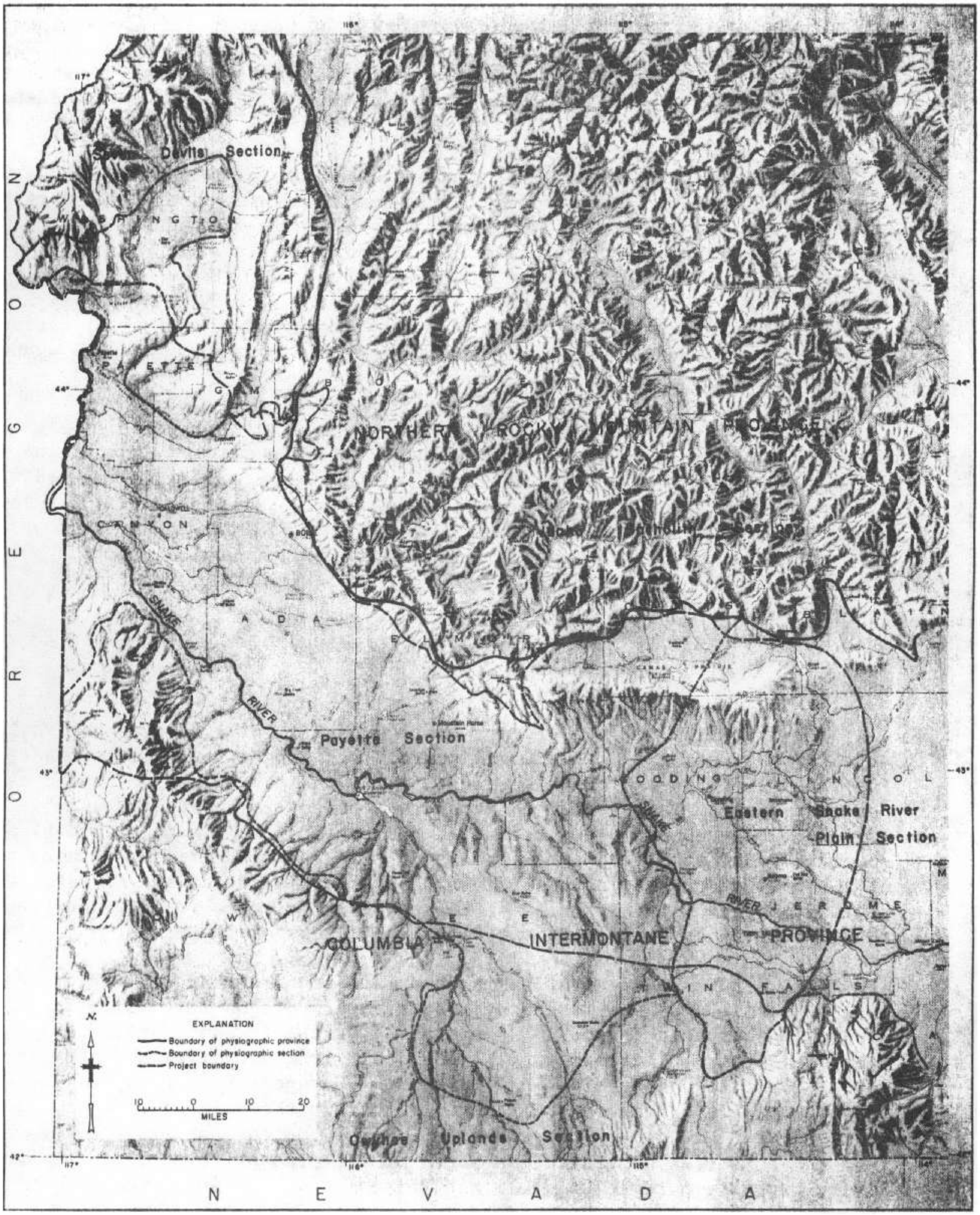

Figure 2. Shaded relief map of southwestern Idaho, with physiographic subdivisions and project boundaries.

The Malheur-Boise-King Hill section is a monotonous flat plain that extends westward into the Malheur River basin of Oregon. In Idaho it encompasses lowlands on both sides of the Snake River, the adjacent ridges, and adjacent basins of the Bruneau, Boise, and Payette Rivers. Elevations range from 2,500 ft near the Idaho-Oregon border to 3,500 ft in the eastern part.

The Seven Devils section is an elevated mountainous mass cut by deep canyons of the Snake and Salmon Rivers. North-south elongated mountain blocks are characterized by steep eastern slopes and gentle-to-moderate western slopes. Elevations in that part of the Seven Devils section included in the project area range from 2,100 to 4,300 ft.

The Owyhee Uplands section is a deeply dissected plateau. Elevations in that part of the section included in the project area range from 4,000 to over 8,000 ft.

The eastern Snake River Plain section is a flat topographic basin that extends from near the Idaho-Wyoming border into the eastern part of the project area; it is a relatively young lava plateau, partially covered with a thin layer of wind-blown soil, and is almost featureless except for low shield volcanoes, cinder cones, and lava ridges. Elevations in that part of the section included in the project area average about 3,000 ft but are as high as 6,500 ft in the foothills of the Rocky Mountains to the north.

GEOLOGY

The boundaries of the project area generally coincide with the maximum extent of Miocene and Pliocene sedimentary rock formations in southwestern Idaho (including areas in which these formations may underlie formations of Quaternary age), except that the eastern boundary is about long. 114°15' W. (Pl. 1). Approximately 40 percent of the project area is underlain by poorly consolidated sedimentary rocks of Pliocene and Pleistocene age; much of the remaining area is underlain by Quaternary alluvium and basalt. Older sedimentary and volcanic rocks of Eocene (?) to Miocene (?) age and granitic rocks of Cretaceous age crop out along the flanks of the basin.

The western Snake River basin is a part of the broad depression that extends across southern Idaho into southeastern Oregon (Fig. 3). This depression has been termed a "downwarp," a "graben," and a "rift" by previous workers. Kirkham (1931b) concluded from stratigraphic and structural studies that the depression is a downwarp. Savage (1958, Fig. 16) indicated that the axis of the downwarp generally follows the present course of the Snake River. Newton and Corcoran (1963, p. 9) noted subsurface evidence that the axis lies several miles north of the present channel of the Snake River, probably between Caldwell and Boise.

Malde and Powers (1962, p. 1202 and 1203) concluded from surface studies in the western Snake River basin that the depression is grabenlike and that middle and later Pliocene and Pleistocene sedimentary rocks were downdropped against early Pliocene volcanic rocks and Cretaceous granitic rocks. The

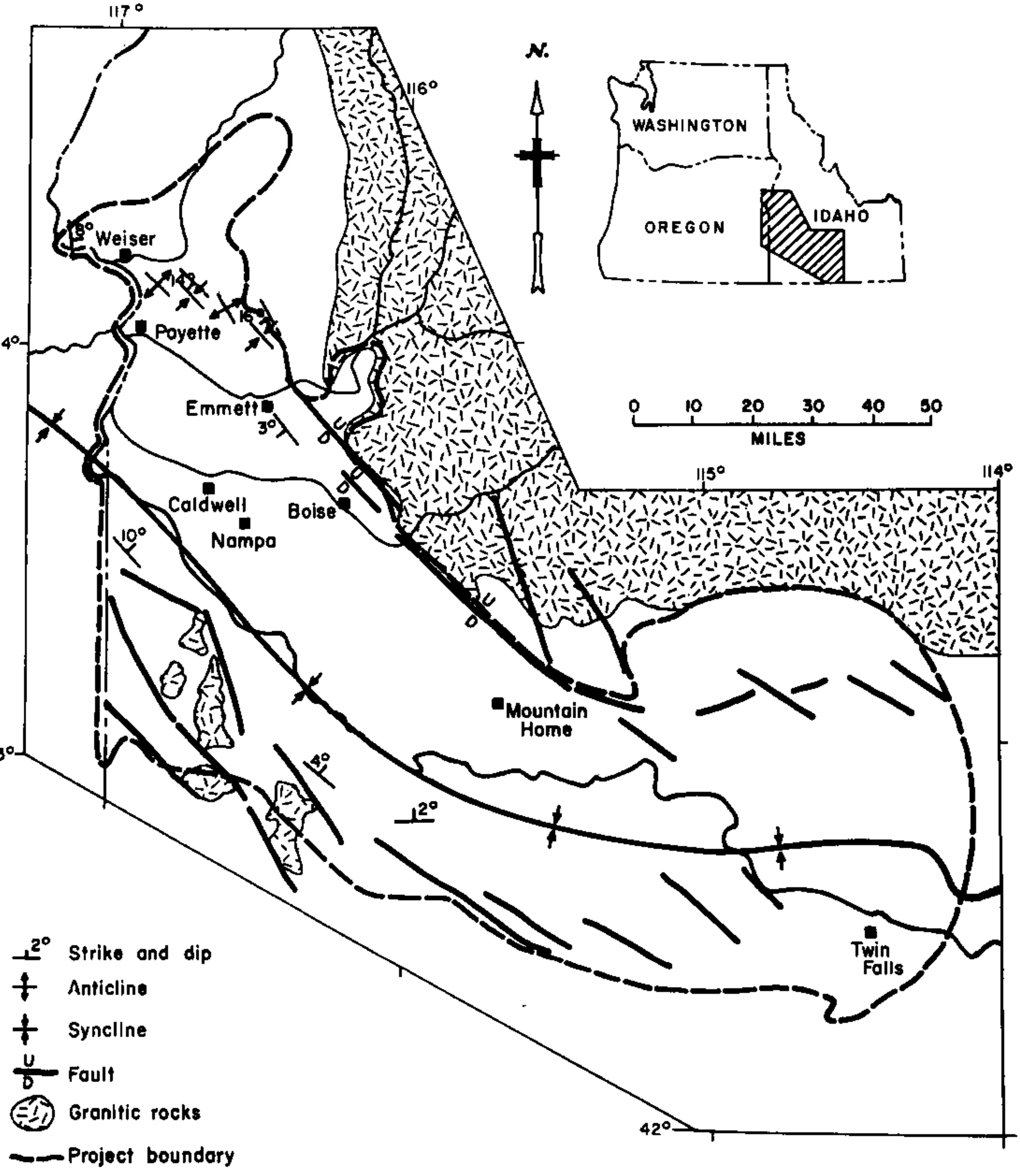

Figure 3 Generalized structure map, western Snake River basin, Idaho. After Ross and Savage (1967, p. 52); Newton and Corcoran (1963, Pl. 1); and Malde and others (1963).

amount of displacement along faults near the northern boundary of this structure is estimated by Malde (1959) to have been at least 5,000 ft during early and middle Pliocene time and 4,000 ft since middle Pliocene time.

Warner (1975) presented evidence of the presence of a major left-lateral rift in southern Idaho that has a displacement of approximately 50 miles and generally coincides with the present channel of the Snake River.

Approximately 12,000 ft of sedimentary and volcanic rocks were penetrated by a deep petroleum well located between Caldwell and Payette (well 35, Pl. 2 and App. H). This well is close to the axis of the downwarp, as located by Newton and Corcoran (1963, p. 9). In a second deep test well, located near Mountain Home (well 34, Pl. 2 and App. H), approximately 10,000 ft of sedimentary rocks were penetrated. Granitic basement was not reached in either of these two wells. The total thickness of Cenozoic sedimentary and volcanic rocks in the deeper parts of the western Snake River basin of Idaho is not known. Malde (1959) noted that, on the basis of gravity measurements near Mountain Home, between 13,000 and 38,000 ft of rock have been downdropped against the Idaho batholith.

There is little deformation of Cenozoic rocks in the western Snake River basin of Idaho. Dips are less than 5° throughout most of the area (Fig. 3). Near the margins of the basin, dips are as steep as 15°; the more steeply dipping beds are generally the oldest.

Previous workers mapped a large number of faults in the project area (Savage, 1958, Figs. 4 and 5; Malde and Powers, 1972; Malde and others, 1963). Many more can be inferred from a map of linear elements on ERTS images (Day, 1974). The primary trend of the mapped faults and linear elements is northwest, approximately parallel to the northern and southern margins of the basin. Only some of the major faults are shown on Figure 3. Several small anticlines and synclines were mapped in the northwestern part of the basin (Kirkham, 1931a; Newton and Corcoran, 1963; Fig. 3, this paper).

CENOZOIC GEOLOGY

Rock units of Cenozoic age in the western Snake River basin are summarized in Figure 4 and are described below.

CHALLIS VOLCANICS

The Challis Volcanics are found only in the northeastern part of the project area (Pl. 1). They include tuffs and flows that range in composition from rhyolite to andesite (Malde and others, 1963). These are the oldest Cenozoic rocks exposed in the project area. They are of Eocene (?) to Miocene (?) age (Malde and others, 1963).

	Generally West of Longitude 116° W. after: Beaulieu (1972); Corcoran and others (1962); Kirkham (1931a); Kittleman and others (1965); Kittleman and others (1967); Malde and Powers (1962); Newton and Corcoran (1963); Savage (1958); and Savage (1961)	Generally East of Longitude 116° W. after Malde and others (1963)
PLEISTOCENE to HOLOCENE	Alluvium unconsolidated sand, silt, clay and gravel	Alluvium unconsolidated sand, silt, and gravel
PLEISTOCENE to HOLOCENE	Snake River eruptives basalt flows and pyroclastic rocks	Snake River Group basalt flows; interbedded gravel
PLEISTOCENE / PLIOCENE	*Idaho Group unconsolidated to semiconsolidated clay, silt, sand, ash, diatomite, limestone, and conglomerate; may include gravels and basalt flows	Idaho Group: Black Mesa Gravel gravel and sand
		Idaho Group: Bruneau Formation unconsolidated silt, clay, diatomite
		Idaho Group: Tuana Gravel with interbedded sand and silt
		Idaho Group: *Glenns Ferry Formation poorly consolidated silt, sand, clay, shale, gravel
		Idaho Group: *Chalk Hills Formation consolidated sand, silt, clay, diatomite
		Idaho Group: Banbury Basalt with minor interbedded sediments
PLIOCENE	*Poison Creek Formation consolidated clay, silt, ash, sandstone, conglomerate	
PLIOCENE	Silicic volc rhy to dac flows undiv	Idavada Volcanics silicic latite welded tuff; some tuff and flows
MIOCENE	Deer Butte Formation siltstone, shale, sandstone, conglomerate	
MIOCENE	Columbia River Basalt with subordinate tuff and sediments	
MIOCENE	*Sucker Creek Formation soft-weathering tuff and tuffaceous shale; minor siltstone and sandstone; *Payette Formation well consolidated ash, shale, and sandstone	
MIOCENE	Columbia River Basalt with subordinate tuff and sediment	
EOCENE(?) to MIOCENE(?)		Challis Volcanics rhyolite to andesite tuffs and flows
CRETACEOUS	Granitic rocks of the Idaho batholith	Granitic rocks of the Idaho batholith granitic rocks; with some meta. and vol.
PRE-CRETACEOUS	Pre-Cretaceous rocks undivided sedimentary and volcanic.	

Figure 4. Stratigraphic correlation chart, western Snake River basin, Idaho.

Asterisk indicates formation or group evaluated for uranium favorability.

COLUMBIA RIVER BASALT

The Columbia River Basalt of Miocene age (Waters, 1961) crops out in the northwestern and southwestern parts of the project area (Pl. 1). Basalt flows with subordinate layers of tuff, ash, and tuffaceous sediments are exposed in sections up to as much as 1,500 ft along the flanks of the basin. Well 35 (Pl. 6) may have penetrated more than 4,200 ft of Columbia River Basalt.

PAYETTE FORMATION

The Payette Formation crops out in the northwestern part of the project area (Pl. 1). The distribution shown on Plate 1 is based on Newton and Corcoran (1963, Pl. 1), Savage (1958, Figs. 4 and 5), Savage (1961, Fig. 4), and Kirkham (1931a, Fig. 13).

The Payette Formation consists of well-consolidated ash, carbonaceous or coaly shale, and sandstone interbedded with some basalt flows (Kirkham, 1931a, p. 219). Rocks of the Payette Formation form thick interbeds in the Columbia River Basalt (Kirkham, 1931a, p. 213). Kirkham (1931a, p. 201) assigned a Miocene age based on stratigraphic, lithologic, and floral evidence. The total thickness is variable and probably does not exceed about 2,000 ft (Newton and Corcoran, 1963, p. 6).

SUCKER CREEK FORMATION

The Sucker Creek Formation crops out in the southwestern part of the project area (Pl. 1). Kittleman and others (1967) mapped this formation in southeastern Oregon and a thin slice of southwestern Idaho between the Idaho-Oregon border and long. 117° W. On the basis of field reconnaissance, we believe that areas to the east of long. 117° W. in Idaho, mapped as "Payette Formation and related strata" by Ross and Forrester (1947), are underlain by Sucker Creek Formation.

"Altered tuffs and volcanic sandstones, vitric tuffs, arkosic sandstones, granite-cobble conglomerates, and carbonaceous volcanic shales" are estimated to be about 1,600 ft in total thickness (Kittleman and others, 1965, p. 6). The formation also includes a thick rhyolite ash-flow tuff, basalt flows, and rhyolitic flows.

The age of the formation is late Miocene, on the basis of fossil evidence and a potassium-argon age of a basalt sample from the formation (Kittleman and others, 1965, p. 6). The Sucker Creek Formation is considered possibly correlative with the Payette Formation (Newton and Corcoran, 1963, p. 6; Kittleman and others, 1965, p. 6).

DEER BUTTE FORMATION

The Deer Butte Formation crops out over approximately 10 square miles in the western part of the project area (Pl. 1). Corcoran and others (1962) mapped this unit in southeastern Oregon and in a thin slice of southwestern Idaho between the Idaho-Oregon border and long. 117° W.

"Soft tuffaceous siltstones and shales grading upward into interbedded tuffaceous siltstones, massive silicified arkosic sandstones and rhyolite-granite conglomerates" (Corcoran and others, 1962) have a total thickness of at least 2,000 ft and possibly as much as 3,000 ft (Kittleman and others, 1965, p. 9). The age of the major part of the formation, on the basis of fossil evidence, is late Miocene (Kittleman and others, 1965, p.10).

SILICIC VOLCANICS UNDIVIDED

Silicic volcanic rocks west of long. 116° W. are shown as "Silicic Volcanics undivided" on Plate 1 and include the Owyhee Rhyolite of Kirkham (1931a) and the Jump Creek Rhyolite of Kittleman and others (1965).

The Silicic Volcanics undivided, which crop out near the margins of the basin in the western part of the project area (Pl. 1), are predominantly flows but include minor amounts of pyroclastic rock. The composition ranges from rhyolite to dacite. The thickest known exposed sections are in the vicinity of Squaw Creek in the southwestern part of the project area. We estimate the maximum thickness exposed in this area to be about 1,000 ft. The Silicic Volcanics undivided are of late Miocene to Pliocene age because they overlie the Miocene Payette Formation and Columbia River Basalt (Newton and Corcoran, 1963, p. 7), they overlie the late Miocene Sucker Creek Formation (Newton and Corcoran, 1963, p. 7), and they underlie the Pliocene Idaho Group (Kirkham, 1931a, p. 201).

IDAVADA VOLCANICS

Silicic volcanic rocks throughout much of the project area east of long. 116° W. have been mapped as Idavada Volcanics by Malde and others (1963). The Idavada Volcanics crop out extensively in the northeastern and southeastern parts of the project area (Pl. 1). In places, the silicic latite welded tuff with subordinate vitric tuff and flows is up to 3,000 ft thick (Malde and others, 1963). The age of the formation is early Pliocene, on the basis of fossil evidence (Malde and Powers, 1962, p. 1201).

POISON CREEK FORMATION

The Poison Creek Formation crops out in the northwestern part of the project area (Pl. 1) and in its type locality in the southwestern part of the project area (Kittleman and others, 1965). The formation has not been mapped south of the Snake River, although previous workers have indicated its presence near Murphy in the southwestern part of the project area (Malde and Powers, 1962, p. 1202; Asher, 1968, p. 56).

Savage (1961, p. 19) described clay, silt, ash, arkose, sandstone, conglomerate, and orthoquartzite in the northwestern part of the project area. In the type locality, Kittleman and others (1965, p. 38) described fine to coarse volcanic or micaceous arkose. Referring to exposures near Murphy and in the type locality, Malde and Powers (1962, p. 1202) stated that the formation consists of (1) consolidated massive beds of volcanic ash and fine-grained tuffaceous detrital material and (2) layers of locally derived sand and gravel.

Little information is available on the thickness of the Poison Creek Formation. Kittleman and others (1965, p. 38) described 43 ft of section in the type locality; Malde and Powers (1962, p. 1202) noted that at least 400 ft of the formation are exposed in a section near Murphy.

The age of the Poison Creek Formation is Pliocene (probably early Pliocene), according to paleontological evidence reported by Kittleman and others (1965, p. 10). They stated that the Deer Butte Formation may be contiguous in part with the Poison Creek Formation along the western margin of the Snake River Plain, although the two formations contain fossils of different ages (late Miocene in the Deer Butte and Pliocene in the Poison Creek). Malde and Powers (1962), on the other hand, considered the Poison Creek to be a part of the Idaho Group.

The identification and correlation of the Poison Creek Formation is one of the major stratigraphic problems in the western Snake River basin. Although solution of this problem is beyond the scope of this project, the following observations are pertinent:

1. The Poison Creek Formation is similar in many respects to formations in the Idaho Group. The relative proportions of conglomerate, sandstone, siltstone, and claystone are similar. Bedding characteristics, grain size, and sorting are also similar. The major differences between the Poison Creek Formation and the Idaho Group are hardness, degree of cementation, and presence of iron staining. In general, sandstones of the Poison Creek Formation are much harder, more silicified, and more pervasively iron stained than those of the Idaho Group.

2. In many localities outcrops of Poison Creek are topographically above outcrops mapped as Idaho Group. The best example is on the southeast side of Little Butte (loc. 19, App. A).

3. All but one of the known outcrop areas of the Poison Creek Formation are within 1 or 2 miles of the edge of the basin (Pl. 1). Several are adjacent to known faults (Newton and Corcoran, 1963, Pl. 1; Savage, 1961, Fig. 4).

4. There is evidence that the siliceous cement in sandstones of the Poison Creek Formation is secondary: (1) the degree of cementation is generally related to grain size; fine-grained, silty material is the least cemented (loc. 65, App. A); and (2) the cementation cuts across original bedding, resulting in "chaotic" apparent dips (loc. 19, App. A).

These observations suggest that, at least in part, rock units mapped as Poison Creek Formation in the western Snake River basin of Idaho are within the Idaho Group. They further suggest that these units are distinct, not because of age or stratigraphic position, but because they include unusually hard and resistant altered sandstones.

IDAHO GROUP

The Idaho Group crops out over about 35 percent of the project area (Pl. 1). It probably underlies Quaternary alluvium and basalt throughout much of the remaining area.

West of Longitude 116° W.

The distribution of the Idaho Group in this area is based on published maps (see Pl. 1). Much of the area shown as Payette Formation and related strata by Ross and Forrester (1947) is considered by the authors to be Idaho Group because of subsequent mapping of the Idaho Group in parts of southwestern Idaho (Savage, 1958, 1961; Newton and Corcoran, 1963; Malde and Powers, 1962; Malde and others, 1963) and on the basis of reconnaissance by the authors.

The Idaho Group in this part of the western Snake River basin consists of unconsolidated to semiconsolidated deposits of clay, silt, sand, ash, diatomite, limestone, and conglomerate (Newton and Corcoran, 1963, p. 8). The sediments are "mainly of fluviatile origin, with the layers of diatomite, limestone, silt, and clay representing local lake basins" (Newton and Corcoran, 1963, p. 8).

The Idaho Group in the Mitchell Butte quadrangle of Oregon, an area contiguous with the present project area, includes a thick series of basalt flows, the Grassy Mountain Basalt (Corcoran and others, 1962, p. 10). This formation has been tentatively identified in two petroleum test wells in the project area: well 35 (Pl. 6) and well 21 (Pl. 4). In well 21, the total thickness of basalt, including the Grassy Mountain Basalt and an overlying unidentified sequence of flows, is about 2,400 ft.

The total thickness of the Idaho Group was estimated by Newton and Corcoran (1963, p. 8) from subsurface studies to be at least 4,000 to 5,000 ft. Kirkham (1931a, p. 237) reported the measurement of a section of the Idaho Group, more than 18,000 ft thick, in the northwestern part of the basin; the possibility of repetition by faulting in the section, however, was not ruled out. Based on a preliminary identification of formations penetrated by well 35 (Pl. 6), the authors of the present report estimate a maximum thickness of 7,800 ft, including 2,400 ft of basalt.

The Idaho Group is separated from older units by a large angular and erosional unconformity (Newton and Corcoran, 1963, p. 8). The age of the Idaho Group in this part of the western Snake River basin is given as Pliocene and later (Kirkham, 1931a, p. 201) and middle to lower Pliocene (Corcoran and others, 1962).

East of Longitude 116° W.

The Idaho Group is separated into formations and mapped in detail over most of the project area east of long. 116° W. (Pl. 1; Malde and Powers, 1962; Malde and others, 1963; Malde and Powers, 1972). Malde and others (1963) divided it into the following (from oldest to youngest):

1. Banbury Basalt: basalt flows locally interbedded with minor amounts of stream and lake deposits, including sand, gravel, silt, clay, and diatomite; maximum thickness approximately 1,900 ft.

2. Chalk Hills Formation: consolidated lake and stream deposits, including sand, silt, clay, and diatomite; also contains some thin ash beds interbedded with minor basalt flows; total thickness approximately 300 ft.

3. Glenns Ferry Formation: poorly consolidated, complexly intertonguing lake and stream deposits, including silt, sand, clay, carbonaceous shale, and gravel; also contains some ash flows; includes basalt flows with subordinate layers of ash and tuff in the Twin Falls area; maximum known thickness 300 ft.

4. Tuana Gravel: gravel interbedded with sand and silt, up to 200 ft thick in type section.

5. Bruneau Formation: unconsolidated lake beds of silt, clay, and diatomite and minor amounts of alluvial silt and sand; also includes gravel beds and basalt flows; outcrops follow present course of Snake River; approximately 800 ft thick.

6. Black Mesa Gravel: unconsolidated sand and gravel composed of reworked older gravels; maximum thickness 25 ft.

The total thickness of the Idaho Group in this part of the project area is not known. Malde and Powers (1962, p. 1202) stated that a composite section (including the Poison Creek Formation) would be nearly 5,000 ft thick. We have tentatively identified a 9,678-ft-thick section of the Idaho Group in well 34 (Pl. 6).

The Idaho Group unconformably overlies rhyolitic rocks of the Idavada Volcanics (Malde and Powers, 1962, p. 1202). Periods of erosion and block faulting or deformation followed deposition of the Banbury Basalt, Chalk Hills Formation, and Glenns Ferry Formation (Malde and others, 1963). The age of the Idaho Group ranges from middle Pliocene for the Banbury Basalt to middle Pleistocene for the Black Mesa Gravel (Malde and Powers, 1962).

SNAKE RIVER GROUP

The Snake River Group (Snake River eruptives of Savage, 1958) consists of basalt flows interbedded with unconsolidated sedimentary rocks. It crops out extensively in a 30- to 40-mile-wide belt through the central part of the western Snake River basin (Pl. 1; Savage, 1958; Malde and others, 1963).

The maximum thickness of the Snake River Group in the western Snake River basin of Idaho is not known. The authors have tentatively identified more than 600 ft of the group in well 67 (App. G) and more than 790 ft in well 108 (App. G).

ALLUVIUM

Recent deposits of unconsolidated alluvial sand, silt, clay, and gravel cover large parts of the project area, especially in the Boise-Weiser and Nampa subareas where they fill the broad valleys of the Snake, Boise, and Payette Rivers (Pl. 2).

FORMATIONS STUDIED

Three criteria were used to select the formations studied in detail: (1) age, (2) total thickness of sedimentary rocks, and (3) degree of consolidation of sedimentary rocks.

Formations of Miocene and Pliocene age were studied if they contained 100 ft or more of sedimentary rocks. The following units satisfy these criteria (Fig. 4): Payette Formation, Sucker Creek Formation, Deer Butte Formation, Poison Creek Formation, Idaho Group (west of long. 116° W.), Chalk Hills Formation (east of long. 116° W.), and Glenns Ferry Formation (east of long. 116°W.).

Pleistocene formations that contain more than 100 ft of partially consolidated sedimentary rocks were studied. The upper Idaho Group in the western part of the project area satisfies this criterion.

The Deer Butte Formation was not studied for the following reasons:

1. It crops out over a small part of the project area near the Idaho-Oregon border (less than 15 square miles, Pl. 1), which is an extension of larger mapped areas in Oregon.

2. The Idaho Group most likely includes correlative map units and was evaluated collectively in the project area west of long. 116° W.

CONCLUSIONS ON FAVORABILITY

To facilitate the discussion of data pertaining to uranium favorability, the project area is divided into 13 subareas (Pl. 2). This subdivision is based on (1) surface and subsurface geology, (2) availability of data useful in determining favorability, and (3) relative uranium favorability.

The discussions of uranium favorability in succeeding sections of this report are organized according to formation and subarea. A distinction is also made between the surface, shallow subsurface (less than 2,000 ft), and the deep subsurface (more than 2,000 ft). This distinction is made because of differences in the types and amounts of data available. In some areas, only surface data are available, whereas in others, both surface and shallow subsurface data are available.

Each favorability discussion includes a presentation of (1) pertinent stratigraphic, lithologic, and chemical data; (2) a summary of favorable (and unfavorable) characteristics; and (3) a statement of the favorability rating and the bases for that rating.

The conclusions of this study are dependent to some degree on the identifications of the formation(s) at each locality. These identifications are based on the following: reference in a published or unpublished report; published geologic maps (Pl. 1); and distinctive stratigraphic and lithologic characteristics that enabled the authors to make a preliminary identification of the formation. The formation name and the basis for its selection are given for each separate locality (App. A).

It was not possible to identify the formations penetrated by most of the water and petroleum test wells used in the study, primarily because of the lack of detailed lithologic information. Consequently, for purposes of this report, it is assumed that sedimentary sequences that were penetrated are in the Idaho Group. This assumption is considered to be generally valid for the following reasons:

1. The Idaho Group either crops out or subcrops throughout the project area, excluding the Sucker Creek, Camas Prairie, and Mount Bennett Hills subareas (Pl. 2).

2. Only 4 of the 91 petroleum test wells and deep water wells used in the study are more than 4,000 ft deep, a figure which must be considered a minimum for the thickness of the Idaho Group (Newton and Corcoran, 1963, p. 8, estimated 4,000 to 5,000 ft; we estimate 7,800 ft in well 35 and 9,678 ft in well 34). This statement must be qualified when considering wells near the margin of the basin.

PAYETTE FORMATION (SURFACE)

The Payette Formation was studied in 11 localitites, all in the Boise-Weiser subarea. Stratigraphic and lithologic data were gathered and rock samples were collected in 10 of these localities (locs. 9, 11, 15, 16, 23, 24, 25, 27, 70, and 71, App. A; Pl. 2). One water sample was collected from a spring located near outcrops of the formation (loc. 26, App. A).

Stratigraphic and Lithologic Characteristics

Kirkham (1931a, p. 220) described the Payette Formation as consisting of well-consolidated ash, carbonaceous or coaly shale, and sandstone, interbedded with some flows. The authors of the present report found this description to be generally valid, especially with regard to the predominance of fine-grained material.

Exposures of the Payette Formation in the localities studied range from about 10 to 600 ft thick. Complete sections of the formation are exposed in only two localities (locs. 11 and 71, Pl. 2).

Sandstone (excluding very fine-grained sandstone) composes about 10 percent of the Payette Formation in all but one locality (loc. 11, App. A). Where present (excluding loc. 11), the sandstone has the following characteristics: thin to thick bedded; tabular in most localities but lenticular in places; most commonly medium grained, also fine grained, coarse grained, or conglomeratic; poorly to moderately well sorted in most localities, well to very well sorted in three localities; soft to very hard; and cemented to various degrees with carbonate, silica, or ferruginous cement. Carbonaceous beds are adjacent to sandstone beds in three localities (locs. 15, 16, and 23), and the sandstone is iron stained in one locality (loc. 25).

The Payette Formation at locality 11 (units 3 through 8, App. A) is more than 280 ft thick and consists almost entirely of sandstone with the following characteristics: thick to very thick bedded; tabular; massive; medium to coarse grained or conglomeratic; poorly to well sorted; and soft and friable. Locality 11 also includes beds of siltstone, silty sandstone, and fine-grained sandstone. Cementing material, if present, is calcite, and some beds are iron stained. Clay is common and carbonaceous material was found in the section.

Chemical Characteristics

Seventeen samples of the Payette Formation were analyzed for equivalent uranium, thorium and potassium by gamma-ray spectrometry. Three of these samples were also analyzed for 60 elements by emission spectroscopy. The one water sample was analyzed for U_3O_8.

The mean (arthmetic mean) equivalent uranium content of the rock samples is 2.4 ppm, somewhat less than the mean (4.0 ppm) for all samples analyzed in the project (Table 1). The following characteristics of the Payette Formation are noted from an equivalent uranium-thorium plot for individual samples (Fig. 5):

1. No sample points are sufficiently removed from the overall distribution to be considered evidence of anomalous uranium content.

2. In none of the five "class A" (generally argillaceous) and "class B" (generally non-argillaceous) sample pairs is the class A sample significantly enriched in equivalent uranium relative to equivalent thorium, when compared with the class B sample.

Anomalously high (two or more standard deviations above the mean) or higher-than-average (one to two standard deviations above the mean) concentrations of six possible chemical indicators of favorability (see section on "Pertinent Criteria") were found in five samples of the Payette Formation (Table 2). These results are not considered evidence of uranium favorability for the following reasons:

Table 1. Mean equivalent uranium, thorium, and potassium content of all rock samples from the western Snake River basin, by formation

	Payette Formation	Sucker Creek Formation	Poison Creek Formation	Idaho Group (Boise-Weiser subarea)	Idaho Group (southern part of basin)	All samples (western Snake River basin)
No. of samples	17	23	13	43	22	118
eU (ppm)						
mean	2.4	5.1	1.7	3.9	5.4	4.0
std dev	1.8	1.8	1.4	4.6	4.1	3.7
eTh (ppm)						
mean	6.6	18.4	7.0	9.2	15.8	11.6
std dev	3.3	7.6	4.0	7.0	8.2	8.0
eK (pct)						
mean	2.13	2.54	2.26	2.05	2.29	2.23
std dev	0.41	1.39	0.72	0.56	0.81	0.84
eU/eTh						
mean	0.36	0.31	0.25	0.69	0.35	0.46
std dev	0.17	0.13	0.10	1.51	0.20	0.93
eU/eK (x10,000)						
mean std dev	1.2	2.9	0.7	2.3	3.0	2.2
std dev	0.9	2.7	0.4	3.1	3.1	2.7
eTh/eK (x10,000)						
mean	3.3	10.5	3.0	5.5	8.5	6.4
std dev	1.9	9.8	1.1	6.1	7.5	7.0

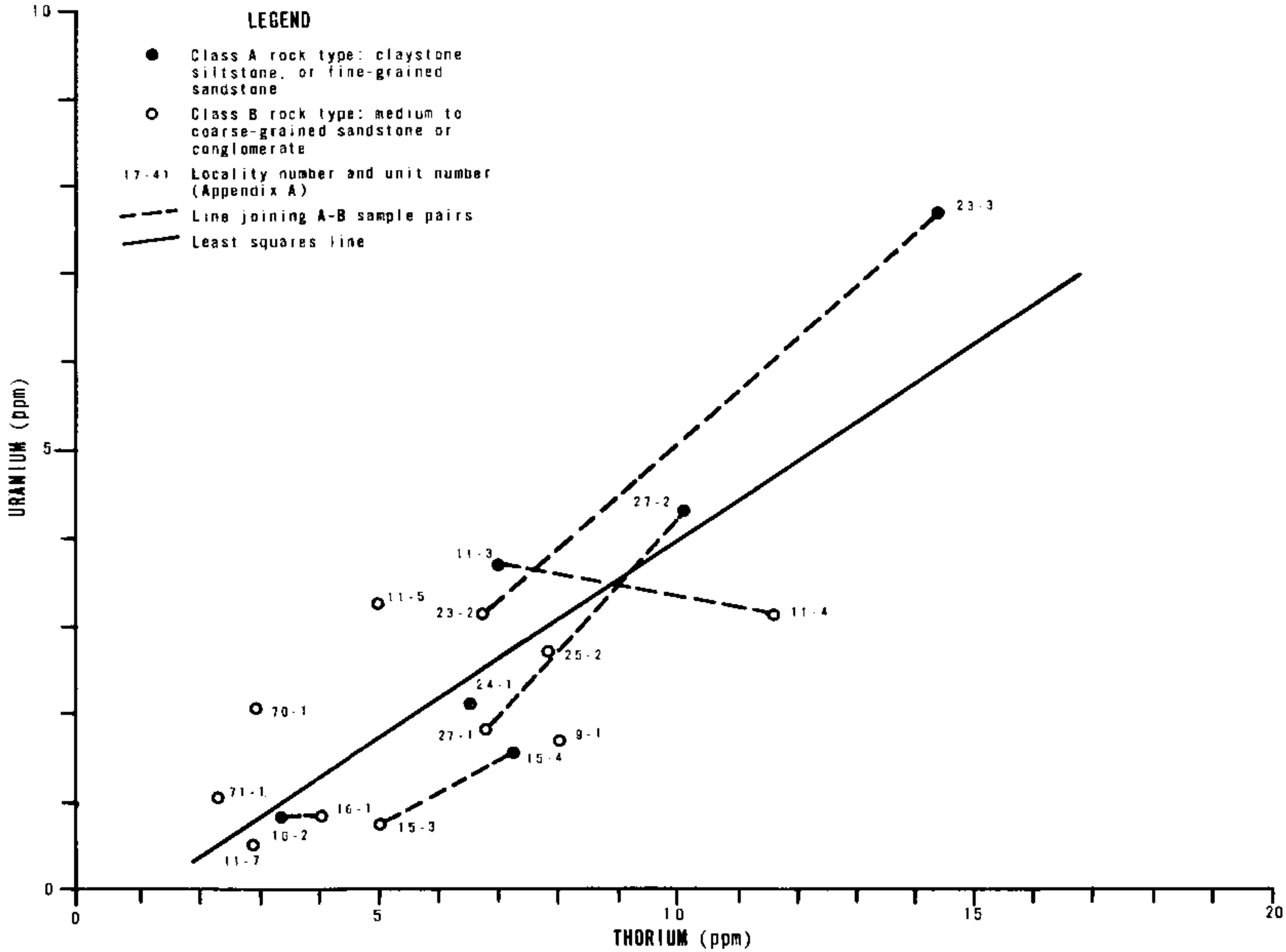

Figure 5. Plot of equivalent uranium versus equivalent thorium for samples of the Payette Formation.

Table 2. Anomalous elemental concentrations in samples of the Payette Formation

Possible indicator element or ratio	All samples in formation or project [a]			Locality - unit number Rock type [b]				
	number detected [c]	mean	std. dev	11-5 ss	16-2 sltst	23-3 ss	25-2 ss	70-1 ss
eU (ppm)	17/17	2.4	1.8	3.3	0.8	7.7	2.7	2.1
eU/eTh	17/17	0.36	0.17	0.66	0.24	0.53	0.34	0.70
eU/eKx10,000	17/17	1.2	0.9	1.8	0.3	3.4	1.4	0.9
eTh/eKx10,000	17/17	3.3	1.9	2.8	1.4	6.4	4.1	1.3
Cu (ppm)	38/38	28	16	NA	60	NA	50	NA
Zn (ppm)	23/38	130	45	NA	100	NA	200	NA

a/ The statistics relative to eU, eTh, and eK are for the named formation; statistics relative to the remaining elements are for all project samples analyzed by emission spectroscopy.

b/ ss=sandstone; sltst=siltstone; NA=not analyzed for; ND=not detected. Two underlines indicates value is two or more standard deviations above the mean; one underline indicates about one standard deviation above the mean.

c/ First number is number of samples in which element was detected; second number is number of samples in formation or project, as applicable.

1. Although the equivalent uranium content of one sample (unit 3, loc. 23) is anomalous when compared with the mean for all samples of the Payette Formation, the sample is not characterized by anomalously high uranium content relative to thorium (Fig. 5).

2. The anomalies in the data for localities 11, 16, 25, and 70 are (1) close to the two-standard deviation dividing line between higher-than-average and anomalous values, (2) single (only one anomalous value per sample), and (3) unsupported by anomalously high or higher-than-average uranium content.

The U_3O_8 content of water from a spring located near outcrops of the Payette Formation is 0.7 ppb (loc. 26, App. F), which is close to the mean (0.9 ppb) for all water samples analyzed in the project.

Uranium Favorability

The stratigraphic, lithologic, and chemical characteristics of the Payette Formation (excluding loc. 11) are consistent with a least favorability rating (Fig. 10). The overall percentage of medium- to coarse-grained or conglomeratic sandstone is about 10 percent. Potential sandstone host rocks are generally less than 20 ft thick. Also, the mean equivalent uranium content of the formation is low. As a consequence of the low favorability rating of the Payette Formation, parts of the Boise-Weiser subarea mapped as Payette Formation or as Columbia River Basalt (with which the Payette is interbedded) are rated of least favorability (Fig. 10).

In the Payette Formation, locality 11 is rated moderately favorable because of the high percentage of permeable medium- to coarse-grained sandstone and the presence of beds more than about 20 ft thick.

PAYETTE FORMATION (SUBSURFACE)

The Payette Formation has been tentatively identified in two wells by the authors (wells 1 and 35; Pl. 2) on the basis of its stratigraphic relationship with the Columbia River Basalt.

In well 1 (Pl. 2), the Payette Formation consists of (1) about 60 ft of volcanic ash, "igneous wash", and quartz grains; (2) 170 ft of shale; and (3) 20 ft of sand (Pl. 3). In this well the formation is of least to moderate favorability. The range of favorability is assigned because of the uncertainty inherent in the lithologic log.

In well 35 (Pl. 2), the Payette Formation is about 350 ft thick and consists of about 80 percent felsite and 20 percent sandstone (Pl. 6). The sandstone is tan to gray, very fine to fine grained, tuffaceous, and pyritic. This interval is rated least favorable because of the absence of medium- to coarse-grained material.

SUCKER CREEK FORMATION (SURFACE)

The Sucker Creek Formation was studied in 13 localities, all in the Sucker Creek subarea. Stratigraphic and lithologic data were gathered and rock samples collected in 9 localities (locs. 50, 51, 52, and 57 through 62, App. A; Pl. 2). Water samples were collected from springs in 4 localities (locs. 53 through 56, App. A).

Stratigraphic and Lithologic Characteristics

The authors are not aware of any published information on the Sucker Creek Formation in the project area. About 4 miles west of the project area in Malheur County, Oregon, the type section of the formation consists of 585 ft of volcanic sandstone, volcanic arkose, volcanic shale, and lapillistone (Kittleman and others, 1967, p. 31). (The system of terminology used by Kittleman and others is nongenetic and does not imply an epiclastic or pyroclastic origin.) Most of the units in the type section are composed predominantly of clay or fine- to very fine-grained material. Only one unit, a coarse-grained friable volcanic arkose with about 10 percent matrix (unit 3, Kittleman and others, 1967, p. 33), is coarse enough to be considered a potential uranium host rock. The possibility that the volcanic sandstones (terminology of Kittleman and others, 1967), which make up most of the type section, were potential host rocks at one time cannot be ruled out, however, considering the possibility that they are alteration products of tuffaceous rocks.

The authors' findings with regard to the overall stratigraphic and lithologic characteristics of the Sucker Creek Formation in the Sucker Creek subarea are in agreement with the description of the type section. In general, the total thickness of the formation in the Sucker Creek subarea is comparable to that (1,600 ft) suggested by Kittleman and others (1967, p. 6). The percentage of medium- to coarse-grained or conglomeratic material of probable epiclastic origin in the formation appears to be greater, however, in the Sucker Creek subarea than in the type section.

Three partial sections of the Sucker Creek Formation, each about 400 ft thick, were studied in the Sucker Creek subarea: French John Hill (loc. 58); Little Squaw Creek (loc. 59 and 60); and Dry Creek (loc. 52, 61, and 62). In three additional localities studied (loc. 50, 51, and 57), less than 100 ft of Sucker Creek Formation is exposed.

The French John Hill section (loc. 58, App. A), about 540 ft thick, includes an estimated 360 ft of Sucker Creek Formation (units 1 through 5) and more than 180 ft of rhyolite breccia and rhyolite (units 6 and 7). In this section the Sucker Creek Formation consists of tuffaceous rocks, some that appear to be pyroclastic and others that appear to be epiclastic. Only two units in the section (units 2 and 3, loc. 58, App. A) are considered possible host rocks. Unit 2, approximately 15 ft thick, is a fine-grained tuff or tuffaceous sandstone. Unit 3, approximately 75 ft thick, is a conglomeratic tuffaceous sandstone or pumiceous tuff composed of about 50 percent pumiceous pebbles in an altered (probably tuffaceous) matrix.

The Little Squaw Creek section (loc. 60, App. A), about 450 ft thick, includes approximately 400 ft of Sucker Creek (units 1 through 8) and more than 50 ft of volcanic rock (unit 9). In this section the Sucker Creek consists of about 200 ft of sandstone and siltstone and about 200 ft of drab, soft-weathering rocks, perhaps correlative with the "volcanic sandstones" in the type section described by Kittleman and others (1967). The sandstone in this section forms thick beds and is fine to coarse grained, poorly to moderately sorted, and soft. This part of the section appears to be fluvial in origin. In contrast to the type section and to the French John Hill section, there is a noticeable absence of tuffaceous material in the sandy part of the section, except at the very top. No carbonaceous material was identified in the section.

The Dry Creek section (locs. 52, 61, and 62) of the Sucker Creek Formation, about 400 ft thick, consists of approximately 30 percent sandstone, and the remainder is drab, soft-weathering rocks, which may be correlative with volcanic sandstones in the type section. The sandstones are in three separate intervals in the section (locs. 61, App. A): a lower 16-ft interval (locs. 52), a middle 31-ft interval (loc. 61), and an upper 75-ft interval (loc. 62).

The lower and middle sandy intervals of the Dry Creek section are composed of soft, poorly sorted, tuffaceous conglomeratic rocks in medium to thick beds with some cross bedding. The clasts are pumiceous and pebble-size; the matrix is medium grained. Carbonaceous claystone beds are present in the intervals.

The upper sandy interval of the Dry Creek section is composed of sandstone with subordinate siltstone and claystone. The sandstone is fine to medium grained, medium bedded, tuffaceous in part, and probably fluvial in origin. Trace amounts of carbonaceous material are present in the sandstone or in adjacent argillaceous beds.

In the three remaining localities studied (loc. 50, 51, and 57), each less than 100 ft thick, between 10 and 20 ft of sandstone is exposed. The sandstone is fine grained to conglomeratic (predominantly medium grained), poorly to well sorted, soft to medium hard, tuffaceous, and medium to very thick bedded with some internal cross bedding. Carbonaceous material is present in the sandstone or in adjacent argillaceous beds. Rock units in these localities are similar to and probably correlative with units in the lower and middle sandy intervals of the Dry Creek section.

The authors have concluded from studies of the French John Hill (loc. 58), Little Squaw Creek (locs. 59 and 60), and Dry Creek sections (locs. 52, 61, and 62), and from reconnaissance of the Sucker Creek subarea that the formation in this area consists of different intervals or facies with the following composition: (1) predominantly soft-weathering, fine-grained material (not described in this report), possibly similar to the "volcanic sandstones" (terminology of Kittleman and others, 1967) in the type area in Oregon; (2) predominantly tuffaceous rocks (French John Hill section); (3) mixture of soft-weathering fine-grained material and tuffaceous sedimentary rocks (Dry Creek section); and (4) predominantly sandstone and siltstone (Little Squaw Creek section).

Because the lithologic characteristics (and hence possibly the uranium favorability) of these intervals or facies are so different and before the uranium favorability of the Sucker Creek subarea as a whole could be evaluated, some concept of the relative stratigraphic position and extent of these intervals or facies had to be developed. The following observations were used as the basis for the favorability assessment:

1. Both the French John Hill and Little Squaw Creek sections are capped by volcanic flow rocks (Silicic Volcanics undivided, Pl. 1). Consequently these two sections must form the upper part of the Sucker Creek Formation.

2. The French John Hill section rather than the Little Squaw Creek section appears to be more representative of the Sucker Creek Formation where the formation is overlain by flow rocks in the northern part of the subarea (Pl. 1).

3. The Dry Creek section and soft-weathering, fine-grained (possibly volcanic) rocks not described herein appear to be representative of the formation throughout most of the Sucker Creek subarea, excluding T. 1 S., R. 5 W., and T. 1 N., R. 5 W. This conclusion is supported by the similarities between strata exposed in the lower and middle sandy intervals of the Dry Creek section and strata exposed in three other localities (locs. 50, 51, and 57).

Chemical Characteristics

Twenty-three samples of the Sucker Creek Formation were analyzed for equivalent uranium, thorium, and potassium by gamma-ray spectrometry. Seven of these samples were also analyzed by emission spectroscopy. In addition, four water samples were analyzed for U_3O_8.

The mean equivalent uranium content of the rock samples is 5.1 ppm, slightly higher than the mean (4.0 ppm) for all project samples (Table 1). The following characteristics of the Sucker Creek Formation are noted from an equivalent uranium-thorium plot for individual samples (Fig. 6):

1. Two samples are anomalously high in equivalent uranium relative to equivalent thorium (57-2 and 62-1).

2. In at least two of the eight "class A" (generally argillaceous) and "class B" (generally non-argillaceous) sample pairs (57-2, 57-1; and 62-1, 62-2), the class A sample appears to be significantly enriched in equivalent uranium relative to equivalent thorium when compared with the class B sample.

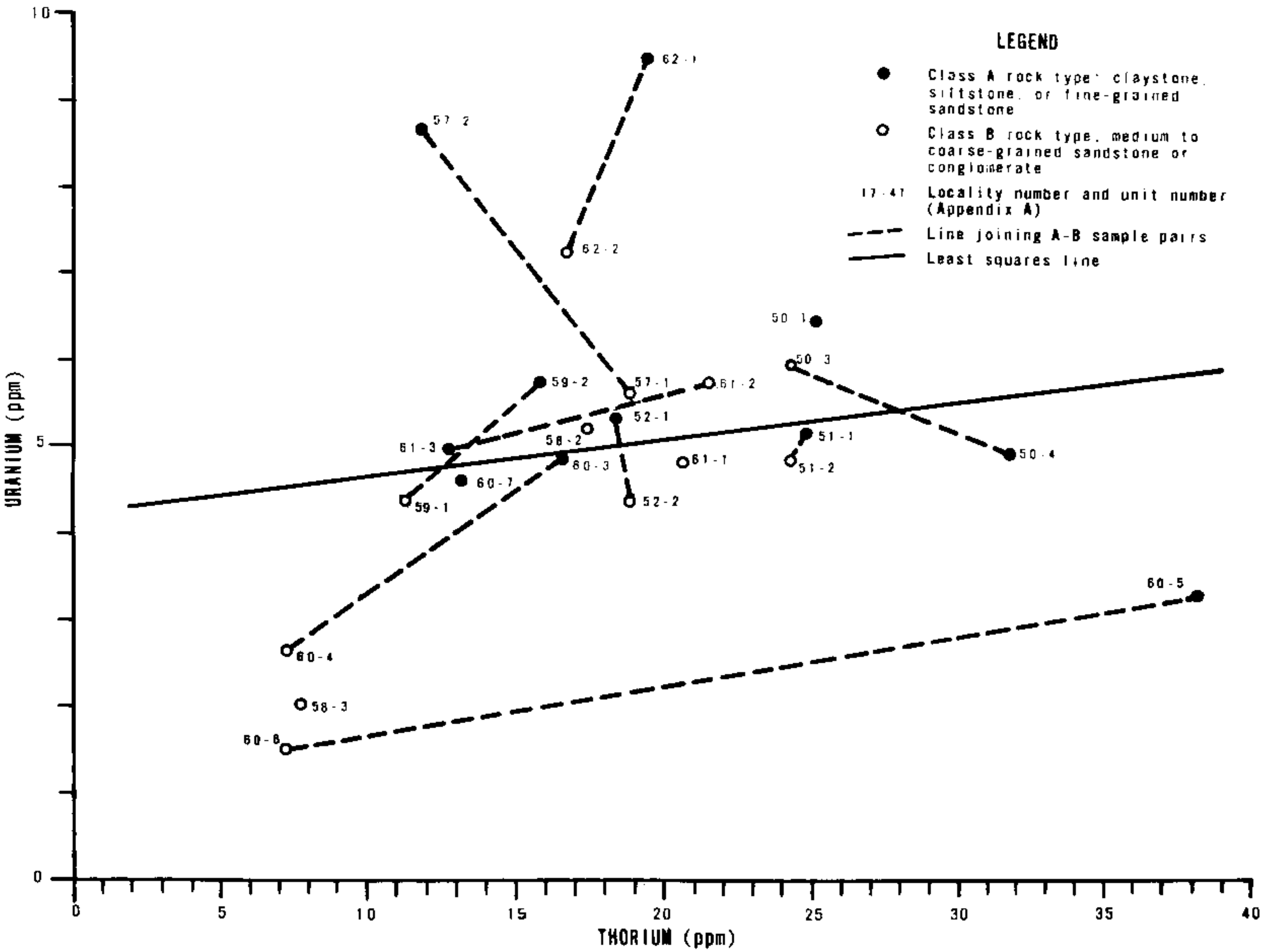

Figure 6. Plot of equivalent uranium versus equivalent thorium for samples of the Sucker Creek Formation.

Six samples of the Sucker Creek Formation contain anomalously high concentrations of at least one of the possible chemical indicators of favorability (Table 3). Five of the six samples are from class A rock types adjacent to potential host rocks.

The chemical data for four of the samples (Table 3) are not considered indicative of uranium favorability because they are unsupported by anomalously high concentrations of equivalent uranium or another key indicator, such as the eU/eTh ratio. It is suggested that these anomalies are related to source material composition rather than to passage of uranium-bearing solutions.

The chemical data for the two remaining samples (57-2 and 62-1) are considered indicative of uranium favorability because of (1) the apparent enrichment of equivalent uranium relative to equivalent thorium in both samples (Fig. 6), (2) anomalously high concentration of equivalent uranium relative to the mean for the formation, (3) high equivalent uranium content relative to the mean for all project samples (4.0 ppm), and (4) anomalously high eU/eTh ratio of sample 57-2 and anomalously high eU/eK ratio of sample 62-1.

The U_3O_8 content of four samples of water from springs located in or near outcrops of the Sucker Creek Formation (locs. 53 through 56, App. A) ranges from 0.2 to 1.7 ppb (App. F). None of the amounts are considered anomalous when compared with the mean (0.9 ppb) for all water samples analyzed in the project.

Uranium Favorability

The Sucker Creek Formation has the following characteristics, which are consistent with the greatest favorability rating:

1. The formation includes an appreciable thickness of sandstone, an estimated 200 ft in the Little Squaw Creek section and 100 ft in the Dry Creek section. Sandstone composes about 30 percent of the formation.

2. The sandstone appears to be fluvial in origin and forms beds more than 20 ft thick.

3. Beds of poorly sorted, medium- to coarse-grained sandstone are present in the formation. This sandstone is either permeable or, considering the degree and type of cementation, may have been permeable at one time.

4. Carbonaceous material is generally present, either in the sandstone or in adjacent argillaceous beds.

5. Tuffaceous rocks are abundant in the formation and are present in the section above the host rocks.

6. The mean uranium content (5.1 ppm) is higher than the mean for all project samples (4.0 ppm).

7. Chemical data for samples from two localities are indicative of uranium favorability.

Table 3. Anomalous elemental concentrations in samples of the Sucker Creek Formation

Possible indicator element or ratio	All samples in formation or project a/			Locality - unit number Rock type b/					
	number detected c/	mean	std dev	51-1 sltst	57-2 sltst	59-2 clyst	60-5 sltst	62-1 sltst	62-2 ss
eU (ppm)	23/23	5.1	1.8	5.1	8.7	5.7	3.2	9.5	7.2
eU/eTh	23/23	0.31	0.13	0.21	0.74	0.36	0.08	0.49	0.43
eU/eKx10,000	23/23	2.9	2.7	1.9	4.9	7.9	3.7	11.9	3.0
eTh/eKx10,000	23/23	10.5	9.8	9.1	6.6	21.8	43.9	24.3	6.9
Nb (ppm)	7/38	21	14	20	NA	NA	ND	ND	40
Zn (ppm)	23/38	130	45	100	NA	NA	100	100	200

a/ The statistics relative to eU, eTh, and eK are for the named formation; statistics relative to the remaining elements are for all project samples analyzed by emission spectroscopy.

b/ sltst=siltstone; clyst=claystone; ss=sandstone; NA=not analyzed for; ND=not detected. Two underlines indicates value is two or more standard deviations above the mean; one underline indicates about one standard deviation above the mean.

c/ First number is number of samples in which element was detected; second number is number of samples in formation or project, as applicable.

The potential uranium host rocks are found in what the authors have tentatively identified as the middle and upper parts of the Sucker Creek Formation (Dry Creek and Little Squaw Creek sections, respectively). Because the middle part probably extends throughout the Sucker Creek subarea, the subarea as a whole is rated of greatest favorability (Fig. 10). Sandstones in the upper part of the formation, also rated of greatest favorability, must be considered potentially more favorable, considering that they are generally more permeable, have a higher percentage of coarse-grained material, and form thicker beds. Considering the distribution of the younger Silicic Volcanics undivided (Pl. 1) and information from field reconnaissance, the maximum extent of the more favorable upper part of the formation is probably as follows:

1. east side of T. 3 S., R. 5 W., and T. 2 S., R. 5 W.;

2. north and east parts of T. 1 S., R. 5 W.; and

3. possibly in the subsurface in T. 1 N., R. 5 W.

The possibility that the Sucker Creek Formation extends beyond the Sucker Creek subarea cannot be ruled out. Rocks described as brown and green shale in the interval 525 to 546 ft of well 56 (Pl. 2 and App. G), located just north of the subarea, may be in the Sucker Creek Formation.

POISON CREEK FORMATION (SURFACE)

The Poison Creek Formation was studied in nine localities, seven of which are in the Boise-Weiser subarea (loc. 3, 4, 5, 6, 19, 20, and 68; Pl. 2), and two of which are in the northern part of the Sucker Creek subarea (loc. 65 and 66; Pl. 2). Stratigraphic and lithologic data were gathered and rock samples collected in all nine localities. A water sample was collected from a spring in one locality (loc. 19).

Stratigraphic and Lithologic Characteristics

Savage (1961, p. 19), referring to outcrops in the Boise-Weiser subarea, described the Poison Creek Formation as consisting of clay, silt, ash, arkose, sandstone, conglomerate, and orthoquartzite. Kittleman and others (1965, p. 38) described the type locality (possibly the same as the authors' loc. 65) in the northern part of the Sucker Creek subarea as consisting of well to moderately well indurated volcanic arkose, micaceous arkose, and rhyolite pebble conglomerate overlying severely altered and friable volcanic sandstone.

The areas mapped as Poison Creek Formation (Pl. 1) are characterized by the presence of hard to very hard, commonly iron stained and silicified, medium-grained to conglomeratic sandstone. (Locality 20 is an exception; in it, the hard rock is a sandy siltstone.) Finer grained and less consolidated rock units are generally interbedded with the hard sandstone. In one locality, the hard sandstone appears to overlie less consolidated rocks mapped as Idaho Group (loc. 19). In another locality (loc. 65), the hard sandstone overlies drab soft-weathering units, which were included in the formation by Kittleman and others (1965, p. 38) but which appear to be possibly in the Sucker Creek Formation. In a third locality (loc. 7), very hard silicified sandstone similar to that found in the Poison Creek Formation, has been mapped as Idaho Group.

Five partial sections of the Poison Creek Formation were studied:

1. State Penitentiary section (loc. 3, 4, 5, and 6), approximately 50 ft thick and composed entirely of sandstone;

2. Little Butte section (loc. 19), approximately 200 ft thick and composed of about half sandstone;

3. Big Willow Creek east section (loc. 20), approximately 30 ft thick and primarily composed of sandstone;

4. Flat Top Butte section (loc. 65 and 66), approximately 350 ft thick and composed of about one-third sandstone; and

5. Schiller Creek section (loc. 68), approximately 200 ft thick and primarily composed of sandstone.

The sandstone in the above sections has the following characteristics: thin to thick bedded or massive, and generally cross bedded; medium to very coarse grained; well or moderately well sorted; hard to very hard; feldspathic or arkosic in three sections, quartzose in three sections; generally siliceous, which appears to be a result of alteration; and generally iron stained. Soft- to medium-hard siltstone is interbedded with the sandstone in some of the localities.

Chemical Characteristics

Thirteen samples of the Poison Creek Formation were analyzed for equivalent uranium, thorium, and potassium by gamma-ray spectrometry. Two of these samples were analyzed for 69 elements by emission spectroscopy. One water sample was analyzed for U_3O_8.

The mean equivalent uranium content of the rock samples (1.7 ppm) is much lower than the mean for all project samples (4.0 ppm, Table 1). The following characteristics of the Poison Creek Formation are noted from an equivalent uranium-thorium plot for individual samples (Fig. 7): (1) No samples are either anomalously high or low in equivalent uranium. (2) There was no significant enrichment of equivalent uranium relative to equivalent thorium in the three A-B sample pairs.

Anomalously high concentrations of at least one of the possible chemical indicators of favorability were detected in two samples (Table 4). Both samples are of class A rock types adjacent to potential host rocks.

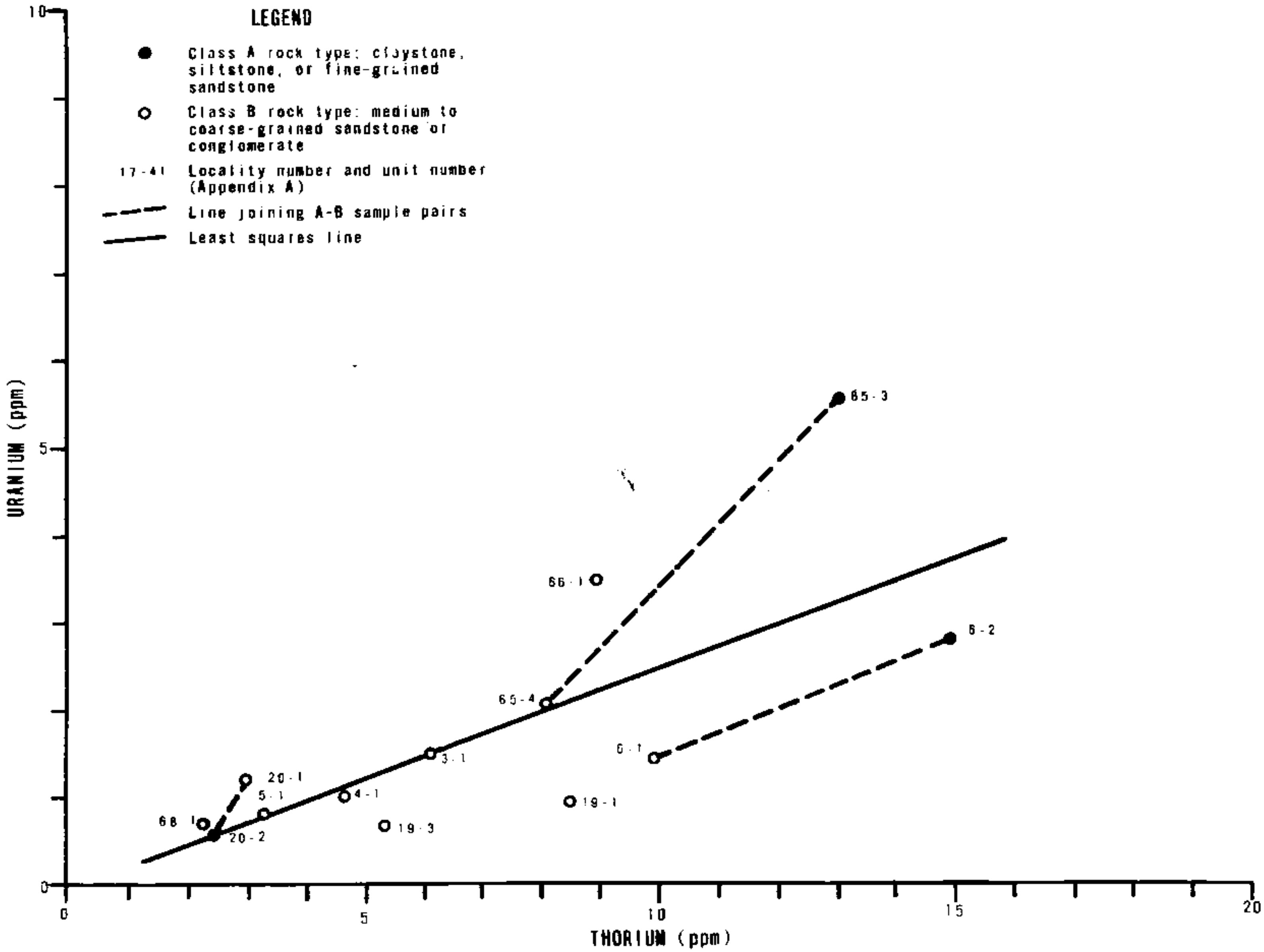

Figure 7. Plot of equivalent uranium versus equivalent thorium for samples of the Poison Creek Formation.

Table 4. Anomalous elemental concentrations in samples of the Poison Creek Formation

Possible indicator element or ratio	All samples in formation or project[a/]			Locality - unit number rock type[b/]	
	number detected[c/]	mean	std dev	6-2 clyst	65-3 sltst
eU (ppm)	13/13	1.7	1.4	2.7	5.4
eU/eTh	13/13	0.25	0.10	0.18	0.42
eU/eKx10,000	13/13	0.7	0.4	0.95	1.6
eTh/eKx10,000	13/13	3.0	1.1	5.2	3.7
Li (ppm)	20/38	12	18	20	NA

a/ The statistics relative to eU, eTh, and eK are for the named formation; statistics relative to the remaining elements are for all project samples analyzed by emission spectroscopy.

b/ clyst=claystone; sltst=siltstone; NA=not analyzed for; ND=not detected. Two underlines indicates value is two or more standard deviations above the mean; one underline indicates about one standard deviation above the mean.

c/ First number is number of samples in which element was detected; second number is number of samples in formation or project, as applicable.

The anomalously high value of the ratio eTh/eK in sample 6-2 is not considered indicative of uranium favorability because (1) it is not supported by anomalously high concentrations of uranium or any of the other possible indicators, and (2) it is less than the mean eTh/eK content (6.4 x 10,000) of all project samples (Table 1). The anomalous values of eU and eU/eK in sample 65-3 are not considered evidence of uranium favorability because they are close to the respective mean for all project samples.

The U_3O_8 content of water from a spring near outcrops of the Poison Creek Formation in the middle of the Little Butte section is 1 ppb (loc. 19, App. F). This is close to the average (0.9 ppb) for all water samples analyzed in the project.

Uranium Favorability

The Poison Creek Formation has several characteristics that are consistent with a moderate favorability rating:

1. The formation includes at least 100 ft and probably as much as 200 ft of coarse-grained sandstone.

2. The sandstone appears to be fluvial in origin and forms beds more than 20 ft thick.

3. The sandstone, although generally of low permeability, may have been permeable at one time, considering the probable secondary nature of the cementation.

4. The sandstone is felspathic or arkosic in three of the five sections studied.

5. The rocks are generally iron stained.

On the negative side, the sandstones are generally well sorted to moderately well sorted, and the mean equivalent uranium content is the lowest of any formation or group of samples in the study. Because outcrop areas of Poison Creek Formation are presumably underlain by other formations of higher favorability, the relative uranium favorability of Poison Creek outcrop areas is not shown on Figure 10.

IDAHO GROUP (SURFACE AND SHALLOW SUBSURFACE)

In this section of the report, all subdivisions of the project area are considered, with the exception of the Sucker Creek subarea. The two subareas in which field work was concentrated, the Boise-Weiser and Murphy-Chalk Hills subareas, are considered first. The remaining subareas are considered, in general, from west to east.

A total of 65 samples of the Idaho Group were collected and analyzed for chemical composition. The distribution of these samples in the project area (Pl. 2) is as follows: Boise-Weiser subarea, 43 samples; Murphy-Chalk Hills subarea, 18 samples; Reynolds Basin subarea, 2 samples; and Glenns Ferry-Hagerman subarea, 2 samples.

For purposes of statistical evaluation, samples from the Boise-Weiser subarea are treated as one group and samples from the remaining three subareas are treated as a second group. The former is designated as "samples of the Idaho Group from the Boise-Weiser subarea"; the latter is designated as "samples of the Idaho Group from the southern part of the basin."

Three samples of waters, which possibly flow from formations in the Idaho Group, were collected. Of these three samples, one is from the Boise-Weiser subarea, one is from the Murphy-Chalk Hills subarea, and one is from the Castle Butte subarea.

Newton and Corcoran (1963, p. 8) described the Idaho Group in the western part of the basin as consisting of unconsolidated to semiconsolidated deposits of clay, silt, sand, ash, diatomite, limestone, and conglomerate. The authors of the present report found much more sandstone in the surface than is implied in the description by Newton and Corcoran. When subsurface data are considered, however, the description may be valid.

Malde and others (1963) described the two formations evaluated by the authors of the present report in the eastern part of the project area, the Chalk Hills and Glenns Ferry Formations (see section on Cenozoic geology, this paper). The authors of the present report found these descriptions to be valid.

Boise-Weiser Subarea

Stratigraphic and lithologic data were gathered and rock samples were collected in 19 localities (locs. 1, 2, 7, 8, 10 through 14, 17, 18, 22, 28 through 32, 67, and 69; Pl. 2) in this subarea. A water sample was collected in one locality (loc. 21).

Stratigraphic and lithologic data on the shallow subsurface were obtained from lithologic logs for 11 water wells and from lithologic and (or) electric logs for 9 petroleum test wells (including 2 in Oregon near the state line; Pl. 2). In addition, information on radioactivity in the shallow subsurface was obtained from a gamma-ray log for one well (well 8, Pl. 2).

Stratigraphic and Lithologic Characteristics. Surficial exposures of the Idaho Group in the Boise-Weiser subarea include thick sequences of sandstone, conglomerate, siltstone, and claystone. Sandstone appears to be the dominant rock type. In the field studies, the authors concentrated on localities with good exposures of medium- to coarse-grained sandstone and conglomerate. Fine-grained sedimentary rocks were studied in only three localities (locs. 22, 30, and 69).

In 15 of the 19 localities studied, less than 75 ft of the Idaho Group is exposed. Thicker sections, up to 650 ft thick, are exposed in 4 localities (locs. 2, 13, 17, and 18). The overall percentage of medium- to coarse-grained or conglomeratic sandstone in the thicker section is about 70 percent.

The sandstones and conglomerates in the Idaho Group in the Boise-Weiser subarea form thin to very thick beds (generally less than 50 ft thick) that are externally tabular and internally layered, cross bedded, or massive. They range from poorly sorted to very well sorted; the hardness ranges from soft or medium hard to hard and very hard. The degree and type of cementation are varied. Siliceous cement is the most common; ferruginous and carbonate cement, the least common. In many localities, the rocks are clay-bound. The composition of the sandstone ranges from quartzose to arkose; in 5 localities (locs. 2, 7, 8, 22, and 32), the rocks are feldspathic or arkosic.

Carbonaceous material is present in many of the localities studied, either in the sandstone (loc. 2, 11, 17, 18, and 67) and/or in adjacent fine-grained beds (loc. 13, 17, 22, and 67). Beds of coaly claystone and carbonaceous claystone up to 6 ft thick are present in one locality (loc. 17).

The potential host rocks are iron stained in several localities. In some of these localities, weathering cannot be ruled out as a cause of staining. In other localities the iron staining is most likely the result of alteration and therefore is considered evidence of favorability.

In the shallow subsurface in the Boise-Weiser subarea, data on the depth and thickness of sand intervals were obtained from lithologic and/or electric logs for 19 petroleum test wells and water wells. Additional data, such as depth to basement, thickness of beds, grain size, hardness, and presence of carbonaceous material, were obtained for eight of the wells.

The overall percentage of sand in the shallow subsurface is greatest within about 10 miles of the margin of the basin and generally decreases with increasing distance from that margin. In 7 wells around Boise (wells 15, 38, 46, 50, 51, 52, and 55; Pl. 2) and 2 wells between Emmett and Weiser (wells 3 and 32), sands are present throughout the shallow subsurface interval penetrated by the well, and the overall sand percentage ranges from about 25 to 70 percent (excluding intervals that can be identified as alluvium or basement). (See App. G for logs of water wells and Pls. 3 through 5 for lithologic columns of petroleum test wells.) In wells 2 and 8 (Pls. 3 and 4), only about 4 to 6 miles southwest of a line through wells 3 and 32, the sand percentage is noticeably lower (10 to 15 percent) and the thick sandstones are mostly confined to the 0- to 500-ft interval. In wells 5, 19, and 20 (Pl. 4), about 6 miles farther to the southwest, good sand intervals are absent.

Sand percentages are generally low (less than 30%) in the vicinity of Weiser (wells 1, 39, 40, and 41), but thick sand intervals are reported in some wells (well 39, interval 0 to 50 ft; and well 41, interval 1,203 to 1,370 ft, App. G). Additional favorable characteristics of sand intervals are reported in logs of deep water wells in the vicinity of Boise: (1) thick to very thick beds of medium- to coarse-grained sandstone (wells 46, 50, 51, 52, and 55; App. G); (2) different degrees of hardness (wells 38, 50, and 51; App. G); and (3) possible carbonaceous material (well 38; App. G). The overall sand percentage is low (about 20 percent) in a 400-ft well near Horseshoe Bend (well 44) but favorable characteristics are reported: 10- to 35-ft-thick sandstone beds and coal layers.

Basaltic rock, tentatively identified as Columbia River Basalt, was penetrated in two wells in the vicinity of Weiser: (1) at a depth of 270 ft in well 39 (App. G); and (2) at a depth of 620 ft in well 1 (Pl. 3).

Chemical and Radioactivity Characteristics. Forty-three samples of the Idaho group from the Boise-Weiser subarea were analyzed for equivalent uranium, thorium, and potassium by gamma-ray spectrometry. Thirteen of these samples were also analyzed for 69 elements by emission spectroscopy. The mean equivalent uranium content of the rock samples (3.9 ppm) is close to the mean (4.0 ppm) for all project samples (Table 1). One water sample was also analyzed for U_3O_8.

The following characteristics of the Idaho Group in the Boise-Weiser subarea are noted from an equivalent uranium-thorium plot for individual samples (Fig. 8):

1. Equivalent uranium is enriched relative to equivalent thorium in four samples (11-11, 17-10, 17-41, and 67-6) and possibly in a fifth sample (2-2).

2. There is a very pronounced grouping and separation of "class A" (generally argillaceous) and "class B" (generally non-argillaceous) sample types in the 12 sample pairs. The separation is probably not due to secondary enrichment of uranium because, within most of the individual A-B sample pairs, there is no apparent enrichment of uranium relative to thorium (the two members have similar U/Th ratios). The separation of sample types suggests primary differences in compositon due to provenance or to fractionation during erosion and transportation.

3. In only two of the twelve A-B sample pairs (2-2, 2-1; and 17-10, 17-11) is the class A sample significantly enriched in equivalent uranium relative to equivalent thorium when compared with the class B sample. (The other sample pairs, not identified on Fig. 8 because of their number, are 1-1, 1-2; 13-3, 13-3; 17-30, 17-31; 17-40, 17-41; 18-5, 18-6; 22-1, 22-2; 28-1, 28-2; 29-2, 29-1; 32-2, 32-3; and 67-3, 67-4.)

Anomalously high concentrations of at least one of the possible chemical indicators were found in 12 of the 43 samples collected in the Boise-Weiser subarea (Table 5). Seven of the anomalous samples (2-2, 13-3, 17-10, 17-30, 17-40, 32-1 and 32-2) are from fine-grained beds adjacent to medium- to coarse-grained potential host rocks.

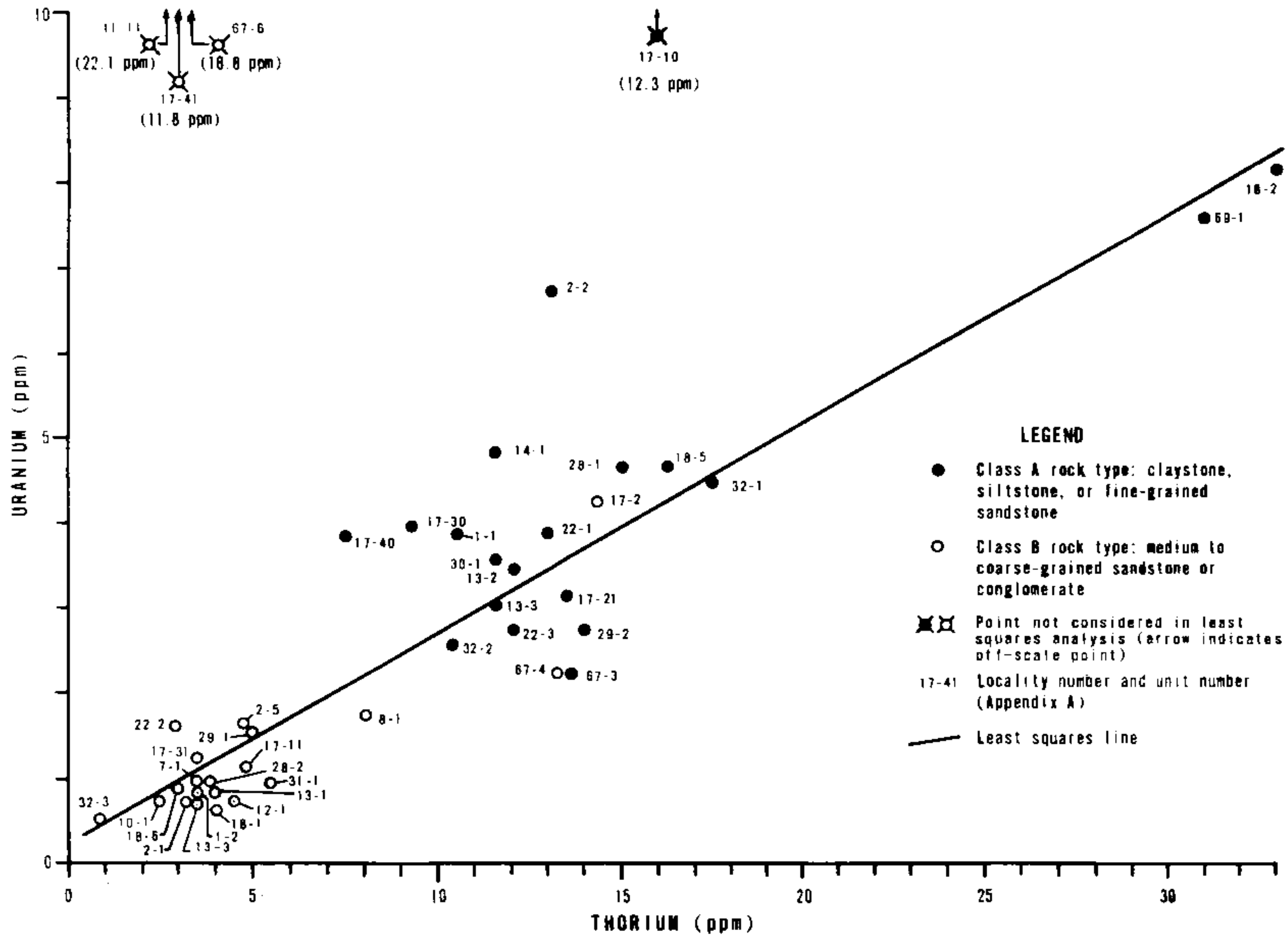

Figure 8. Plot of equivalent uranium versus equivalent thorium for samples of the Idaho Group, Boise-Weiser subarea.

Table 5 Anomalous elemental concentrations in samples of the Idaho Group Boise-Weiser subarea

Possible indicator element or ratio	All samples in formation or project [a]: number detected [c]	mean	(std dev)	Locality - unit number, Rock type [b]: 2-2 clyst	11-11 ss	13-3 clyst	17-10 clyst	17-30 sltst	17-40 clyst	17-41 ss	18-2 sltst	32-1 sltst	32-2 clyst	67-6 cgl	69-1 clyst
eU (ppm)	43/43	3.9	(4.6)	6.7	22.1	3.0	12.3	3.9	3.8	11.8	8.1	4.4	2.5	18.8	7.5
eU/eTh	43/43	0.69	(1.51)	0.52	7.89	0.26	0.77	0.42	0.51	4.07	0.25	0.25	0.27	5.70	0.24
eU/eKx10,000	43/43	2.3	(3.1)	3.3	14.5	1.7	11.5	2.3	1.9	5.3	6.8	2.2	0.94	9.4	6.8
eTh/eKx10,000	43/43	5.5	(6.1)	6.3	1.8	6.6	14.9	5.3	3.7	1.3	27.7	8.6	3.5	1.7	27.9
As (ppm)	1/38	300	(-)	300	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA
B (ppm)	36/38	27	(21)	10	10	10	50	50	80	10	30	80	50	NA	NA
Cr (ppm)	23/38	13	(8)	10	10	ND	10	10	20	ND	20	30	30	NA	NA
Cu (ppm)	38/38	28	(16)	30	30	50	80	40	20	10	30	10	10	NA	NA
Li (ppm)	20/38	12	(18)	10	ND	ND	6	4	10	ND	5	20	80	NA	NA
Mn (ppm)	38/38	800	(1800)	100	3000	1000	400	5000	10,000	1500	200	100	200	NA	NA
P (ppm)	14/38	see note d		ND	>10,000	>10,000	500	800	7000	5000	ND	ND	ND	NA	NA
Sn (ppm)	5/38	4	(2)	ND	ND	ND	ND	ND	8	ND	ND	ND	ND	NA	NA
V (ppm)	34/38	50	(47)	100	30	90	20	60	200	100	40	30	200	NA	NA
Zn (ppm)	23/38	130	(45)	100	100	ND	100	100	100	ND	100	200	200	NA	NA

a/ The statistics relative to eU, eTh, and eK are for the named formation; statistics relative to the remaining elements are for all project samples analyzed by emission spectrography.

b/ clyst=claystone; ss=sandstone; sltst=siltstone; cgl=conglomerate; NA=not analyzed for; ND=not detected. Two underlines indicates value is two or more standard deviations above the mean; one underline indicates about one standard deviation above the mean.

c/ First number is number of samples in which element was detected; second number is number of samples in formation or project, as applicable.

d/ Less than 10,000 ppm for 9 samples; greater than 10,000 ppm for 5 samples.

The twelve anomalous samples are separated into three groups according to their chemical composition:

1. Anomalously high (more than two standard deviations above the mean) content of equivalent uranium and at least one of the possible indicators (samples 11-11, 17-10, 17-41, and 67-6). The results for these samples are considered evidence of uranium favorability.

2. Anomalously high content of at least two of the possible indicators other than uranium (samples 17-40, 32-1, and 32-2). The results for these samples are considered probable evidence of uranium favorability. The validity of this assumption is supported by the fact that one of the samples in this group (sample 17-40) is from a rock unit adjacent to a unit (represented by sample 17-41) with anomalously high equivalent uranium content.

3. Anomalously high content of one of the possible indicators other than uranium (samples 2-2, 13-3, 17-30, 18-2, and 69-1). The results for these samples are not considered sufficient evidence of favorability.

The U_3O_8 content of a sample of water from a spring located near outcrops of the Idaho Group (loc. 21) is 0.3 ppb (App. F), less than the mean (0.9 ppb) for all water samples analyzed in the project.

The one gamma-ray log in the Boise-Weiser subarea (well 8, Pl. 3) was examined for evidence of abnormal radioactivity in the shallow subsurface. No part of the log is considered anomalous.

Uranium Favorability. The Boise-Weiser subarea is divided into two parts for purposes of rating the favorability of the Idaho Group: (1) the southeastern part, which includes the general area around Boise, Emmett, and Horseshoe Bend (Fig. 10), and (2) the northwestern part, which includes the general area around Payette, Weiser, and the Weiser River valley.

The Idaho Group in the surface and shallow subsurface in the southeastern part of the Boise-Weiser subarea has the following characteristics consistent with a greatest favorability rating:

1. The overall percentage of sandstone ranges from about 25 to 75 percent.

2. The group includes thick sequences, up to 600 ft, of medium- to coarse-grained sandstone.

3. Sandstone beds between 20 and 50 ft thick are generally present in the section.

4. The sandstone generally has some degree of permeability.

5. Carbonaceous material is generally present, either in the potential host rocks or in adjacent fine-grained beds.

6. The sandstones are feldspathic or arkosic in many areas and iron stained in some.

7. Several faults pass through the area.

8. The chemical composition of samples from three localities indicates favorability.

In addition, this part of the Boise-Weiser subarea is adjacent to and laps upon granitic rocks of the Idaho batholith. The granitic rocks are potential uranium source rocks.

On the negative side, there is an absence of tuffaceous rocks above the potential host rocks. This may be, however, only apparent considering the paucity of geologic data on the area.

It should be noted that most of the data points (surface and subsurface), on which this conclusion is based, are located east of a north-south line through Emmett. The extension of a greatest favorability rating to the remainder of the southeast portion is based on (1) high sand percentage in wells 3 and 32 (Pl. 3); (2) favorable grain size and bedding characteristics in well 32; and (3) an assumption that the overall structural and geologic environment are unchanged throughout the area.

The northwestern part of the Boise-Weiser subarea is rated moderately favorable on the basis of sand percentage (10-15 percent) in wells near Payette and Weiser. Surficial rocks in the area are generally fine grained (loc. 29, App. A).

The overall thickness of the Idaho Group in this area, based on well logs and on surface geology, is much less (about one-tenth or less) than in most other parts of the western Snake River basin, which suggests that this area is a separate basin or outlier of the western Snake River basin.

Murphy-Chalk Hills Subarea

The Idaho Group was studied on the surface in 11 localities in this subarea. Stratigraphic and lithologic data were gathered and rock samples collected in 9 localities (locs. 33, 36, 37, 39, 40, 41, 43, 63, and 64; Pl. 2). Water samples were collected in 2 additional localities (locs. 38 and 42). Stratigraphic and lithologic data on the shallow subsurface were obtained from lithologic logs for 11 water wells, ranging in depth from 335 to 1,560 ft.

Stratigraphic and Lithologic Characteristics. The Idaho Group in the Murphy-Chalk Hills subarea consists of unconsolidated to poorly consolidated deposits of fine-grained sand, silt, and clay with minor deposits of medium- to coarse-grained sand and conglomerate. The authors' work was limited to localities with outcrops of the medium- to coarse-grained or conglomeratic rocks, with the exception of locality 40, which includes outcrops of oolite.

The medium- to coarse-grained or conglomeratic rocks are poorly sorted to well sorted and form beds less than 20 ft thick, where the total thickness is exposed. These rocks are conglomeratic and medium hard to hard in most of the localities. The degree of cementation is varied; siliceous, and ferruginous cement are present. There is evidence in 6 localities that the rocks are fluvial in origin; in 5 localities the rocks form lenticular channel deposits. In addition, the rocks are arkosic in one locality, iron stained in 3 localities, contain carbonaceous material in 1 locality, and contain silica-replaced wood and other fossils in 3 localities. Tuffaceous rocks are superjacent or subjacent to the coarse-grained rock in two localities.

Data on the depth and thickness of sand intervals in the shallow subsurface in the Murphy-Chalk Hills subarea were obtained from lithologic logs for 11 wells (Pl. 2). Additional data on grain size and hardness were obtained from the logs for 4 wells.

The overall percentage of sand (excluding nonsedimentary rocks and alluvium) is 20 percent or less in 8 of the 11 wells. It is more than about 40 percent in 3 wells (wells 68, 69, and 100).

According to the logs, sandstone or conglomerate beds more than approximately 20 ft thick are present in each of the wells. The presence of coarse-grained sandstone or conglomerate is reported in logs of 4 wells (wells 74, 97, 99, and 100) and hard sandstone beds are present in 2 wells (wells 68 and 90).

Chemical Characteristics. Seventeen samples of the Idaho Group in the Murphy-Chalk Hills subarea were analyzed for equivalent uranium, thorium, and potassium by gamma-ray spectrometry. Seven of these were analyzed for 69 elements by emission spectroscopy. Two water samples were analyzed for U_3O_8.

The mean equivalent uranium content of 22 samples of the Idaho Group from the southern part of the basin is 5.4 ppm (Table 1), somewhat higher than the mean of the Idaho Group in the Boise-Weiser subarea (3.9 ppm) and also higher than the mean for all project samples (4.0 ppm). The following characteristics of the Idaho Group in the Murphy-Chalk Hills subarea are noted from an equivalent uranium-thorium plot for individual samples (Fig. 9).

1. Four samples are anomalously high in equivalent uranium relative to equivalent thorium (samples 37-5, 41-3, 63-1, and 63-2).

2. In none of the four "class A" (generally argillaceous) and "class "B" (generally non-argillaceous) samples is the class A sample significantly enriched in equivalent uranium relative to equivalent thorium, when compared with the class B sample.

Anomalously high concentrations of at least one of the possible chemical indicators of favorability were found in 5 samples from 3

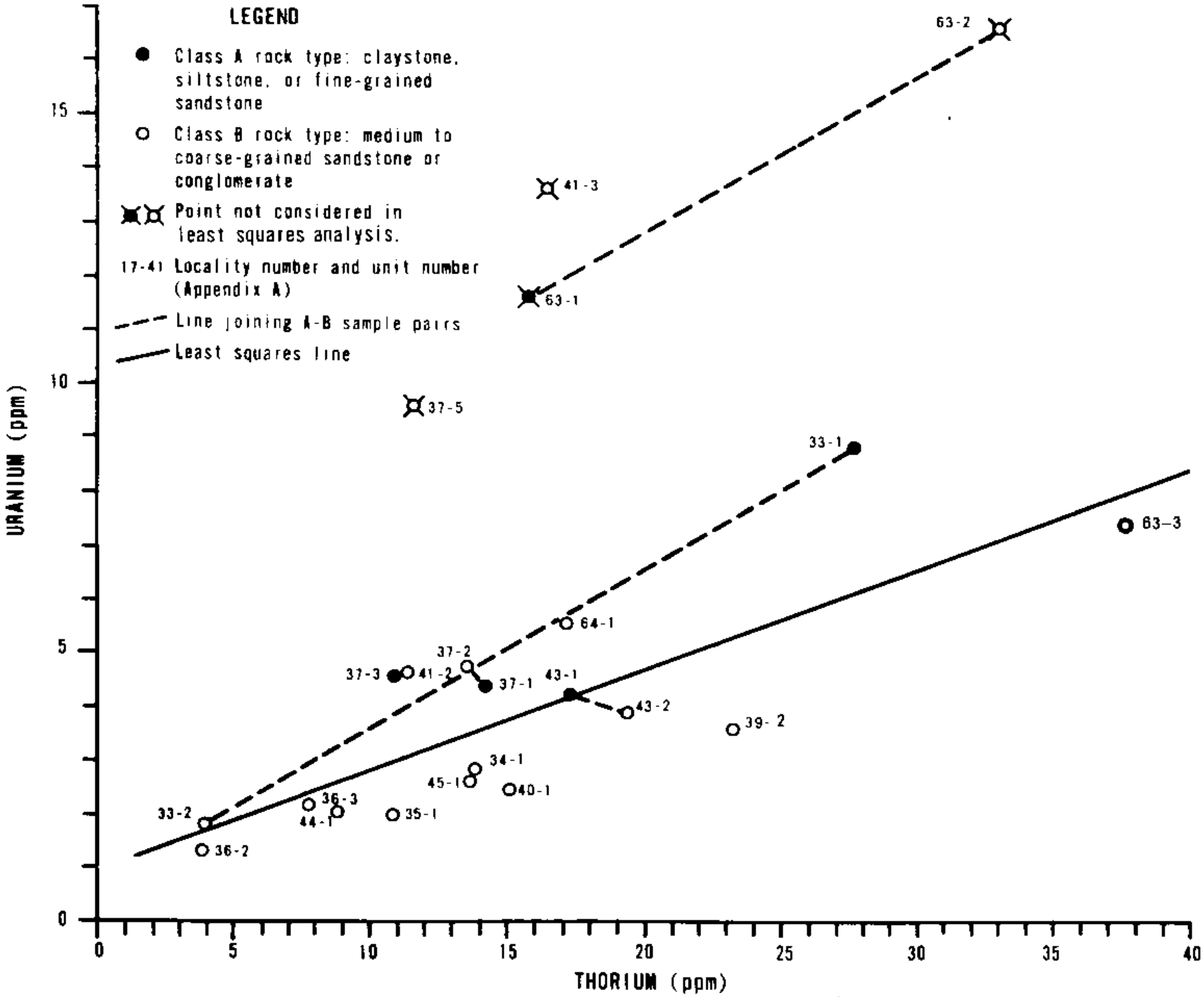

Figure 9. Plot of equivalent uranium versus equivalent thorium for samples of the Idaho Group from the southern part of the basin.

separate localities in the Murphy-Chalk Hills subarea (Table 6). These results are considered evidence of uranium favorability because of the following:

1. The equivalent uranium content of at least one sample in each locality is anomalously high relative to equivalent thorium when compared with the least-squares, best-fit correlation line on an equivalent uranium-thorium plot (for example, samples 37-5, 41-3, 63-1, and 63-2; Fig. 9).

2. The equivalent uranium content of samples from 2 localities (41-3 and 63-2) is anomalously high when compared with the mean concentrations in either (1) the group of samples from the Murphy-Chalk Hills subarea or (2) all project samples (Table 6).

3. The anomalously high equivalent uranium content is supported by the anomalously high value of at least one of the other indicators. In at least one sample from each of the 3 localities, the eU/eTh ratio, considered to be one of the most important indicators, is also anomalously high.

The U_3O_8 content of water emerging from the basalt member of the Chalk Hills Formation (loc. 42) is 1.8 ppb (App. F), much higher than the mean (0.9 ppb) of all project water samples and the highest of all the water samples analyzed. This is not sufficiently high, however, to be considered evidence of uranium favorability.

Uranium Favorability. The Idaho Group in the surface and shallow subsurface of the Murphy-Chalk Hills subarea is rated of moderate to greatest favorability because of moderately favorable stratigraphic and lithologic characteristics and highly favorable chemical characteristics. The favorable stratigraphic and lithologic characteristics are summarized as follows:

1. Moderate sandstone percentage (10 to 25 percent) in all 8 of 11 water wells and high percentage (40 to 60 percent) in 3 wells; also low to moderate sandstone percentage (5 to 20 percent) in surface localities (locs. 33, 37, and 63; App. A).

2. Thick sequences of sandstone, from 100 to 700 ft, on the basis of water well data.

3. Presence of sandstone or conglomerate beds more than 20 ft thick in each of the wells.

4. Surficial evidence of fluvial origin and some degree of present or original permeability.

5. Presence of feldspar, iron staining, and carbonaceous material in some localities.

Table 6. Anomalous elemental concentrations in samples of the Idaho Group, Murphy-Chalk Hills subarea

Possible indicator element or ratio	All samples in formation or project [a] number detected [c]	mean	std dev	Locality - unit number, rock Type [b] 37-5 cgl	41-3 ss	63-1 sltst	63-2 cgl	63-3 ss
eU (ppm)	22/22	5.4	4.1	9.5	13.6	11.6	16.6	7.0
eU/eTh	22/22	0.35	0.20	0.75	0.82	0.73	0.50	0.20
eU/eKx10,000	22/22	3.0	3.1	3.4	8.2	10.84	9.9	7.0
eTh/eKx10,000	22/22	8.5	7.5	4.6	10.0	14.8	19.7	35.7
B (ppm)	36/38	27	21	NA	NA	50	20	10
Cr (ppm)	23/38	13	8	NA	NA	20	ND	ND
Li (ppm)	20/38	12	18	NA	NA	30	ND	ND
P (ppm)	14/38	see note d		NA	NA	>10,000	>10,000	>10,000
V (ppm)	34/38	50	47	NA	NA	80	40	10

[a] The statistics relative to eU, eTh, and eK are for the named formation; statistics relative to the remaining elements are for all project samples analyzed by emission spectroscopy.

[b] cgl=conglomerate; ss=sandstone; sltst=siltstone; NA=not analyzed for; ND=not detected. Two underlines indicates value is two or more standard deviations above the mean; one underline indicates about one standard deviation above the mean.

[c] First number is number of samples in which element was detected; second number is number of samples in formation or project, as applicable.

[d] See Appendix D for distribution of values.

The favorable chemical characteristics of surface samples include (1) high mean equivalent uranium content (5.4 ppm), the highest of any sample group in the project, and (2) chemical characteristics indicative of favorability in 3 localities.

The favorability of the Idaho Group in this area is probably close to that of the Sucker Creek Formation, considering such factors as sand percentage and chemical characteristics. The Sucker Creek Formation, however, contains a higher percentage of tuffaceous material.

In this area, the Idaho Group is probably less favorable than in the Boise-Weiser subarea, considering the lower percentages of potential host rock and carbonaceous material in the Murphy-Chalk Hills subarea.

Because the only formations recognized in the surface and shallow subsurface of the Murphy-Chalk Hills subarea are those in the Idaho Group, the entire subarea is rated of the same favorability as the Idaho Group: moderate to greatest.

Castle Butte Subarea

Stratigraphic and lithologic data on the Idaho Group in the Castle Butte subarea were obtained from surface studies in 2 localities (described below) and from lithologic logs for 5 water wells (Pl. 2), ranging in depth from 1,620 to 3,080 ft. Chemical data were obtained from the analysis of 1 water sample (loc. 38, App. A).

Stratigraphic and Lithologic Characteristics. The Castle Butte subarea is physiographically characterized by grass-covered, low rolling hills and flatlands. The Idaho Group is poorly exposed.

A section of the Idaho Group, approximately 100 ft thick, is exposed 1-1/4 miles northeast of Fossil Butte along an unimproved road. The section consists of poorly consolidated siltstones, tuffaceous siltstones, and sandstones in parallel even beds. The siltstones, which compose about 80 percent of the section, are greenish-gray, thin bedded, moderately hard, and friable. Thin, gray scoriacious ash beds are interbedded with the siltstones.

Sandstones in the Fossil Butte section are brownish to tan-gray, fine to medium grained, soft, friable, poorly to moderately well sorted, and micaceous. Thin, moderately well-sorted, coarse-grained sandstones are interbedded with the fine- to medium-grained sandstones. A section exposed in a road cut along Idaho state highway 45 northwest of Oreana consists of very fine-grained, soft, friable sandstone and soft, unconsolidated siltstone.

According to the lithologic logs of 5 water wells in the Castle Butte subarea (wells 75, 76, 81, 82, and 83; App. G), the shallow subsurface interval of the Idaho Group consists almost entirely of shale. Except for near-surface deposits tentatively identified as alluvium, no sand intervals are reported. The overall sand percentage is less than about 5 percent in all of the wells.

Radioactivity and Chemical Characteristics. The radioactivity in the two localities studied, as measured with a field scintillometer, is below average.

The U_3O_8 content of water flowing from an artesian well (loc. 38) is 0.4 ppb (App. F), less than the mean (0.9 ppb) for all project water samples.

Uranium Favorability. The characteristics of the Idaho Group in the surface and shallow subsurface in the Castle Butte subarea, especially with regard to the overall percentage and thickness of medium- to coarse-grained or conglomeratic deposits, are consistent with a least favorable rating.

Reynolds Basin Subarea

Stratigraphic and lithologic data were gathered and rock samples were collected in 2 localities (locs. 34 and 35) in the Reynolds Basin subarea. Additional stratigraphic and lithologic data were obtained from the report of McIntyre (1966), who informally applied the name Reynolds Basin Group to "an intertonguing sequence of olivine basalt flows, silicic tuffs, diatomites, arkosic sands and granitic gravels, and felsitic to glassy flows of latite." The maximum thickness of the group, according to McIntyre (1966), rarely exceeds 1,000 ft. The age is probably late Miocene or early Pliocene. In the absence of correlations between the subdivisions of the Reynolds Basin Group and the formations evaluated in the present report, the discussions of sedimentary rocks in this group are included with those of the Idaho Group.

Stratigraphic and Lithologic Characteristics. McIntyre (1966) divided the Reynolds Basin Group into 7 units, but only 2 of these units, the Boston Ranch unit and the "arkosic unit," contain significant beds of sedimentary rock.

The Boston Ranch unit, up to 800 ft thick (McIntyre, 1966, p. 127), consists of "altered fine vitric tuff, diatomite, pumicite, pumice breccia, and lignite" with subordinate "detritus derived from granitic or basaltic terranes" (McIntyre, 1966, p. 125). The "arkosic unit," up to 150 ft thick, consists of "fluviatile deposits of arkosic sand, granitic gravel, and clay found in the east-central and northeastern part of the Reynolds Basin" (McIntyre, 1966, p. 135).

The authors studied a sandstone unit (loc. 35, App. A) that may be representative of sedimentary rocks in the Boston Ranch unit. The sandstone is medium grained, well sorted, soft, and biotitic. It forms a tabular unit with internal cross bedding, which is apparently fluvial in origin. Sandstone, perhaps representative of the arkosic unit, was studied in locality 34 (App. A). In this locality the sandstone is coarse grained, well sorted, very hard, and biotitic. The rock is cemented with siliceous material and contains silica-filled fractures. The sandstone unit includes many conglomeratic lenses up to 1 ft thick. In other localities (not described in this report), the sandstone is poorly sorted.

Chemical Characteristics. Two samples of the Reynolds Basin Group from the Reynolds Basin subarea were analyzed for equivalent uranium, thorium, and potassium by gamma-ray spectrometry. The equivalent uranium contents of the two samples are 2.8 and 2.0 ppm (loc. 34 and 35, respectively). Both figures are about half the mean (5.4 ppm, Table 1) for all samples of the Idaho Group from the southern part of the project area and significantly less than the mean for all project samples (4.0 ppm). On an equivalent uranium-thorium plot of individual samples (Fig. 9), the points that represent these samples are not sufficiently far from the correlation line to be considered anomalous.

Uranium Favorability. The Idaho Group (Reynolds Basin Group of McIntyre, 1966) in the Reynolds Basin subarea is considered moderately favorable (Fig. 10) because of the following criteria:

1. There is an appreciable thickness of medium- to coarse-grained sandstone in the group, up to 150 ft.

2. The sandstone is arkosic and, at least in part, poorly sorted.

3. The sandstone forms beds more than 20 ft thick.

4. Tuffaceous rocks are present in the section, underlying the potential host rocks.

5. Lignite beds are present in the section.

On the negative side, the equivalent uranium content of two samples collected is relatively low, and the potential host rocks (arkosic unit of Reynolds Basin Group) have low permeability because of siliceous cement.

Parts of the subarea mapped as granitic rocks (Pl. 2) are least favorable (Fig. 10) in accordance with the definition of that rating. Those parts mapped as Columbia River Basalt or Silicic Volcanics undivided are rated least favorable because of the probability that the thickness of Cenozoic sedimentary rocks underlying these areas is not more than 100 ft. The latter conclusion was reached because sedimentary rocks have not been mapped between basement (granitic) rocks and the Columbia River Basalt or Silicic Volcanics in the area.

Nampa Subarea

Stratigraphic and lithologic data on the Idaho Group in the Nampa subarea were obtained from (1) lithologic logs for 9 water wells, ranging in total depth from 524 to 1,263 ft (Pl. 2 and App. G), and (2) lithologic and (or) electric logs for 5 petroleum test wells, ranging in total depth from 3,048 to 11,963 ft (Pls. 2, 3, and 4). Information on radioactivity was also obtained from a gamma-ray log for one well (well 12, Pl. 3).

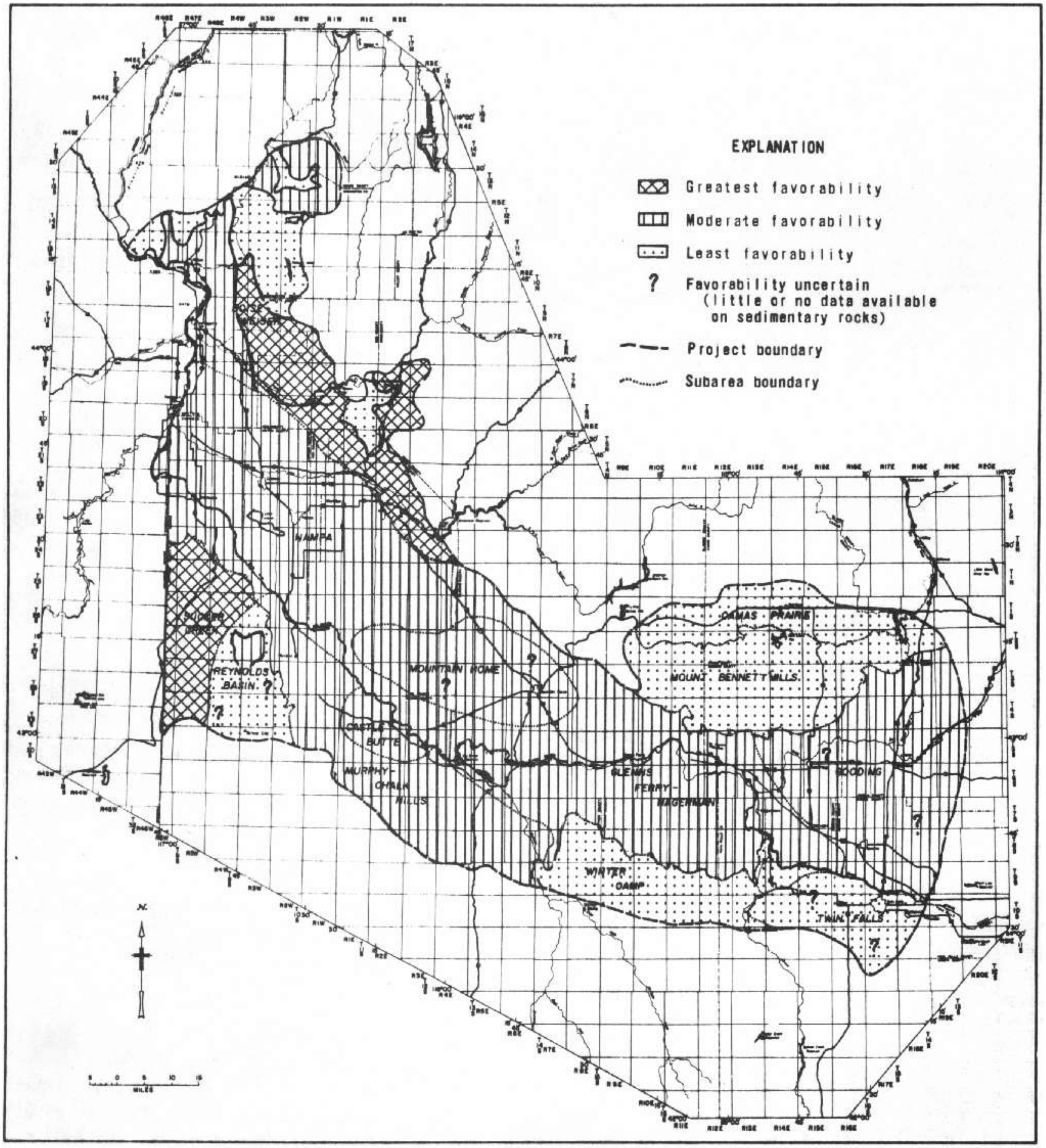

Figure 10. Relative uranium favorability of Cenozoic sedimentary rocks in the surface and shallow subsurface, western Snake River basin, Idaho.

Stratigraphic and Lithologic Characteristics. About half of the well logs are of good quality; the remainder, of fair quality. Information on depth and thickness of sand intervals is available for all of the wells; on grain size, for 7 wells (wells 21, 35, 36, 42, 45, 47, and 53); on hardness or degree of consolidation, for 5 wells (wells 12, 21, 35, 47, and 48); on depth to basement rock, for one well (well 56); and on characteristics of individual beds possibly related to favorability for 5 wells (wells 21, 35, 36, 49, and 53).

The overall percentage of sand in the shallow subsurface interval of these wells ranges from about 10 percent to 70 percent. In only 2 wells (wells 13 and 21; Pl. 3 and 4, respectively) is there less than 20 percent sands.

Additional characteristics of the sand intervals, reported on individual logs, are (1) presence of sandstone beds more than 20 ft thick (most wells); (2) presence of medium- to coarse-grained sandstone (all wells with grain size information); (3) different degrees of consolidation or hardness (wells 21, 47, and 48); (4) unconsolidated nature (wells 12 and 35); (5) presence of tuffaceous rocks in the upper part of the interval (wells 21 and 36); (6) presence of gas (well 21) and "wood" (interval 221 to 229 ft, well 49) as possible reductants; (7) presence of pyrite (interval 520 to 525 ft, well 35); and (8) possible oxidation of sandstone (interval 324 to 396 ft, well 53). Basement rock, tentatively identified as Columbia River Basalt, was reached at a depth of 676 ft in well 56.

Radioactivity Characteristics. The gamma-ray log (well 12, Pl. 3) was examined for evidence of abnormal radioactivity in the shallow subsurface. No part of the log is considered anomalous. The highest radioactivity, about twice background and nearly off-scale, is in a siltstone interval from 745 to 800 ft.

Uranium Favorability. The stratigraphic and lithologic characteristics of the Nampa subarea (especially sand percentage, thickness of beds, grain size) in the shallow subsurface are consistent with a rating of moderately favorable.

Mountain Home Subarea

Stratigraphic and lithologic data on the Idaho Group in the Mountain Home subarea were obtained from lithologic logs for 9 water wells, ranging in total depth from 535 to 1,150 ft (Pl. 2). In each of these wells a thick sequence of basalt interbedded with sedimentary rocks was penetrated. The basal depth of this sequence ranges from 220 ft (well 66) to 920 ft (well 72). The base of the basalt sequence was probably not reached in 4 of the 9 wells (wells 65, 67, 70, and 78), which ranged in total depth from 535 to 795 ft.

Sedimentary rocks, perhaps correlative with the Idaho Group, were reached in 5 of the wells (wells 64, 66, 71, 72, and 77). The thickness of the sedimentary sequence ranges from 94 ft (well 77) to 343 ft (well 66).

The upper 500 ft of the shallow subsurface interval in the Mountain Home subarea is considered least favorable because of the predominance of basalt. The 500- to 1,500-ft interval is also probably least favorable for the following reasons:

1. The presence of gravel in the sedimentary sequence below the basalt in 3 wells (wells 64, 66, and 72). In one well (well 72), the gravel continues to a depth of 1,150 ft.

2. The composite thickness of the uppermost formations of the Idaho Group (Black Mesa Gravel, Bruneau Formation, and Tuana Gravel, formations not evaluated in the present study because of age and poor consolidation) is about 1,000 ft.

The 1,500- to 2,000-ft interval (approximately) may include parts of the Glenns Ferry and Chalk Hills Formations, each estimated to be about 300 ft thick.

On the assumption that the basal part of the shallow subsurface interval in the Mountain Home subarea contains sedimentary rocks correlative with those in the Nampa subarea (rated as medium favorable), the Idaho Group in the Mountain Home subarea is rated moderately favorable.

Glenns Ferry-Hagerman Subarea

Stratigraphic and lithologic data on the Idaho Group in the surface and shallow subsurface in the Glenns Ferry-Hagerman subarea were obtained from (1) published reports (Malde and Powers, 1962; and Malde and others, 1963); (2) field reconnaissance; (3) field studies of two localities (locs. 44 and 45, App. A); (4) lithologic logs for 18 water wells, ranging in total depth from 240 to 4,000 ft (Pl. 2 and App. G); and (5) lithologic and (or) electric logs for 3 petroleum test wells ranging in total depth from 2,068 to 9,678 ft (Pls. 2 and 5). Chemical data were also obtained from analyses of 2 rock samples.

Stratigraphic and Lithologic Characteristics. Much of the Glenns Ferry-Hagerman subarea is underlain by the Glenns Ferry Formation of the Idaho Group (Pl. 2). The older Chalk Hills Formation is not known to crop out in the area.

The Glenns Ferry Formation consists of (1) even-bedded claystone, siltstone, and very fine sandstone (predominantly lacustrine) and (2) fine- to coarse-grained fluvial sandstone. The authors' work was limited to studies of the fluvial sandstones.

The fluvial sandstones are generally well sorted, cross bedded, and poorly consolidated. Poorly sorted, coarse-grained sandstone is locally present (loc. 44). Hard, well-sorted, feldspathic sandstone is present at Grindstone Butte (loc. 45) and at several other localities in the area.

Lithologic logs for 17 of the 21 wells (including 3 petroleum test wells) are of fair to good quality. The logs for 4 water well (wells 88, 89, 91, and 103) are of poor quality and consequently were not used in the evaluation.

The 17 wells with acceptable lithologic logs were grouped according to probable formations penetrated as follows:

1. Quaternary sedimentary rocks, based on the presence of gravels (wells 79, 85, and 107; total depth, 240 to 730 ft).

2. Quaternary basalt (wells 92, 93, 102, and 109; total depth, 362 to 830 ft).

3. Glenns Ferry and (or) Chalk Hills Formations (wells 29, 31, 34, 37, 58, 84, and 101; total depth, 460 to 9,678 ft).

4. Tertiary silicic volcanics, basalt, and Quaternary sedimentary formations (wells 104, 105, and 106; total depth, 800 to 1,204 ft).

The Idaho Group in areas represented by wells in groups 1 and 2 (above) can be rated only by making assumptions as to the characteristics of the remainder of the shallow subsurface interval not penetrated by these wells. (This is analogous to the situation in the Mountain Home subarea.) Additional characteristics of the wells in group 3 are discussed below. The area represented by the wells in group 4 must be considered least favorable because of the absence of pre-Quaternary sedimentary rocks.

In six of the seven group 3 wells that penetrated sedimentary formations, sand composes less than about 20 percent. In one well (well 84), sand composes about 70 percent. In most of the wells, 20-ft beds of sandstone are reported. In two logs describing grain size (wells 34 and 58), the presence of medium-grained to coarse-grained sandstone is noted. Arkosic sandstone is reported in the log for well 58. Different degrees of hardness, from soft to hard, are reported in the log for well 101. Pyrite is reported in well 34. In general, the two intervals considered most favorable in these wells are the 223- to 283-ft interval of coarse arkosic sandstone in well 58 and the 1,730- to 2,000-ft interval of very fine to medium-grained sandstone with a trace of pyrite in well 34.

<u>Chemical Characteristics</u>. Two samples of the Idaho Group in the Glenns Ferry-Chalk Hills subarea were analyzed for equivalent uranium, thorium, and potassium by gamma-ray spectrometry. The equivalent uranium contents are 2.0 and 2.6 ppm (locs. 44 and 45, respectively). Both values are less than half the mean (5.4 ppm; Table 1) for all samples of the Idaho Group from the southern part of the project area and are

significantly less than the mean for all project samples (4.0 ppm). The locations of the points representing these samples on an equivalent uranium-thorium plot for individual samples (Fig. 9) are not anomalous.

Uranium Favorability. The characteristics of the Idaho Group in the surface and subsurface in the Glenns Ferry-Hagerman subarea are, in general, consistent with a moderately favorable rating (Fig. 10). The overall sand percentage is moderate (from 10 to 20 percent) in wells that penetrate the entire shallow subsurface interval (wells 29, 31, 34, and 37). Thick beds of medium- to coarse-grained sandstone, up to 100 ft thick, are present in most of these wells. Favorable characteristics such as the presence of arkose or pyrite are reported in two wells.

At least a part of the Glenns Ferry-Hagerman subarea (not shown on Fig. 10) must be considered least favorable because of the absence of formations being evaluated (wells 104, 105, and 106; Pl. 2).

Gooding Subarea

Stratigraphic and lithologic data on the subsurface in the Gooding subarea were obtained from lithologic logs for 6 water wells, ranging in total depth from 408 to 790 ft (Pl. 2 and App. A). Four of these wells (wells 73, 94, 95, and 108), ranging in depth from 529 to 790 ft, do not reach the base of the thick sequence of basalt tentatively identified as Idaho Group. Sedimentary rocks, perhaps belonging to the Idaho Group, are present in the interval 408 to 473 ft of well 80 (total depth 473 ft) and the interval 459 to 547 ft of well 110 (total depth 730 ft). Rhyolitic volcanic rocks (tentatively identified as Tertiary Silicic Volcanics undivided, Pl. 1) underlie the sedimentary rocks in well 110.

The sedimentary sequence in well 80 consists of hard and soft sandstone with some gravel, according to the drillers' log (App. G). This may be a local feature, considering its proximity to outcrops of the older silicic volcanics (Pl. 2). The sedimentary sequence in well 110 contains about 10 percent sandstone.

The Idaho Group in the shallow subsurface in the Gooding subarea is considered of possible moderate favorability (Fig. 10) on the basis of the probability that strata of moderate favorability, similar to those in the neighboring Glenns Ferry-Hagerman subarea, underlie the thick sequence of Quaternary rocks. If the entire sequence of Quaternary rocks representing the upper Idaho Group (estimated to be 1,000 ft, Malde and Powers, 1962) is present underlying up to 800 ft of Snake River Group, the rocks of moderate favorability are in the basal 200 ft (approximately) of the shallow subsurface interval.

There is evidence that at least a part of the Gooding subarea (not shown on Fig. 10) is least favorable. In well 110 there are less than 100 ft of sedimentary rocks that might be in the formations being evaluated.

Camas Prairie Subarea

Stratigraphic and lithologic subsurface data in the Camas Prairie subarea were obtained from lithologic logs for 4 water wells, ranging in total depth from 308 to 578 ft (wells 59, 60, 61, and 62, Pl. 2; App. G). Granitic basement rocks were reached at a depth of about 500 ft in wells 61 and 62. The remainder of the section in each of the wells is tentatively identified as Quaternary in age because of the presence of gravel throughout the sedimentary sequence in 3 of the 4 wells. This identification is consistent with the fact that Tertiary sedimentary rocks, possibly correlative with the Chalk Hills or Glenns Ferry Formations, have not been mapped in the area (Pl. 1).

The Camas Prairie subarea is rated least favorable (Fig. 10) because of the absence of the formations being evaluated.

Mount Bennett Hills and Winter Camp Subareas

The Mount Bennett Hills and Winter Camp subareas are rated least favorable because the formations being evaluated (Chalk Hills and Glenns Ferry Formations) are absent. All but small parts of these subareas are mapped as Cretaceous granitic rocks, Challis Volcanics, Idavada Volcanics, and Banbury Basalt.

Twin Falls Subarea

The Twin Falls subarea was mapped as basalt of the Glenns Ferry Formation by Malde and others (1963). It is not considered likely that a significant sequence of Tertiary sedimentary rocks (more than about 100 ft) underlies these basalt flows for the following reasons:

1. Contiguous areas to the south and west are mapped as either Banbury Basalt or Idavada Volcanics, both of which underlie the formations being evaluated.

2. In well 100, there are less than 100 ft of sedimentary rocks that may be considered as being in the Chalk Hills or Glenns Ferry Formations. This well is located just north of the subarea boundary.

3. There should be less sedimentary rock throughout this subarea (south of well 110) because it is further from the axis of the basin.

Because of the probable absence of a significant sequence of sedimentary rocks in the formations being evaluated, the Twin Falls subarea is rated least favorable.

IDAHO GROUP (DEEP SUBSURFACE)

Stratigraphic and lithologic data on the deep subsurface interval in the project area were obtained from (1) lithologic and (or) electric logs for 12 petroleum test wells (Pl. 2), ranging in total depth from 2,775 to 11,963 ft and (2) lithologic logs for 4 deep water wells, ranging in total depth from 2,960 to 4,000 ft. Of the deep wells, 10 are in the Boise-Weiser and Nampa subareas; 3 are in the Castle Butte subarea; and 3 are in the central part of the Glenns Ferry-Hagerman subarea. Information on radioactivity in the deep subsurface was obtained from gamma-ray logs for 2 wells (wells 8 and 12, Pl. 3).

Boise-Weiser and Nampa Subareas

Depth of the 10 deep wells in the Boise-Weiser and Nampa subareas ranges from 2,775 to 11,963 ft. Of the 10 wells, 9 are less than 5,200 ft deep.

The relative uranium favorability of deep subsurface intervals was determined solely on the basis of sandstone percentage (Table 7). The relative favorability varies from least to greatest in the wells, and there is no general pattern to the favorability except that two of the three wells with high favorability intervals (wells 2 and 3) are also the nearest to the edge of the basin.

No part of the two gamma-ray logs (wells 8 and 12, Pl. 3) can be considered as characterized by abnormal radioactivity in the deep subsurface.

Castle Butte Subarea

The total depth of 3 deep water wells in the Castle Butte subarea ranges from 2,960 to 3,080 ft (Pl. 2). The relative uranium favorability of the deep subsurface interval of two of these wells (wells 75 and 76) is low, based on the percentage of sandstone (less than 5 percent). The relative favorability of this interval in the third well (well 81) was not determined, because it depends on the interpretation of units described in the log (App. A) as "rock."

Glenns Ferry-Hagerman Subarea

The total depth of the 3 deep wells in the central part of the Glenns Ferry-Hagerman subarea ranges from 3,808 to 9,678 ft (Pl. 2). The relative uranium favorability of the deep subsurface intervals, based on the percentage of sandstone, ranges from least to greatest (Table 7). In general it appears that the upper part of the deep subsurface interval in the wells (2,000 to 3,200 ft in well 29; 2,000 to 4,220 ft in well 34) is most favorable and the deeper part (3,200 to 3,808 ft in well 29; 4,220 to 9,002 ft in well 34; 2,000 to 4,000 ft in well 37) is least favorable.

Table 7. Relative favorability of deep subsurface intervals

Well number	Depth interval (ft)[a]	Percent sandstone (est.)	Sandstone characteristics	Favorability rating
Boise-Weiser and Nampa subareas				
2	2,000 - 4,011(TD)	40	--	greatest
3	2,000 - 4,017(TD)	75	--	greatest
5	2,000 - 2,775(TD)	<15	--	least-moderate
8	2,000 - 3,521(TD)	< 5	tuffaceous, in part	least
12	2,000 - 4,528(TD)	20	some fine to med. grained; arkosic in interval 3,430 - 4,530	moderate
13	2,000 - 3,048(TD	<10	--	least
20	2,000 - 3,650(TD)	< 5	--	least
21	2,000 - 4,460	30	firm to friable; gas shows; mostly fine to medium grained; some beds whitish, tuffaceous, feldspathic	greatest (2,000 - 3,160) moderate (3,160 - 4,460)
	4,460 - 5,189(TD)	< 5	--	least
35	2,000 - 3,850	5	fine to coarse grained, poorly sorted, calcareous, in interval 3,370 - 3,450	least
	3,850 - 6,250	< 5	--	least
	6,250 - 7,800	5	fine to medium grained with carbonaceous material; pyrite in underlying shale	least
	7,800 - 8,730	< 5	--	least
	8,730 - 9,090(TD)	<20	very fine grained tuffaceous	least-moderate
36	2,000 - 2,350	< 5	--	least
	2,350 - 3,610(TD)	< 5	--	least
Glenns Ferry-Hagerman subarea				
29	2,000 - 3,200	50	interbedded "lime" and lava	moderate-greatest
	3,200 - 3,808(TD)	< 5	--	least
34	2,000 - 4,220	60	some beds white, fine to coarse grained, with trace of pyrite	moderate-greatest
	4,220 - 4,750	< 5	--	least
	4,750 - 9,002(TDL)	5	some medium to coarse grained; some arkosic	least
37	2,000 - 3,900	< 5	--	least
	3,900 - 4,000	< 5	--	least

[a] TD = total depth; TDL = total depth logged.

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APPENDIX A

STRATIGRAPHIC AND LITHOLOGIC DATA FOR SAMPLE LOCALITIES

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STRATIGRAPHIC AND LITHOLOGIC DATA FOR SAMPLE LOCALITIES

LOCALITY 1. STARVIEW ROAD

SW¼NE¼SW¼ sec. 19, T. 3 N., R. 3 E.; Boise meridian; Ada County, Idaho. The section described below is exposed along Starview Road. Units 1 and 2 are exposed in a roadcut about 500 feet from the intersection with Idaho state highway 21, opposite the Boise Cascade mill. In the Idaho Group according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
3.	Not described in detail; claystone, reddish brown; soft, with sandstone stringers	100
2.	Sandstone, yellowish gray (weathers to streaked light yellowish gray); coarse grained, moderately well sorted; medium hard, friable and earthy (weathered surface is smooth); lenticular, massive bedding; lower contact sharp and regular. Sample 12001	10
1.	Sandstone, grayish yellow (weathers to light gray); fine grained, well sorted; medium hard, friable and earthy, clay cement; lenticular bed with internal thin, parallel even bedding; lower contact sharp and regular; some interbedded thin layers of claystone. Sample 12002	3
	Total estimated thickness	113

LOCALITY 2. BARBER ROAD

SE¼SW¼NE¼ sec. 19, T. 3 N., R. 3 E.; Boise meridian; Ada County, Idaho. The section exposed on the south-facing slope of the hill north of Barber Road consists of an estimated 150 feet of clayey fine grained sandstone and clayey siltstone with some interbedded coarser grained clastic material. Samples were collected from conglomeratic sandstone (unit 3) in the upper part of the section, and claystone and fine grained sandstone from near the contact between the lower sandy and overlying clayey parts. In the Idaho Group according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
6.	Sandstone, clayey; fine grained	50
5.	Sandstone, conglomeratic, feldspathic; dusky yellow (weathers to light gray); medium grained, well sorted; medium hard, friable and earthy (weathered surface smooth); medium, parallel even bedding; contains wood fragments. Sample 12003	10
4.	Sandstone; fine grained	50
3.	Claystone	20
2.	Claystone, grayish orange (weathers to streaked medium orange gray); medium hard, loose and earthy (weathered surface is smooth); parallel uneven external bedding; parallel uneven laminar internal beds; lower contact sharp and irregular; contains iron-stained sand stringers. Sample 12004	1

LOCALITY 2. (continued)

Unit		Estimated thick. (ft)
1.	Sandstone, grayish yellow, (weathers to streaked light yellowish gray); coarse grained, moderately sorted; containing carbonized wood; medium hard, friable and earthy; clay cement; very thin, parallel uneven bedding; lower contact gradational. Sample 12005 collected from near top of unit	20

LOCALITY 3. PENITENTIARY RIDGE EAST

SE¼SW¼SE¼ sec. 12, T. 3 N., R. 2 E.; Boise meridian; Ada County, Idaho. The east-west trending ridge located north of the old state penitentiary and mapped as Poison Creek Formation by Newton and Corcoran (1963) is capped by a hard and resistant sandstone which is approximately 50 feet thick. This unit was sampled in two different areas (localities 3 and 4). A medium hard sandstone unit stratigraphically below the capping sandstone was sampled at Locality 5. Also, a soft sandstone and siltstone/claystone sequence in a gully just south of this ridge, and probably separated from it by an east-west fault, was sampled in locality 6. Poison Creek Formation according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
1.	Sandstone, conglomeratic, arkosic; very pale orange (weathers medium reddish gray); coarse grained, moderately well sorted; hard, compact and earthy (weathered surface is smooth); siliceous-ferruginous cement; thin, planar crossbedding; lower contact sharp and regular. Contains massive 1 foot to 4 foot beds of well cemented, poorly sorted, gray sandstone and conglomeratic lenses with three inch clasts of subrounded granitic material. Forms cap rock at the top of ridge. Sample 12006.	15

LOCALITY 4. PENITENTIARY RIDGE WEST

NE¼SE¼SW¼ sec. 12, T. 3 N., R. 2 E.; Boise meridian; Ada County, Idaho. See note under description of locality 3 regarding relationship of this and other localities in the area. Poison Creek Formation, according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
1.	Sandstone, conglomeratic, feldspathic; light greenish gray (weathers medium brownish gray); coarse grained, moderately sorted; very hard, compact and earthy (weathered surface is smooth); siliceous cement; massive bedding; lower contact sharp and regular. Contains local lenses of conglomerate with granite and quartz clasts. Sample 12007	30

APPENDIX A (continued)

LOCALITY 5. STATE PENITENTIARY

SE¼SW¼SE¼ sec. 12, T. 3 N., R. 2 E.; Boise meridian; Ada County, Idaho; 500 yards northeast of old state penitentiary in bulldozer cut. See note under description of locality 3 regarding relationship of this and other localities in the area. Poison Creek Formation according to Newton and Corcoran (1963, Pl. 1).

Unit	Estimated thick. (ft)
1. Sandstone, conglomeratic, feldspathic; very pale orange (weathers to streaked light orange gray); very coarse grained, moderately sorted; medium hard, compact and earthy (weathered surface is smooth); very thin, parallel, even bedding; castings, pellets, graded bedding; lower contact gradational. Sample 12008.....	5

LOCALITY 6. STATE PENITENTIARY WEST

NE¼NW¼NE¼ sec. 13, T. 3 N., R. 2 E.; Boise meridian; Ada County, Idaho. See note under description of locality 3 regarding relationship of this and other localities in the area. The total section exposed in this gully is about 15 feet thick. The following are representative of the thin to very thin bedded units in the section. Poison Creek Formation according to Newton and Corcoran (1963, Pl. 1).

Unit	Estimated thick. (ft)
2. Claystone; pale greenish yellow (weathers to streaked light yellowish gray); containing carbonized wood; soft, plastic and earthy; external tabular uneven bedding with internal very thin, parallel uneven bedding, lower contact sharp and irregular. Sample 12010..	1
1. Sandstone; white (weathers to banded light yellowish gray); medium grained, moderately sorted; containing carbonized wood; medium hard, friable and earthy; clay cement; thin, parallel uneven bedding; lower contact sharp and irregular. Sample 12009...	1
Total estimated thickness	2

LOCALITY 7. TABLE ROCK

SE¼SE¼NW¼ sec. 18, T. 3 N., R. 3 E.; Boise meridian; Ada County, Idaho. Section of cap rock on northeast rim of Table Rock. May be correlative with hard sandstone in localities 3 and 4. Idaho Group; mapped as Idaho formation by Savage (1958, Fig. 4).

LOCALITY 7. (continued)

Unit	Estimated thick. (ft)
1. Sandstone, conglomeratic, feldspathic; pinkish gray (weathers to streaked light brownish gray); very coarse grained, well sorted; very hard, compact and earthy; siliceous cement; medium size, parallel even bedding; lower contact sharp and regular. Resistant, cliff forming. Contains localized lenses of conglomerate. Sample 12011........................	50

LOCALITY 8. TABLE ROCK NORTH

SW¼SW¼NE¼ sec. 18, T. 3 N., R. 3 E.; Boise meridian; Ada County, Idaho. Approximately 100 feet below the northeast rim of Table rock; in cut along road to Table Rock. May be correlative with sequence in locality 6 except contains gravel lenses. Idaho Group; mapped as Idaho formation by Savage (1958, Fig. 4).

Unit	Estimated thick. (ft)
1. Sandstone, feldspathic; yellowish gray (weathers to streaked light orange gray); coarse grained, poorly sorted; soft, friable and earthy, (weathered surface is smooth); clay cement; thin, parallel even bedding; lower contact sharp and regular. Sample 12012..	4

LOCALITY 9. CURRANT CREEK

NE¼NW¼NW¼ sec. 33, T. 5 N., R. 2 E.; Boise meridian; Ada County, Idaho; 1.4 miles north along Currant Creek from junction with Dry Creek. The section in this area consists of about 300 feet of pale yellowish gray to brown siltstone and/or claystone with some interbedded sandy siltstone and basalt or basaltic conglomerate. This section, mapped as Payette Formation (?) by Savage (1958), is overlain by more than 50 feet of basalt. The following unit, the most radioactive in the section, was sampled near the base of the exposed section in the roadcut, where it is underlain and overlain by claystone. Payette Formation; mapped as Payette Formation (?) by Savage (1958, Fig. 4).

Unit	Estimated thick. (ft)
1. Sandstone, light olive brown (weathers to streaked medium brown); fine grained, well sorted; medium hard, friable and earthy; (weathered surface is smooth); clay cement; very thin, parallel even bedding; lower contact is sharp and regular. Contains abundant biotite and scattered clast of basalt. Sample 12013.	10

LOCALITY 10. DRY CREEK RIDGE

NE¼SE¼SE¼ sec. 32, T. 5 N., R. 2 E.; Boise meridian; Ada County, Idaho. The unit described below is part of a section of soft to hard sandstone adjacent to the Currant Creek road, just south of the saddle between Currant and Dry Creeks. In the Idaho Group according to Newton and Corcoran (1963, Pl. I).

LOCALITY 10. (continued)

Unit		Estimated thick. (ft)
1.	Sandstone, conglomeratic; dusky yellow (weathers to medium yellowish gray); very coarse grained, well sorted; medium hard, friable and earthy; clay cement; external tabular uneven bedding with internal massive bedding; lower contact sharp and regular. Sample taken from 6 foot grader cut. Unit is poorly exposed everywhere else, but capped by a resistant 1 foot to 2 foot thick sandstone. Sample 12014	5

LOCALITY 11. SPRING VALLEY

SW¼SW¼NE¼ sec. 24, T. 5 N., R. 1 E.; Boise meridian; Ada County, Idaho. The following section is exposed on the north side of Spring Valley. Mapped as Payette Formation by Savage (1958, Fig. 4). On the assumption that unit 9 is the Columbia River Basalt, units 3 thru 8 should be Payette Formation, and unit 11, Idaho Group.

Unit		Estimated thick. (ft)
11.	Sandstone, granitic, conglomeratic; dark yellowish brown (weathers to dark brown); very coarse grained, well sorted; containing fossil bone fragments and petrified wood; medium hard, compact and earthy (weathered surface is smooth); siliceous cement; massive bedding; lower contact is sharp and regular. Resistant sandstone is located near the top of the bluff. Sample 12015.	3
10.	Covered	30
9.	Basalt	100
8.	Siltstone and fine grained sandstone	30
7.	Sandstone, conglomeratic, dusky yellow (weathers to light brownish gray); very coarse grained, poorly sorted; soft, friable and earthy; calcite cement; massive bedding; lower contact gradational. Poor outcrop of unconsolidated sediments. Sample 12016	10
6.	Sandstone, conglomeratic, medium to coarse grained	80
5.	Sandstone, conglomeratic, light olive brown (weathers to light brown); medium grained, poorly sorted; soft, friable and earthy; clay cement; massive bedding; lower contact is gradational. Sample 12017	50
4.	Sandstone, light olive brown (weathers to banded light orange gray); medium grained, well sorted; soft, friable and earthy; clay cement; massive bedding; lower contact is gradational. Sandstone is micaceous and iron stained. Sample taken at base of unit. Sample 12018	100

LOCALITY 11. (continued)

Unit		Estimated thick. (ft)
3.	Sandstone, silty, dusky yellow (weathers to streaked light orange gray); fine grained, moderately sorted; soft, friable and earthy; thin, parallel, uneven beds, lower contact sharp and regular. Sample 12019	10
2.	Covered	100
1.	Granite	50
	Total estimated thickness	563

LOCALITY 12. ROBBS CREEK

NW¼NW¼SE¼ sec. 4, T. 6 N., R. 2 E.; Boise meridian; Boise County, Idaho. Approximately 70 feet of section is exposed in a sandstone bluff located east of Idaho state highway 15. The unit described was sampled at the base of this bluff. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Sandstone, pale olive (weathers to mottled medium gray); coarse grained, poorly sorted; hard, compact and dull, (weathered surface is rough); siliceous cement; massive bedding. Sample taken at the base of unit. Sample 12020	10

LOCALITY 13. HORSESHOE BEND ROAD

NW¼NW¼SW¼ sec. 16, T. 6 N., R. 2 E.; Boise meridian; Boise County, Idaho; section in roadcut along Idaho state highway 15, south of Horseshoe Bend. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
3.	Claystone (2%); light olive gray, (weathers to banded medium brownish gray); medium hard, brittle, earthy; very thin, parallel even bedded, lenticular channel; lower contact sharp and regular. Sample 12024 Sandstone (98%); dusky yellow (weathers to light gray); medium to very coarse grained, poorly sorted; soft, friable, earthy; thin, planar cross bedding; lower contact sharp and regular; characterized by irregular iron stained bands. Sample 12023 of medium grained sandstone from near the middle of the unit adjacent to sample 12024	200

LOCALITY 13. (continued)

Unit		Estimated thick. (ft)
2.	Sandstone, silty; light olive gray (weathers to banded medium grayish brown); fine grained, moderately sorted; abundant carbonaceous material; medium hard, compact, earthy; very thin, parallel even beds, some clay and coarser sand size material; possible lake or pond deposit. Sample 12022.......	34
1.	Sandstone, grayish yellow (weathers to light orangish gray); very coarse grained, poorly sorted; soft, friable, earthy, with some medium hard layers; thin, trough cross bedding. Sample 12021..	20
	Water sample taken from spring south of the measured section. Water probably flowing from the Idaho Group. Sample 12025	
	Total estimated thickness	254

LOCALITY 14. COTTONWOOD CREEK

NW¼SE¼SW¼ sec. 9, T. 6 N., R. 2 E.; Boise meridian; Boise County, Idaho; section in roadcut along Idaho state highway 15, south of Horseshoe Bend. Outcrops of claystone such as in this roadcut are not widespread in the area. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Claystone; moderate yellowish brown (weathers to medium brown); carbonaceous; medium hard, brittle, earthy; parallel even bedding. Sample 12026......................................	75

LOCALITY 15. SWEET VALLEY SOUTH

NW¼NE¼NW¼ sec. 14, T. 7 N., R. 1 E.; Boise meridian; Gem County, Idaho. A section of sedimentary rocks, approximately 200 feet thick, is poorly exposed on the south slope of a hill on the Loy Drake property at the stated location. This section can be seen from Idaho state highway 52 (a few miles east of the town of Sweet) as a reddish brown colored, partly grassy, slope. Payette Formation according to Savage (1961, Fig. 4). The section is described briefly as follows:

Unit		Estimated thick. (ft)
5.	Claystone, silty; very poorly exposed; carbonaceous material...	40
4.	Sandstone, clayey; yellowish gray (weathers to purplish gray); fine grained, poorly sorted; carbonaceous; soft, plastic, earthy; massive bedding; lower contact sharp and regular. Sample 12028...	2

LOCALITY 15. (continued)

Unit		Estimated thick. (ft)
3.	Sandstone; grayish orange (weathers to medium brown); medium grained, moderately sorted; soft, friable, earthy; calcite cement; medium thick, parallel even bedding. Sample 12027...	2
2.	Sandstone; coarse grained; very poorly exposed	20
1.	Claystone/siltstone; reddish brown; very poorly exposed; carbonaceous material	150
	Total estimated thickness	214

LOCALITY 16. SWEET VALLEY WEST

SE¼NW¼SE¼ sec. 10, T. 7 N., R. 1 E.; Boise meridian; Gem County, Idaho. The following section is exposed in a recent roadcut on the west side of a grass covered hill on the Loy Drake property near the town of Sweet. The coarse grained sandstone forms channels which are about 20 feet wide and 1 to 3 feet thick. Payette Formation according to Savage (1961, Fig. 4).

Unit		Estimated thick. (ft)
4.	Siltstone and fine grained sandstone, thin bedded	5
3.	Sandstone; coarse to very coarse grained, poorly sorted, cross bedded; channel fill	3
2.	Siltstone, clayey; yellowish gray (weathers to medium gray); poorly sorted; carbonized wood; medium, compact, earthy; massive, lenticular channel; lower contact sharp and regular. Sample 12030...	1
1.	Sandstone, arkosic; yellowish gray (weathers to light orangish gray); coarse grained, poorly sorted; medium hard, friable, earthy; trough cross bedded, lenticular channel. Sample 12029..	3
	Total estimated thickness	12

LOCALITY 17. FREEZEOUT HILL

CenterSE¼ sec. 20, T. 6 N., R. 1 W.; Boise meridian; Gem County, Idaho. A thick section of the Idaho Group (as shown on Plate 1 of Newton and Corcoran, 1963) is exposed in a series of four roadcuts along Idaho state highway 16, south of Emmett. The area is referred to locally as Freezeout Hill. The total thickness of Idaho Group exposed in this area is on the order of 650 feet, based on chain-and-compass measurements. The actual thickness, however, may be greater or less than this because of possible faults between the roadcuts and at least one known fault in the exposed section. The section exposed is briefly described below. The section exposed in roadcut 4 (the southernmost) generally overlies that in roadcut 3, etc. Samples were collected

LOCALITY 17. (continued)

from selected more favorable coarse grained units and adjacent fine grained (silty or clayey) units throughout the section. Most of the units are light to medium gray, soft, friable, and tabular even. In the Idaho Group according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
Roadcut 4		
	– – – – – – – Erosion surface – – – – – – –	
51.	Soil, probably Quaternary	75
50.	Gravel, probably Quaternary; irregular lower contact with 2 feet of relief	2
49.	Sandstone, fine to medium grained; medium hard, friable; cross bedded; micaceous	10
48.	Sandstone, coarse to very coarse grained; well sorted; medium hard, friable	4
47.	Sandstone, conglomeratic; poorly sorted	20
46.	Sandstone, fine to medium grained or conglomeratic, in medium to very thin beds; little clay; some lenses of conglomerate	25
45.	Sandstone, coarse grained; massive; poorly sorted at the base, well sorted at the top; contains 3 inch carbonaceous claystone lenses	25
44.	Sandstone, fine to coarse grained; in thin beds	10
43.	Sandstone, medium grained with some fine grained and clayey sandstone, hardest unit in Freezeout Hill section; medium to thin bedded; crossbedded	20
42.	Conglomerate, pebbly; with some medium to coarse grained sandstone; thick bedded	25
	– – – – – – – Fault – – – – – – –	
41.	Sandstone, yellowish gray; fine to coarse grained, poorly sorted; very thin to medium bedded. Sample 12038 of coarse grained sandstone with carbonaceous streak from base of unit	10
40.	Claystone, silty, light olive gray; with some fine sandstone or siltstone; medium to thin bedded; carbonaceous. Sample 12037 from top of unit	12
39.	Sandstone, pebbly; very poorly sorted; with moderately sorted very coarse sandstone at the top	50
38.	Claystone, siltstone, and fine sandstone; micaceous; in very thin sinuous beds	3

LOCALITY 17. (continued)

Unit		Estimated thick. (ft)
37.	Sandstone, medium grained	3
Roadcut 3		
	(The section in this roadcut overlaps that in roadcut 4, by approximately 100 feet, barring the presence of major faults between the two roadcuts).	
36.	Claystone/siltstone; medium bedded	20
35.	Sandstone, coarse grained with some pebbles; moderately well sorted; fine grained at the base	25
34.	Sandstone, fine grained; with siltstone and some claystone; thin to very thin bedded; may be carbonaceous	25
33.	Sandstone, coarse to very coarse grained; pebbly in part; generally moderately sorted; well sorted at top; massive	40
32.	Sandstone, fine grained	3
31.	Sandstone, yellowish gray; coarse grained, poorly sorted; calcite cement. Sample 12036	3
30.	Siltstone, calcareous, yellowish gray (weathers light gray to brownish gray); coarse grained, well sorted. Sample 12035	4
29.	Sandstone, fine grained, with some coarse grains; thin bedded	8
28.	Claystone and coarse grained sandstone; in medium to thin, sinuous beds; claystone contains organic material	15
27.	Sandstone, coarse grained, poorly sorted; massive; with long sweeping crossbeds	25
26.	Fine grained sandstone and siltstone; thin to very thin beds; crossbedded with ripple marks; some medium grained sandstone; may contain carbonaceous material	10
25.	Sandstone, fine to coarse grained; poorly to moderately well sorted; medium to thin bedded; some lenticular beds	20
24.	Coal/carbonaceous claystone, soft	6
23.	Sandstone, medium to coarse grained; moderately well sorted	3
Roadcut 2		
	(From the attitude of the beds it appears that the base of the section in roadcut 3 should correlate closely with the top of the section in roadcut 2.)	
22.	Not described in detail. Fine to coarse grained sandstone with some siltstone; medium bedded with some thin and thick beds	100

LOCALITY 17. (continued)

Unit		Estimated thick. (ft)
21.	Claystone, carbonaceous, pale yellowish brown; medium hard; contains leaves. Sample 12034	2
20.	Sandstone (fine grained)/siltstone; containing some coarse grains of quartz	6
19.	Sandstone, coarse to very coarse grained	6
18.	Sandstone, fine to medium grained	10
17.	Claystone and fine to coarse grained sandstone; in thin to very thin beds	6
16.	Sandstone, fine grained	20
15.	Sandstone, coarse grained, and pebble conglomerate; very poorly sorted with lenses of heavy mineral concentrations; cross bedded	20
14.	Sandstone, fine to medium grained, becoming coarser upwards; silty in part; thin bedded	20
13.	Sandstone, coarse grained, and pebble conglomerate with some clayey lenses; massive with some cross beds	35
12.	Claystone to medium grained sandstone; very thin bedded	1
11.	Sandstone, coarse grained; in part, pebble conglomerate; poorly sorted. Sample 12033 of very coarse grained, moderately sorted, yellowish gray sandstone	15
10.	Claystone, silty; dark yellowish brown; carbonaceous at bottom and top. Sample 12032	3
9.	Sandstone, medium grained	3
8.	Covered	10
	Roadcut 1	
7.	Sandstone, coarse grained	15
6.	Sandstone, medium grained; fine grained at bottom	8
5.	Coarse grained sandstone to pebble conglomerate; poorly sorted, thin to very thin bedded	10
4.	Sandstone, fine to medium grained; medium bedded	4
3.	Conglomerate, pebble	0.5

LOCALITY 17. (continued)

Unit		Estimated thick. (ft)
2.	Sandstone, yellowish gray; very coarse grained, moderately well sorted. Sample 12031	6
1.	Covered	10
	Total estimated thickness	811.5

LOCALITY 18. BLACK CANYON DAM

SE¼SE¼NW¼ sec. 22, T. 7 N., R. 1 W.; Boise meridian; Gem County, Idaho; along irrigation canal, just north of Idaho state highway 52. Unit 1 is exposed on the north side of the canal, units 2 thru 6 on the south side; unit 2 probably overlies unit 1. Probably in the Idaho Group according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
6.	Sandstone, arkosic; yellowish gray, medium grained, well sorted; hard, resistant, compact and dull, becoming softer upwards (weathered surface is rough); siliceous cement; massive bedding; lower contact sharp and irregular; pebbly in places. Sample 12073	40
5.	Claystone, dark yellowish orange (weathers to banded brownish orange); medium hard, brittle and earthy; very thin, parallel even bedding; lower contact gradational. Sample 12072	0.5
4.	Siltstone, medium hard	5
3.	Cobble conglomerate and coarse grained sand, hard, lenticular; thin to medium beds	10
	- - - - - - - - - - - - - - - Fault - - - - - - - - - - - - - -	
2.	Siltstone, pale greenish yellow (weathers to streaked dark grayish brown); medium hard, compact and dull; siliceous cement; medium disturbed irregular bedding; lower contact is covered; Sample 12071	20
1.	Sandstone, grayish yellow (weathers to medium gray brown); coarse grained to conglomeratic, poorly sorted; hard, compact and dull; siliceous cement; thin massive bedding. Sample 12070	8
	Total estimated thickness	83.5

LOCALITY 19. LITTLE BUTTE

NW¼NW¼SE¼ sec. 21, T. 7 N., R. 1 W.; Boise meridian; Gem County, Idaho. Top of section is top of Little Butte. Base is approximately 400 feet above irrigation canal which passes through locality 18. Poison Creek Formation according to Savage (1961, Fig. 4).

LOCALITY 19. (continued)

Unit		Estimated thick. (ft)
3.	Sandstone, feldspathic, quartz; white (weathers to spotted medium blackish gray); coarse grained with clayey matrix, poorly sorted; very hard, compact and dull (weathered surface is rough and pitted); siliceous cement; thick, massive bedding; lower contact is covered. Sandstone is the resistant cap rock at top of Little Butte. Characterized by chaotic apparent dips and orangish to reddish solution banding. Sample 12074 collected from near middle of unit below cliffs which form top of Little Butte and above rocky slope	100
2.	Partially covered; long gentle slope with some outcrops of resistant sandstone characterized by chaotic dips	100
1.	Sandstone, conglomeratic, quartz; white (weathers to spotted blackish gray); pebbles and coarse sand in a clayey matrix; hard, compact and dull; siliceous cement; thin, planar cross-bedding; contains irregular layers and lenses of dark silty material. Sample 12075....................................	5
	Total estimated thickness	205

Water sample collected from spring near middle of the section described above, on the southeast side of Little Butte. Sample 12076.

LOCALITY 20. BIG WILLOW CREEK EAST

NW¼SW¼SW¼ sec. 34, T. 9 N., R. 2 W.; Boise meridian; Payette County, Idaho; section along Dry Creek in roadcut where Dry Creek meets the head of Big Willow Creek Canyon is represented by a sequence of sandstones and siltstones containing abundant volcanic debris. Section was poorly exposed and it was impossible to tell the total thickness of the Poison Creek in this area. The exposure occurs in an area of faulting (Savage, 1961) and may represent a fault sliver of Poison Creek Formation. Poison Creek Formation, according to Savage (1961, Fig. 4).

Unit		Estimated thick. (ft)
2.	Siltstone, sandy, volcanic; grayish brown (weathers to spotted dark gray); very hard, compact and earthy (weathered surface is rough), siliceous cement; thin parallel even bedding; lower contact sharp and regular. Contains many glassy, scoriaceous, and ash grains. Contains a few thin interbeds of brownish purple hard claystone. Sample 12078.........................	8
1.	Sandstone, grayish orange (weathers to banded medium brownish orange); medium grained, well sorted; medium hard, friable and earthy (weathered surface is rough); ferruginous cement; medium, parallel even bedding; iron oxide filled fractures. Sandstone is very micaceous and contains interbeds of gray, coarse grained, thin bedded sandstone and gray medium hard, very thin bedded siltstone. Sample 12077....................................	20
	Total estimated thickness	28

LOCALITY 21. WET GULCH SPRING

NW¼NW¼SW¼ sec. 13, T. 9 N., R. 3 W.; Boise meridian; Payette County, Idaho. Idaho Group; mapped as Idaho Formation by Savage (1961, Fig. 4).

Water sample taken from a spring above the road where Alkali Creek meets Little Willow Creek. Water probably flowing from upper Idaho Group. Sample 12079.

LOCALITY 22. BIG WILLOW CREEK

NW¼SE¼NW¼ sec. 26, T. 8 N., R. 4 W.; Boise meridian; Payette County, Idaho; section exposed in the west-facing bluffs at the mouth of Big Willow Creek. The section, about 300 feet thick, consists of very thin to very thick bedded fine to very fine grained sandstone and siltstone (units 1 and 3, below) with subordinate thin beds of coarse grained sandstone (unit 2, below). The section is capped by a 2-foot thick hard limestone bed which seems to have a wide horizontal extent. All of the sequence is poorly consolidated. The samples were collected from the lower 60 feet of the section. Idaho Group; mapped as Idaho formation by Savage (1961, Fig. 4).

Unit		Estimated thick. (ft)
3.	Sandstone, yellowish gray (weathers to mottled whitish gray); very fine grained, well sorted; soft, friable and earthy (weathered surface is rough); very thin, parallel even bedding; iron oxide filled fractures; lower contact is sharp and irregular. Sandstone is very biotitic and iron streaked. Contains some poorly consolidated tan sandstone interbeds which are soft, medium to fine grained, and moderately sorted. Sample 12080	3
2.	Sandstone, arkosic; grayish yellow (weathers to streaked yellowish brown); very coarse grained, poorly sorted; soft, friable and dull, (weathered surface is rough); ferruginous cement; massive bedding; lower contact sharp and irregular. Sandstone is biotitic and iron stained. Interbedded with unit 1 to form a 60 foot sequence at the base of the outcrop. Sample 12081.	2-1/2
1.	Siltstone, yellowish gray (weathers to light grayish brown); well sorted; medium hard, compact and earthy (weathered surface is rough); ferruginous cement; external, medium, tabular uneven bedding with internal, very thin, parallel even bedding; wood imprints and clasts; lower contact is sharp and irregular. Siltstone is biotitic and iron streaked with a weathered surface which is a light grayish brown crusted coating, that also coats the interbedded sandstones. There are many thin massive lenticular sand interbeds in the siltstone. Sample 12082...	6
	Total estimated thickness	11-1/2

LOCALITY 23. CRANE CREEK

SE¼NE¼SE¼ sec. 35, T. 12 N., R. 3 W.; Boise meridian; Washington County, Idaho. The section described below is exposed near the bottom of Crane Creek Canyon. The base of the section is about 100 feet above the creek on the north wall of the canyon. The lateral extent of the exposure is about 100 feet; it is surrounded by basalt, indicating that it may be a fault block or an anticline. Samples were collected of the more radioactive sandstone. Payette Formation according to Kirkham (1931a, Fig. 13).

Unit		Estimated thick. (ft)
5.	Siltstone, grading upward into fine grained, silty sandstone; 15 foot bed at base; reminder is thin to very thin bedded; contains leaf imprints near base	50
4.	Claystone, carbonaceous	40
3.	Sandstone, moderate yellowish brown (weathers to banded orange brown); medium grained, moderately sorted, containing organic carbonaceous material; hard, compact and dull; siliceous cement; thin, lenticular bed, with internal very thin, parallel even bedding; lower contact sharp and regular. Sample 12084	0.5
2.	Sandstone, moderate brown (weathers to dark brown); fine grained, well sorted, containing carbonaceous organic material; medium hard, compact and earthy, (weathered surface is rough); ferruginous cement; very thin, parallel even bedding; lower contact is sharp and regular. Sample 12083	1
1.	Siltstone/fine grained sandstone; medium bedded with thin beds of medium grained sandstone; some claystone	10
	Total estimated thickness	91.5

LOCALITY 24. SOUTH CRANE CREEK ROAD

NW¼NE¼NW¼ sec. 9, T. 11 N., R. 2 W.; Boise meridian; Washington County, Idaho; section in roadcut along South Crane Creek road. Although mapped as Columbia River Basalt (Kirkham, 1931a, Fig. 13), this unit is considered by us to be in the Payette Formation, based on (1) proximity (one-half mile to west) to basalt outcrops, suggesting that it is interbedded with the Columbia River Basalt and (2) low radioactivity characteristic of the Payette Formation.

Unit		Estimated thick. (ft)
1.	Siltstone, sandy; yellowish gray (weathers to light yellowish brown); poorly sorted; soft, friable and dull (weathered surface is smooth); massive bedding. Sample 12085	15

LOCALITY 25. SOUTH CRANE CREEK ROAD WEST

NW¼SW¼SW¼ sec. 13, T. 11 N., R. 3 W.; Boise meridian; Washington County, Idaho; section in roadcut along South Crane Creek road. Payette Formation according to Kirkham (1931a, Fig. 13).

Unit		Estimated thick. (ft)
2.	Sandstone, light olive gray (weathers to banded light greenish brown); medium grained, very well sorted; soft, friable and dull (weathered surface is rough); ferruginous cement; lower contact sharp and regular. Characterized by reddish brown iron stained curves. Sample 12086	3
1.	Siltstone	8
	Total estimated thickness	11

LOCALITY 26. PEARL DISTRICT

CenterSW¼ sec. 27, T. 6 N., R. 1 E.; Boise meridian; Gem County, Idaho; spring located near prominent draw trending south-southwest through section 27. Payette Formation, according to Newton and Corcoran (1963, Pl. 1).

Water sample taken from spring in siliceous volcanics. Sample 12087.

LOCALITY 27. BEAR CREEK

SW¼SE¼NW¼ sec. 30, T. 11 N., R. 3 W.; Boise meridian; Washington County, Idaho. A section of Payette Formation (as mapped by Kirkham, 1931), approximately 200 feet thick, is exposed north of the road along Bear Creek. This section is overlain by basalt (probably Columbia River) and is gradational upward from coarse sandstone and siltstone/claystone (units described below) to siltstone. The units described outcrop in roadcuts at the base of the section. Payette Formation according to Kirkham (1931a, Fig. 13).

Unit		Estimated thick. (ft)
1.	Claystone, silty (95%); light olive brown (weathers to dark yellowish brown); containing carbonaceous material; medium hard, compact and earthy (weathered surface is smooth); clay cement; very thin, parallel even bedding, lower contact sharp and regular. Sample 12088 Sandstone (95%), yellowish gray (weathers to light yellowish brown); medium grained, moderately sorted; soft, friable and dull (weathered surface is smooth); very thin, planar cross bedding. Contains dark volcanic fragments and is characterized by iron banding. Sample 12089	10

LOCALITY 28. LANDFILL

NW¼SE¼SE¼ sec. 16, T. 11 N., R. 5 W.; Boise meridian; Washington County, Idaho. Total section of 25 feet was exposed in bulldozer cut at Monroe Creek sanitary

LOCALITY 28. (continued)

landfill two miles east of Weiser. Interbedded sand, clay and siltstone sequence which is poorly exposed and forms rolling hills elsewhere. In the Idaho Group, according to Newton and Corcoran (1963, Pl. 1).

Unit		Estimated thick. (ft)
2.	Sandstone, dusky yellow (weathers to streaked brownish gray); medium grained, moderately sorted; soft, friable and dull (weathered surface is rough); ferruginous cement; external, medium, tabular uneven bedding with internal, massive bedding; lower contact is sharp and regular. Sandstones contain three inch to six inch clay clasts which are aligned with the bedding. Upper contact surface appears to be erosional and covered by valley alluvium. Sample 12091....................	10
1.	Claystone, silty; yellowish gray (weathers to mottled brownish gray); containing dark minerals; soft, friable and dull (weathered surface is rough); ferruginous cement; external, medium, tabular uneven bedding, with internal, massive bedding; lower contact is sharp and regular. Sample 12090......	2
	Total estimated thickness	12

LOCALITY 29. LITTLE WEISER RIVER

NW¼NE¼SE¼ sec. 13, T. 14 N., R. 2 W.; Boise meridian; Adams County, Idaho; section in roadcut on Little Weiser River. Sediments in the lower Weiser River valley are poorly exposed, unconsolidated silts and fine sands with some interbedded clays forming low rolling hills and flat valley areas which are farmed. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
2.	Sandstone, dusky yellow (weathers to banded light brown); fine grained, well sorted; medium hard, compact and dull (weathered surface is rough); thin, parallel even bedding; lower contact sharp and regular. Sandstone is very micaceous, and deeply rusty red stained at conglomerate contact. Sample 12093.....	3
1.	Conglomerate, moderate brown (weathers to dark reddish brown); cobble size clasts with a coarse sand matrix; very hard, compact and dull (weathered surface is rough and knobby); siliceous cement; massive bedding; lower contact sharp and regular. Conglomerate appeared to have a limited areal extent and was not exposed anywhere else. Sample 12092........	4
	Total estimated thickness	7

LOCALITY 30. DIXIE CREEK

SW¼NE¼NE¼ sec. 16, T. 13 N., R. 2 W.; Boise meridian; Washington County, Idaho. Section in roadcut on county road, two miles east of Dixie Creek. Unit 1 (described below) is overlain by three feet of hard tan siltstone which is in

LOCALITY 30. (continued)

turn overlain by 20 feet of unconsolidated, poorly exposed, soft, tan sandstone, which is coarse grained and poorly sorted with the same composition as unit 1, but with very little silt or clay. Unit 1 rests on Columbia River Basalt (exposed down the road). Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Siltstone, sandy; dusky yellow (weathers to streaked brownish gray); poorly sorted, medium hard, compact and earthy (weathered surface is rough); clay cement; very thin, parallel even bedding. Sample 12094......................................	3

LOCALITY 31. SHEEP CREEK

NW¼NW¼SW¼ sec. 33, T. 13 N., R. 4 W.; Boise meridian, Washington County, Idaho; section in roadcut along U.S. highway 95 at Sheep Creek. Consists of predominantly fine grained micaceous sands containing volcanic detrital material, which are overlain by 25 feet of pinkish brown basalt with interbedded fine sands and clays. The sample was taken of the most radioactive and favorable lithology in the section. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Sandstone, yellowish gray (weathers to light grayish white); medium grained, very well sorted; soft, friable and earthy (weathered surface is rough); thin, parallel even bedding. Sandstone is very micaceous and has interbedded coarse grained layers (containing volcanic red and black fragments) and a few one to two foot interbeds of gray and black, medium hard clay containing volcanic ash. Sample 12095.......................	75

LOCALITY 32. COVE ROAD

NW¼NW¼SE¼ sec. 11, T. 10 N., R. 4 W.; Boise meridian; Washington County, Idaho. Section in roadcut on Cove Road 2-3/4 miles southeast of Presley Station. Total section 300 feet of interbedded sands and silts with a few clays. The section has several one foot to three foot resistant sandstone beds. One of the beds is the cap rock of the bluffs and the other bed is in the center of the section. Sediments are predominantly unconsolidated and form the grassy covered slopes of the area. In the Idaho Group according to Newton and Corcoran (1963, Pl. 1).

LOCALITY 32. (continued)

Unit		Estimated thick. (ft)
3.	Sandstone, very light gray (weathers to spotted light gray); medium grained, well sorted; very hard, compact and dull (weathered surface is pitted); siliceous cement; lower contact sharp and regular. Sample 12098	3
2.	Claystone, sandy; yellowish gray (weathers to light gray); very poorly sorted; soft, friable and dull, (weathered surface is rough); calcareous cement; thin, parallel even bedding; lower contact sharp and regular. Interbedded with sandy siltstone (unit 1) and has silt and sand stringers. The unit is very micaceous with mica in bands and iron streaks. Sample 12097	2
1.	Siltstone, sandy; light olive gray (weathers to light gray); poorly sorted; medium hard, compact and earthy (weathered surface is rough); clay cement; thin parallel even bedding, lower contact sharp and regular; very micaceous. Sample 12096	2
	Total estimated thickness	7

LOCALITY 33. WILSON CEMETERY

SE¼NW¼SW¼ sec. 14, T. 1 S., R. 3 W.; Boise meridian; Owyhee County, Idaho; section in outcrop one and one half miles up Reynolds Creek from Wilson Cemetery at an old prospect site. A sequence of sediments approximately 100 feet thick includes pumiceous tuffs (unit 1), tuffaceous siltstones, and a 20-foot thick hard capping sandstone (unit 2). Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
2.	Sandstone, arkosic; yellowish gray (weathers to spotted medium brownish gray); coarse grained, well sorted, containing organic material; hard, compact and dull, (weathered surface is rough and pitted); siliceous cement; very thin crossbedding; iron oxide filled fractures; lower contact sharp and regular. Contains a few interbeds of medium to fine grained sand with the same color and sorting. Sample 12124	20
1.	Tuff, pumiceous; light bluish gray (weathers to banded medium gray); medium hard, compact and earthy (weathered surface is rough); clay cement; very thin, parallel even bedding with a few local, very thin, crossbeds. Tuff has thin platy volcanic glass and vitreous interbeds with iron-stained bands and streaks. Sample 12125 taken near contact with unit 2	10
	Total estimated thickness	30

LOCALITY 34. REYNOLDS VALLEY

SW¼NE¼SW¼ sec. 30, T. 2 S., R. 3 W.; Boise meridian; Owyhee County, Idaho; section located in outcrop 1.1 miles north of Reynolds. The unit sampled represents the only exposed section we observed of the upper sandstone unit of the Reynolds Basin Group on the north-eastern side of Reynolds Valley. The sediments in this area are poorly exposed and form grassy slopes. Mapped as Reynolds Basin Group by McIntyre (1966). Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Sandstone, arkosic; yellowish gray (weathers to spotted medium brown); coarse grained, well sorted; very hard, compact and dull (weathered surface is rough and pitted); siliceous cement; thin, parallel even bedding; silica filled fractures. Sandstone is biotitic and contains coarse grained rounded volcanic fragments and many conglomeratic lenses four inches to one foot thick. Sample 12126	10

LOCALITY 35. REYNOLDS CEMETERY

NE¼SE¼SW¼ sec. 31, T. 2 S., R. 3 W.; Boise meridian; Owyhee County, Idaho; section located in roadcut along Reynolds Cemetery Road. Represents the only exposure observed by us of the fluvial detrital part of the Boston Ranch unit (McIntyre, 1966) on the east side of the Reynolds Valley. The Boston Ranch unit and the arkosic sandstone unit (locality 34) represent sediments of upper Miocene or lower Pliocene age and are time equivalent to sediments of the Sucker Creek Formation and Poison Creek Formation deposited in adjacent areas. Refer to locality 34 for information on the geologic relationship between this and other localities in the area. Mapped as Reynolds Basin Group by McIntyre (1966). Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Sandstone, yellowish gray (weathers to banded medium gray); medium grained, well sorted; soft, friable and dull (weathered surface is rough); external, thin, tabular uneven bedding with internal, very thin, planar crossbedding. Sandstone is very biotitic with weathered volcanic (red) clasts 1/4 inch to two inch diameter and a few very thin dark solution bands. Sample 12127	10

LOCALITY 36. PICKET CREEK

NW¼NE¼SW¼ sec. 22, T. 4 S., R. 1 W.; Boise meridian; Owyhee County, Idaho. A section approximately 50 feet thick is exposed along the sides of Picket Creek and sampled in a roadcut two and one half miles west of Oreana up

LOCALITY 36. (continued)

Picket Creek road. The section consists of moderately consolidated tuffaceous silts, clays and ash with a few interbedded conglomerates and very coarse to coarse grained sands varying in thickness from 1 to 3 feet. The units sampled are the most lithologically favorable. Mapped as Browns Creek Formation of Middle Pliocene age by Anderson (1965, p. 34). Considered by us to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Genozoic geology).

Unit		Estimated thick. (ft)
3.	Sandstone, dusky yellow (weathers to light brown); very coarse grained, well sorted; soft, friable and dull (weathered surface is rough); clay cement; massive bedding. Sandstone has very thin layers of volcanic ash (?) containing black scoriaceous rounded fragments. Sample 12129	2
2.	Conglomerate, yellowish gray (weathers to light brown); hard, compact, and dull (weathered surface is rough); clay cement; thin, parallel even bedding; lower contact sharp and regular. Matrix is medium grained, well sorted; clasts are I inch pebbles of basalt. Sample 12128	3
1.	Siltstone, tan, medium hard	2
	Total estimated thickness	7

LOCALITY 37. HART CREEK

NE¼NE¼NE¼ sec. 16, T. 5 S., R. 1 W.; Boise meridian; Owyhee County, Idaho; section in outcrop 5.2 miles from Oreana Cemetery up Hart Creek Road is a sequence of tuffaceous siltstones and altered tuffs with interbedded conglomerates and tuffaceous sands. The samples taken represent the coarse favorable lithology of the section. The section is similar to that in locality 36, and may represent the Browns Creek Formation of Anderson (1965, p. 34). Considered by us to be in the Idaho Group. See discussion of Cenozoic geology in text.

Unit		Estimated thick. (ft)
5.	Conglomerate, yellowish gray (weathers to medium brown); very hard, compact and dull, (weathered surface is rough and knobby); siliceous cement; medium, parallel uneven bedding; lower contact is sharp and regular; matrix is coarse grained, poorly sorted sandstone; clasts are one to five inch cobbles of quartzite and are quite angular in places. Conglomerate forms resistant cap at the top of the bluffs. Sample 12133	10
4.	Siltstone, tuffaceous; unconsolidated, poorly exposed	100
3.	Tuffaceous siltstone/altered tuff, yellowish gray (weathers to light brown); medium hard, compact and earthy (weathered surface is rough and pitted); clay cement; thin, parallel even bedding; lower contact sharp and regular. Contains many woody replacements (replaced by yellow mineralization) with vertical	

LOCALITY 37. (continued)

Unit		Estimated thick. (ft)
3. (cont.)	roots in place. There are interbeds two inches to one foot thick of very hard gray siliceous siltstone/tuff containing brown silica replaced wood; also one inch to four inch pebbly interbeds. Sample 12132	20
2.	Conglomerate, volcanic, light olive gray (weathers to streaked yellowish gray); medium hard, compact and dull (weathered surface is knobby); siliceous and clay cement; a thin lenticular channel with thin disturbed irregular bedding, lower contact is sharp and irregular; matrix is a tuff and the basalt clasts range from three inches to one quarter inch with an average 1-1/2 inch in size. Conglomerate has yellow staining concentrated along the base. Sample 12131	1
1.	Tuffaceous sandstone/tuff, yellowish gray (weathers to medium gray); fine grained, well sorted; containing silicified wood; medium hard, compact and earthy (weathered surface is rough); clay cement; very thin, parallel uneven bedding; lower contact is sharp and regular. Lower part gray silty sand with white and yellow silt streaks and bands, but becomes very silty at conglomerate (unit 2) contact. Contains a few pebbly beds one inch to five inches thick with black and clear glass and pumice fragments. Sample 12130	3
	Total estimated thickness	134

LOCALITY 38. CASTLE CREEK

CenterSE¼NW¼ sec. 10, T. 5 S., R. 1 E.; Boise meridian; Owyhee County, Idaho. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Water sample taken from hot artesian water well located on Castle Creek road, 5 miles southeast of Oreana. Water possibly flowing from basalt. Sample 12134.

LOCALITY 39. BIRCH CREEK

NW¼SE¼NW¼ sec. 9, T. 6 S., R. 1 E.; Boise meridian; Owyhee County, Idaho; section exposed in a ravine up Castle Creek road 11.5 miles south of state highway 45 and represents a fluvial channel within the lower Idaho Group sediments in this area. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
3.	Sandstone, medium to fine grained, moderately sorted	2

LOCALITY 39. (continued)

Unit		Estimated thick. (ft)
2.	Sandstone, yellowish gray (weathers to spotted medium gray); coarse grained, moderately sorted; hard, compact and dull; a thick, lenticular channel with internal, thin, planar cross bedding; lower contact is sharp and irregular. Channel varies from 0 feet to 8 feet in thickness and changes facies from a gray cross bedded sandstone to a tan, parallel even bedded sandstone. Lower contact with siltstone below is probably an unconformity and there are clasts of the silt within the basal part of the sandstone. The underlying silt thins as the sand thickens. Sample 12135	8
1.	Siltstone, tan, medium hard	6
	Total estimated thickness	16

LOCALITY 40. PERJUE CANYON

SE¼SW¼NE¼ sec. 14, T. 7 S., R. 2 E.; Boise meridian; Owyhee County, Idaho; section in outcrop up Shoofly Creek road, 12.5 miles from state highway 45 at the mouth of Perjue Canyon. Unit probably represents the active nearshore lacustrine facies of the Glenns Ferry Formation described by Malde and Powers (1962), but their mapping area lies 12 miles to the east of this locality. The oölite (unit 1) described below overlies other dark brown sandy layers which contain abundant basalt grains and several very fossiliferous (cocina) layers six inches to one foot thick. Considered to be in the Idaho Group. See discussion in text on distribution of the Idaho Group (section on Cenozoic geology).

Unit		Estimated thick. (ft)
1.	Oölite, pale yellowish brown (weathers to light brown); coarse grained, well sorted; hard, compact and dull (weathered surface is rough and pitted); calcareous cement; massive bedding; lower contact is covered, contains many dark bands which are parallel with the bedding. Sample 12136	10

LOCALITY 41. BLACKSTONE - GRASMERE ROAD

NE¼NW¼SW¼ sec. 33, T. 7 S., R. 6 E.; Boise meridian; Owyhee County, Idaho; section on east side of prominent knoll along Blackstone - Grasmere Road. The most radioactive and most favorable lithologies (units 2 and 3) were sampled. Idaho Group; mapped as Glenns Ferry Formation by Malde and others (1963).

Unit		Estimated thick. (ft)
3.	Sandstone, conglomeratic; pale yellowish brown (weathers to dark brownish black); medium grained, poorly sorted; clasts primarily volcanic; contains abundant replaced gastropods and wood; hard compact and earthy; thin, parallel even bedding;	

LOCALITY 41. (continued)

Unit		Estimated thick. (ft)
3. (cont.)	lower contact sharp and regular; forms hard cap rock. Sample 12263	4
2.	Sandstone, moderate yellowish brown (weathers to dark yellowish brown); coarse grained, moderately sorted; medium hard, compact and earthy; massive; lower contact sharp, regular. Sample 12262	5
1.	Siltstone, light gray, fine grained, vitreous	20
	Total estimated thickness	29

LOCALITY 42. INDIAN BATHTUB

SW¼NE¼NE¼ sec. 3, T. 8 S., R. 6 E.; Boise meridian; Owyhee County, Idaho. Idaho Group; mapped as Chalk Hills Formation by Malde and others (1963).

Water sample collected at Indian Bathtub spring, source of Hot Creek tributary of Bruneau River. Spring emerges from Chalk Hills basalt member. Sample 12264.

LOCALITY 43. BRUNEAU CANYON

SE¼SE¼SW¼ sec. 35, T. 7 S., R. 6 E.; Boise meridian; Owyhee County, Idaho; section on east rim of Bruneau Canyon, east of junction of Hot Creek and Bruneau River. The section is represented by a capping hard algal limestone which weathers to highly pitted ledges with many solution cavities. This unit is underlain by a fluvial conglomeratic channel with limited horizontal extent which overlies a pale yellowish brown claystone which is poorly exposed, forming the grassy slope below. Samples were collected of the conglomerate in the channel (unit 2) and the claystone (unit 1) four feet below the contact of the units. Idaho Group; located near contact between Chalk Hills and Glenns Ferry Formations on map of Malde and others (1963).

Unit		Estimated thick. (ft)
3.	Limestone, algal	50
2.	Conglomerate, light gray (weathers to medium gray); pebble sized quartzite clasts in coarse grained, unsorted, sandstone matrix; medium hard, loose and earthy; thin, trough, cross bedded, lenticular channel. Lens 300 feet wide, possible paleo-river channel. Sample 12266	10
1.	Claystone, pale yellowish brown (weathers to dark brown); hard compact and earthy; calcite filled fractures; massive bedding; Sample 12265	10
	Total estimated thickness	70

LOCALITY 44. CLOVER CREEK

SE¼NE¼NE¼ sec. 11, T. 5 S., R. 11 E.; Boise meridian; Elmore County, Idaho; 40 foot thick section exposed on south rim of Clover Creek. Section consists predominantly of silt and clay with some medium bedded, fine to coarse grained, poorly sorted, fluvial sandstone interbedded in the sequence. The thickest and most radioactive sandstone was sampled in the old roadcut. Idaho Group; mapped as Glenns Ferry Formation by Malde and others (1963).

Unit		Estimated thick. (ft)
1.	Sandstone, pale yellowish brown (weathers to light yellowish gray); coarse grained, poorly sorted; medium hard, friable, earthy; thin bedding with trough cross bedding. Fluviatile sandstone with minor 1/2 inch clay beds, changes facies to silt 500 feet away. Sample 12267	2

LOCALITY 45. GRINDSTONE BUTTE

SW¼SE¼SE¼ sec. 34, T. 7 S., R. 10 E.; Boise meridian; Elmore county, Idaho; section on prominent outcrop at east end of Grindstone Butte. The sample taken represents the only exposed outcrop we observed of the Glenns Ferry Formation within the Deadman Creek valley. Idaho Group; mapped as Glenns Ferry Formation by Malde and others (1963).

Unit		Estimated thick. (ft)
1.	Sandstone, feldspathic, moderate yellowish brown (weathers to dark yellowish brown); fine grained, well sorted; hard, compact and earthy; massive bedding. Sample 12268	50

LOCALITY 50. STATE LINE

NW¼SW¼SE¼ sec. 2, T. 2 S., R. 6 W.; Boise meridian; Owyhee County, Idaho. This section is exposed next to the stream on the east side of the valley. It is located about one half mile north of the county road. Unit 1 (described below) forms the prominent light gray exposure which can be seen for some distance in the valley. The section is overlain by 10 feet of tuffaceous sandstone (?), glassy volcanics, then several hundred feet of ash or claystone that weathers to a pale yellowish gray or brownish gray clay with abundant float of petrified wood. There are several claim stakes in the area. Mapped as Sucker Creek Formation by Kittleman and others (1967).

Unit		Estimated thick. (ft)
4.	Sandstone, tuffaceous; grayish yellow (weathers to medium yellowish gray); fine grained, moderately sorted; soft, compact; massive bedding; lower contact sharp and regular. Sample 12139	0.5

LOCALITY 50. (continued)

Unit		Estimated thick. (ft)
3.	Tuffaceous sandstone/tuff, ferruginous; pale greenish yellow (weathers to unique medium gray); medium grained, moderately sorted, medium hard, compact; very thin, trough cross bedding; lower contact sharp and regular. Finer grained in lower and upper portions; clay lenses present in upper parts. Soil formed from weathering of this unit is a unique black sand. Sample 12138	12
2.	Tuffaceous sandstone/tuff, light gray (weathers to light gray); fine grained; containing carbonized wood; medium hard, compact; massive bedding; lower contact sharp and regular	6
1.	Vitric tuff/tuffaceous siltstone, pale greenish yellow (weathers to light brownish gray); medium hard, compact, earthy; massive bedding; remnant tuff textures (devitrified). Upper part of unit characterized by platy weathering. Sample 12137	60
	Total estimated thickness	78.5

LOCALITY 51. UPPER SUCKER CREEK

NWCorner sec. 23, T. 3 S., R. 6 W.; Boise meridian; Owyhee County, Idaho. The Sucker Creek Formation is well exposed in the upper Sucker Creek area, east of U.S. highway 95. Based on the weathering characteristics as seen from a distance, most of the formation appears to consist of relatively soft, fine grained sediments or tuffaceous rocks which weather to clay. Some more resistant beds of probably coarser clastic material on the order of 50 feet thick can be seen. Unit 2, described below, is one such bed which outcrops just below the jeep trail, about one and one half miles east of the highway and a half mile south of Sucker Creek. Mapped as Sucker Creek Formation by Kittleman and others (1967).

Unit		Estimated thick. (ft)
2.	Tuffaceous sandstone/tuff, pale greenish yellow (weathers to light grayish yellow); medium hard, compact; medium thick, parallel, even bedding; lower contact gradational. Lower 6 feet is medium bedded, very fine grained and hard with clay balls near the base. Sample collected from upper 15 feet, which is silty to fine-grained, medium hard to hard. Unit weathers out as a prominent ledge. Carbonaceous material in some beds. Probably fluvial. Sample 12140	21
1.	Siltstone, grayish yellow (weathers to light gray); medium hard, compact; parallel even laminae; remnant tuffaceous structure; abundant carbonaceous plant material between laminae. Sample 12141	0.5
	Total estimated thickness	21.5

LOCALITY 52. MCBRIDE CREEK

NW¼NE¼ sec. 36, T. 1 S., R. 6 W.; Boise meridian; Owyhee County, Idaho. A section of the Sucker Creek Formation, about 400 feet thick, is exposed just west of U.S. highway 95 in the Dry Creek or McBride Creek area. Most of the section consists of tuffaceous or fine grained sedimentary rocks which weather to a characteristically drab brownish, grayish, or greenish colored clay. Coarser sedimentary rocks occur near the base of the section (described below) and in the upper part of the section (localities 61 and 62). The section is overlain by a thin siliceous bed, then a sequence of thin to medium beds of silt/tuff and clay. The radioactivity level of these beds is about 50 percent lower than the underlying sandstone (unit 2, described below). Considered to be Sucker Creek Formation. See discussion in text on distribution of this formation (section on Cenozoic geology).

Unit		Estimated thick.(ft)
2.	Sandstone, conglomeratic, tuffaceous; light olive gray (weathers to medium gray); contains subrounded pebbles of light tan-gray pumice, other fragments of volcanic rock, and fragments of quartz; poorly sorted in general; sand-sized material is medium grained and moderately well sorted; contains trace amount of carbonaceous material; soft, friable; lower part is medium bedded; remainder is massive except for faint cross-bedding and pebble lenses. Lower contact sharp. Definitely fluvial. Sample 12143	15
1.	Claystone, carbonaceous, sandy; dusky yellow, medium hard, brittle; massive. Sample 12142	0.5
	Total estimated thickness	15.5

LOCALITY 53. SKULL SPRING

NE¼SW¼SW¼ sec. 6, T. 1 S., R. 5 W.; Boise meridian; Owyhee County, Idaho.

Water sample collected from steel pipe leading to spring. Water may originate in either Sucker Creek Formation or the overlying rhyolite which outcrops just above the spring. Spring is located in an area considered to be Sucker Creek Formation (see discussion of Cenozoic geology in text). Sample 12144.

LOCALITY 54. SANDS BASIN

NW¼NE¼NW¼ sec. 36, T. 1 N., R. 6 W.; Boise meridian; Owyhee County, Idaho.

Water sample collected from surface runoff above apparent spring. Water may originate in either Sucker Creek Formation or in the overlying rhyolite. Spring is located near the contact between the Sucker Creek Formation and the overlying rocks mapped as "silicic volcanics undivided" on Plate 1 (see discussion in text on distribution of Sucker Creek Formation). Sample 12145.

LOCALITY 55. JUMP CREEK

NE¼NE¼NW¼ sec. 36, T. 1 N., R. 6 W.; Boise meridian; Owyhee County, Idaho.

Water sample collected from surface runoff above apparent spring. Water may originate in either Sucker Creek Formation or in the overlying rhyolite. Spring is located near the contact between the Sucker Creek Formation and the overlying rocks mapped as "silicic volcanics undivided" on Plate 1 (see discussion of Cenozoic geology in text). Sample 12146.

LOCALITY 56. WILD HORSE SPRING

NW¼SE¼SE¼ sec. 36, T. 1 S., R. 6 W.; Boise meridian; Owyhee County, Idaho.

Water sample collected from steel pipe leading to spring. Water originates in Sucker Creek Formation, perhaps in sand beds outcropping to the north of here (q.v., descriptions of localities 52, 61, and 62). Spring is located in area mapped as Sucker Creek Formation (see discussion of Cenozoic geology in text). Sample 12147.

LOCALITY 57. LITTLE SQUAW CREEK NORTH

Center sec. 3, T. 1 S., R. 5 W.; Boise meridian; Owyhee County, Idaho. Section exposed in roadcut along U.S. highway 95. Beds in this section may be correlative with those in localities 52 and 61. Similarities are (1) characteristic gray weathering, (2) presence of pebbles of pumice and volcanic rock, (3) level of radioactivity, and (4) significantly lower radioactivity of overlying beds which weather to clay. Considered to be Sucker Creek Formation. See discussion in text on distribution of this formation (section on geologic setting). Rhyolite of "silicic volcanics undivided" (cf. Pl. 1) forms cliffs about 300 feet above the roadcut.

Unit		Estimated thick.(ft)
2.	Siltstone, tuffaceous; light olive brown (weathers medium grayish yellow); poorly sorted; medium hard, compact; massive bedding; lower contact sharp. Sample 12149	0.5
1.	Sandstone, tuffaceous, yellowish gray (weathers to light gray); medium grained, well sorted; medium hard, friable; thick, parallel even beds; contains pebbles of pumice and other types of volcanic rock. Sample 12148	10
	Total estimated thickness	10.5

LOCALITY 58. FRENCH JOHN HILL

SW¼NE¼SE¼ sec. 24, T. 1 N., R. 5 W.; Boise meridian; Owyhee County, Idaho. A section of tuffaceous rocks more than 400 feet thick is exposed northwest of U.S. highway 95, on the south side of French John Hill. Two rock units of possible sedimentary origin (units 2 and 3, described below) were sampled.

LOCALITY 58. (continued)

Units 1 through 5 are considered Sucker Creek Formation; units 6 and 7 are probably "silicic volcanics undivided (Pl. 1). See discussion in text on distribution of these formations (section on Cenozoic geology).

Unit		Estimated thick. (ft)
7.	Rhyolite breccia, dark reddish brown; upper part of unit is probably flow; prominent cliff former	100
6.	Rhyolite breccia; same as unit 7, but slope former; poorly exposed	80
5.	Probably tuffaceous agglomerate; light gray, light yellowish gray, and orangish gray; very irregular beds and lenses of fine grained vitric tuff, conglomerate and blocks of welded tuff; conglomerate contains volcanic clasts, especially of porphyritic black vitric andesite; may have been reworked by water	20
4.	Alternating thick beds of (1) medium gray pumiceous tuff/ sandstone consisting of approximately 50 percent pebbles of pumice and obsidian and (2) medium grayish yellow tuff/tuffaceous siltstone: Some beds may be reworked; slope former	150
3.	Conglomeratic tuffaceous sandstone/pumiceous tuff, moderate olive brown (weathers mottled light gray, medium gray, and light yellowish gray); consists of about 50 percent pumiceous pebbles in a tuffaceous matrix; poorly sorted but containing some sandy layers; thick to very thick bedded, tabular even. Sample 12151	75
2.	Tuff/tuffaceous sandstone; alternating beds of light gray and light yellowish gray (weathers to light grayish brown); poorly sorted, medium hard, friable; in thin, parallel even beds; some coarse grained to conglomeratic lenses between beds; may be air fall or lacustrine. Sample 12150 collected from light gray bed	15
1.	Crystal pumiceous tuff/siltstone/ash, orangish to yellowish gray, (weathers pale olive gray to pale orangish gray), weathers to clay which is typical of much of the Sucker Creek Formation.	100
	Total estimated thickness	540

LOCALITY 59. LITTLE SQUAW CREEK WEST

SE¼NW¼NW¼ sec. 9, T. 1 S., R. 5 W.; Boise meridian; Owyhee County, Idaho. A sandy portion of the Sucker Creek Formation, at least 300 feet thick, is exposed northwest of U.S. highway 95 in sec. 9, T. 1 S., R. 5 W. This prominent south-facing section can be seen from the highway. It is overlain by rhyolite. The complete section is described as locality 60. The partial

LOCALITY 59. (continued)

section described below is located up a small draw to the west of the main scarp and separated from it by a fault. Claim stake present. Considered to be Sucker Creek Formation. See discussion in text on distribution of this formation (section on Cenozoic geology).

Unit		Estimated thick. (ft)
4.	Tuff? probably unit 7 of locality 60	2
3.	Sandstone, coarse to fine grained, soft; with minor interbedded siltstone	70
2.	Claystone, dark yellowish brown (weathers to mottled gray and purple); lenticular; contains carbonaceous material; definitely fluvial in origin; Sample 12153	0.5
1.	Sandstone, tuffaceous; yellowish gray; medium grained, poorly sorted, soft; weathers with appearance of medium bedding but internally massive; contains interbedded pebble conglomerate lenses up to 2 feet thick; contains some brown carbonaceous material; definitely fluvial origin. Sample 12152 collected from near top of unit	50
	Total estimated thickness	122.5

LOCALITY 60. LITTLE SQUAW CREEK

SW¼NE¼NW¼ sec. 9, T. 1 S., R. 5 W.; Boise meridian; Owyhee County, Idaho. The following is a description of the prominent section exposed northwest of U.S. highway 95 in sec. 9, T. 1 S., R. 5 W. Considered to be Sucker Creek Formation. See discussion in text on distribution of this formation (section on Cenozoic geology).

Unit		Estimated thick. (ft)
9.	Volcanic, probably rhyolite; cliff-former	50
8.	Slope-forming rocks, most of which weather to clay; basal beds are dark in contrast to underlying units	200
7.	Siltstone/tuff, yellowish gray; too altered to indentify origin; moderately sorted; forms prominent ledge at base of slope; lower contact sharp and irregular. Sample 12154	3
6.	Sandstone, dusky yellow (weathers to medium gray); predominantly coarse grained but includes fine to medium grained sand and conglomeratic sand; poorly sorted, soft, friable; lower contact probably sharp, irregular; definitely fluvial. Sample 12155 of medium grained sandstone from lower part of unit	10
5.	Siltstone, grading downward to fine sandstone; dusky yellow; thin reddish brown oxidized zone at contact. Sample 12156, collected from top of unit, contains outstanding unidentified black metallic grains	6

LOCALITY 60. (continued)

Unit		Estimated thick. (ft)
4.	Sandstone, dusky yellow (weathers light gray); very fine to coarse grained with some pebble conglomerate in thick beds; poorly to moderately well sorted; soft, friable; may include thin tuff beds but mostly fluvial. Sample 12157 collected from near base of unit	60
3.	Claystone, sandy; dusky yellow (weathers light gray) Sample 12158	1
2.	Same as unit 4	60
1.	Sandstone, fine grained; soft, friable	60
	Total estimated thickness	450

LOCALITY 61. DRY CREEK SOUTH

NW¼NW¼SW¼ sec. 31, T. 1 S., R. 5 W.; Boise meridian; Owyhee County, Idaho. A section of the Sucker Creek Formation, about 400 feet thick, is exposed just west of U.S. highway 95 on the east side of Dry Creek. Most of the section consists of fine grained clastic or pyroclastic rocks which weather to a characteristically drab brown, gray, or green clay. Medium to coarse grained sedimentary rocks occuring in the section were sampled and are described in this appendix as localities 52, 61, and 62. The relationship of these partial section is as follows:

Sandstone, mostly fine to medium grained, with interbedded siltstone/claystone, (see description of locality 62)	75
fine-grained pyroclastic or tuffaceous rocks which weather to drab brown, gray or green clay; varicolored; slope former.	75
conglomeratic sandstone (see description of locality 61)	31
fine-grained pyroclastic or tuffaceous rocks which weather to drab brown, gray or green clay; varicolored; slope former.	200
conglomeratic sandstone (see description of locality 52)	16

Locality 61 is the south roadcut along the old highway. Considered to be Sucker Creek Formation. See discussion in text on distribution of this formation (section on Cenozoic geology). The following is a description the section exposed:

Unit		Estimated thick. (ft)
4.	Sequence of sandstone, reddish brown claystone, and siltstone in thin beds	6
3.	Claystone, silty; moderate yellowish brown (weathers to medium grayish brown); carbonaceous, soft, massive. Lower contact sharp and regular. Sample 12161	0.5

LOCALITY 61. (continued)

Unit		Estimated thick. (ft)
2.	Sandstone, tuffaceous, conglomeratic; light olive gray (weathers to medium gray) medium grained, moderately sorted, soft; thick, parallel even bedding, lower contact sharp and regular; contains lenses of subrounded pebbles; pebbles are predominantly pumice but also include dark volcanic rock fragments and angular glass fragments; characteristic medium gray weathering of unit suggests possible correlation with unit 3, locality 50; finer grained at base; grades upward into fine silty sandstone; Sample 12160	15
1.	Sandstone, conglomeratic; yellowish gray (weathers to light yellowish gray), medium grained, poorly sorted, soft; thin faint trough cross bedding. Sample 12159	15
	Total estimated thickness	36.5

LOCALITY 62. DRY CREEK NORTH

SE¼NE¼NE¼ sec. 36, T. 1 S., R. 6 W.; Boise meridian; Owyhee County, Idaho. Locality 62 is the north roadcut along the old U.S. highway 95. It is located approximately one-quarter of a mile north of locality 61. The relationship of the partial section exposed in this locality to sections exposed in two other localities (numbers 52 and 61) is described in the discussion of locality 61. The section exposed in this locality, approximately 75 feet thick, consists of medium beds of fine to medium grained sandstone and siltstone or claystone. Trace amounts of carbonaceous material are found in most of the tan to reddish brown siltstone/claystone beds and also in some of the sandstone beds. Most of the section appears to be fluvial. Samples were collected from the thickest bed occurring in the section (unit 2, described below) and from an underlying siltstone (unit 1 below). Considered to be Sucker Creek Formation. See discussion in text on distribution of this formation (section on Cenozoic geology).

Unit		Estimated thick. (ft)
2.	Sandstone, yellowish gray (weathers to light gray); medium grained, well sorted; 33% glass shards; medium hard, friable; thick bedded, faintly cross bedded; lower contact sharp, irregular. Fine grained in part. Sample 12163	5
1.	Siltstone, yellowish gray (weathers to light gray); well sorted, hard, brittle; massive bedded; lower contact gradational. Sample 12162	0.6
	Total estimated thickness	5.6

LOCALITY 63. CHALK HILLS

NW¼NE¼NE¼ sec. 36, T. 7 S., R. 3 E.; Boise meridian; Owyhee County, Idaho; section on the eastern slope at the south end of the Chalk Hills. The 300-foot-thick section in this locality consists of unconsolidated to moderately

LOCALITY 63. (continued)

consolidated massive silts, fine sands, clays, and ash beds varying in color from light gray to pink with minor conglomeratic channels and sand interbeds of variable thickness. Units 2 and 3 described below are from a 50-foot wide channel. Idaho Group; units 1 thru 3 are probably Chalk Hills Formation; unit 4 is probably Bruneau Formation. The general section in this area is described by Malde and Powers (1962).

Unit		Estimated thick. (ft)
5.	Terrace gravels	25
4.	Siltstone and fine grained sandstone, light gray	175
3.	Sandstone, conglomeratic; yellowish gray, (weathers to light gray); medium grained, moderately sorted; contains plant and vertebrate fossils; medium hard, friable, earthy; thin, parallel even bedding. Sample 12165	5
2.	Conglomerate, moderate yellowish brown (dark yellowish orange); pebble sized clasts of quartzite, volcanics and siltstone in well sorted matrix; abundant plant and vertebrate fossils; medium hard, friable, earthy; thin, parallel even bedded; lenticular channel. Sample 12164	5
1.	Siltstone, dusky yellow (weathers to medium brownish gray); coarse grained, moderately sorted; medium hard, friable, earthy; thin, parallel even bedding. Sample 12166 collected from top of unit a few hundred feet north of where samples of unit 2 and 3 were collected	90
	Total estimated thickness	300

LOCALITY 64. CHALK HILLS NORTH

SW¼SW¼SW¼ sec. 30, T. 7 S., R. 4 E.; Boise meridian; Owyhee County, Idaho; section on the eastern slope at the south end of the Chalk Hills, approximately one half mile northeast of locality 63. Unit 2 described below may be correlative with units 2 and 3 of locality 63. Idaho Group; probably Chalk Hills Formation. The general section in this area is described by Malde and Powers (1962).

Unit		Estimated thick. (ft)
2.	Sandstone, ferruginous; light bluish gray (weathers to medium bluish gray); medium grained, well sorted; medium hard, friable, earthy; massively bedded in lower part to thinner bedded in upper portion. Lower contact is sharp and regular. Sample 12167	20
1.	Siltstone, yellowish brown	6
	Total estimated thickness	26

LOCALITY 65. FLAT TOP BUTTE

NW¼NE¼NW¼ sec. 21, T. 2 N., R. 5 W.; Boise meridian; Owyhee County, Idaho. The following section is exposed on the southwest side of Flat Top Butte. Units 3 thru 7 may comprise the type section of the Poision Creek Formation (see Kittleman and others, 1965, p. 38). The underlying units weather very similar to units of the Sucker Creek Formation (e.g. Dry Creek area; see localities 52, 61, and 62, this appendix).

Unit		Estimated thick. (ft)
7.	Sandstone, reddish brown; very hard, silicified; forms top of butte	15
	- - - - - - - - - Possible fault or unconformity - - - - - - -	
6.	Sandstone, reddish brown; medium grained, silicified	10
5.	Weathered surface consists of clay; probably altered tuffaceous or fine grained sedimentary rock	10
4.	Sandstone, feldspathic, quartz; yellowish gray, (weathers to dark reddish brown); medium grained, well sorted; siliceous cement, very hard; ripple marks; thick, parallel even bedding. Lower contact gradational. Forms prominent resistant ledge on south side of butte. Sample 12270 collected from thin bedded upper part of unit which appears less silicified and less altered.	12
3.	Siltstone, yellowish gray (weathers to light grayish orange); well sorted, medium hard, friable, fossiliferous, ripple marks; very thin, parallel even bedding with small scale cross beds. Lower part of unit consists of siltstone; upper part consists of siltstone interbedded with medium grained micaceous sandstone. Sample 12269 collected from middle part of unit	8
2.	Mostly rubble-covered slope with drab olive brown clay, which probably represents altered tuffaceous or fine grained sedimentary rock; outcrop of silty claystone midway up slope	100
1.	Low rolling hills of soft rock which weathers to a drab olive brown/light purple; occassional resistant ledge	200
	Total estimated thickness	355

LOCALITY 66. FLAT TOP BUTTE WEST

SE¼NE¼SW¼ sec. 16, T. 2 N., R. 5 W.; Boise meridian; Owyhee County, Idaho. This locality is located approximately one half mile north of locality 65. In this locality a section of sandstone more than 100 feet thick is exposed. In general, the section is less silicified than at locality 65. Orange limonite staining indicates passage of water. The unit described is found near the base of a resistant knob. Correlative with upper part of section at locality 65 (units 3 thru 7 of that locality) and therefore probably Poison Creek Formation.

LOCALITY 66. (continued)

Unit		Estimated thick. (ft)
1.	Sandstone, very light gray (weathers to light grayish orange); fine grained, well sorted; medium hard, friable; thin, parallel even bedding. Sample 12271	20

LOCALITY 67. BIG GULCH CREEK

SE¼SW¼NW¼ sec. 10, T. 5 N., R. 1 E.; Boise meridian; Ada County, Idaho. The section described is exposed on the north side of the creek. This locality is close to contact between the Idaho Group and granitic rocks of the Idaho batholith on Plate 1 of Newton and Corcoran (1963). The referenced map also shows outcrops of Columbia River Basalt in the general area. Unit 1 of the described section is therefore probably the Columbia River Basalt. Units 3 thru 7 are probably in the Idaho Group, considering the abundance of coarse clastic material and general absence of ash, claystone or siltstone beds.

Unit		Estimated thick. (ft)
7.	Partially covered to top of ridge. Probably same as unit 6.	18
6.	Conglomerate; light brown; well sorted, with pebble-sized clasts; hard, massive bed; altered. Sample 12274	2
5.	Covered; probably mostly coarse sand; outcrop of sandy siltstone near middle of unit	170
4.	Sandstone, light olive gray, medium grained, poorly sorted; alternating soft to medium hard beds with varying amounts of carbonate cement; in medium thick beds, internally massive; some thin conglomerate, especially near base; contains some fossils. Sample 12273 collected from medium hard, calcite cemented bed near middle of unit	30
3.	Claystone, silty; dusky yellow, massive; possibly carbonaceous, Sample 12272 collected from near top of this unit	1
2.	Covered	3
1.	Basalt	100
	Total estimated thickness	324

LOCALITY 68. SCHILLER CREEK

NW¼NW¼NE¼ sec. 17, T. 6 N., R. 1 E.; Boise meridian; Gem County, Idaho. This locality is located on the west side of a 3,644 foot peak which is north of Schiller Creek in the NE¼, sec. 17, T. 6 N., R. 1 E. The peak is capped by up to 200 feet of very hard resistant sandstone. The rock unit described below is part of the southward dipping very resistant ledge about 200 feet

LOCALITY 68. (continued)

below the peak. Considered Poison Creek Formation; located in or near large area shown as Poison Creek-Deer Butte on Plate 1 of Newton and Corcoran (1963).

Unit		Estimated thick. (ft)
1.	Sandstone, arkosic, granitic; light brown, very coarse grained; well sorted, very hard, brittle, thin bedded. Sample 12275	20

LOCALITY 69. ANDERSON CREEK

NE¼NE¼SW¼ sec. 8, T. 6 N., R. 1 E.; Boise meridian; Gem County, Idaho. In gully on west side of jeep trail; about one fourth mile below saddle near center of sec. 8, T. 7 N., R. 1 E. Close to contact between Idaho Group and Poison Creek-Deer Butte Formation, as shown on plate 1 of Newton and Corcoran (1963). Probably in lower Idaho Group.

Unit		Estimated thick. (ft)
1.	Claystone/tuff, yellowish gray, medium hard, massive. Sample 12276	6

LOCALITY 70. DEAD INDIAN RIDGE SOUTHWEST

SE¼SW¼SW¼ sec. 22, T. 11 N., R. 7 W.; Boise meridian; Washington County, Idaho. The Payette section (as mapped by Kirkham, 1931) is at least 600 feet thick in this area. Most of the section consists of fine grained (siltstone/claystone/tuff) slope-forming rock units. The lower slopes are pale grayish to blackish brown and include an occassional medium thick bed of coarse grained to conglomeratic sandstone (described below and in locality 71). The upper slopes, to the northwest especially, consist of light gray to light pinkish gray tuff/siltstone which may be medium hard to very hard. Radioactivity throughout the section is generally much lower than the average. The following unit is found in the lower slopes on the west side of the prominent draw which trends north from the ranch house. Payette Formation, according to Kirkham (1931a, Fig. 13).

Unit		Estimated thick. (ft)
1.	Sandstone, dusky yellow (weathers yellowish gray to tan), medium grained, poorly sorted, very hard, compact, carbonate cement; medium thick, parallel even bedding; unit poorly exposed but appears to be tabular; pebbly, in part. Sample 12277	3

LOCALITY 71. DEAD INDIAN RIDGE SOUTHEAST

SE¼SE¼SW¼ sec. 22, T. 11 N., R. 7 W.; Boise meridian; Washington County, Idaho. See discussion of locality 70 for description of general section in this area. The rock unit described below is exposed in the lower slopes which form the east side of the prominent draw trending north from the ranch house. This rock unit is probably underlain by Columbia River Basalt. Payette Formation, according to Kirkham (1931a, Fig. 13).

Unit		Estimated thick. (ft)
2.	Siltstone/tuff; hard, thin to very thin bedded	50
1.	Sandstone, fine to coarse grained or conglomeratic, in thin beds; interbedded with siltstone or claystone. Sample 12278 of sandstone with following characteristics: yellowish gray, medium grained, well sorted, calcareous, very hard and brittle	10
	Total estimated thickness	60

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APPENDIX B

GAMMA-RAY SPECTROMETRIC ANALYSES OF ROCK SAMPLES

APPENDIX B

GAMMA-RAY SPECTROMETRIC ANALYSES OF ROCK SAMPLES

Sample number	Locality and unit number	eU (ppm)	eTh (ppm)	eK (pct)
12001	1-2	0.8	3.5	2.63
12002	1-1	3.8	10.4	2.71
12003	2-5	1.6	4.7	2.55
12004	2-2	6.7	13.0	2.05
12005	2-1	0.7	3.2	2.56
12006	3-1	1.5	6.1	1.90
12007	4-1	1.0	4.7	1.89
12008	5-1	0.8	3.3	1.83
12009	6-1	1.4	9.9	2.70
12010	6-2	2.7	14.9	2.85
12011	7-1	0.9	3.4	2.28
12012	8-1	1.7	8.0	2.71
12013	9-1	1.7	8.1	1.69
12014	10-1	0.7	2.4	1.74
12015	11-11	22.1	2.8	1.52
12016	11-7	0.5	2.9	2.02
12017	11-5	3.3	5.0	1.81
12018	11-4	3.2	11.6	1.83
12019	11-3	3.7	7.0	1.91
12020	12-1	0.7	4.5	2.56
12021	13-1	0.8	3.9	2.47
12022	13-2	3.4	12.0	2.64
12023	13-3	0.7	3.5	2.84
12024	13-3	3.0	11.6	1.76
12026	14-1	4.8	11.5	1.26
12027	15-3	0.7	5.1	2.51
12028	15-4	1.6	7.3	2.08
12029	16-1	0.8	4.1	2.76
12030	16-2	0.8	3.4	2.51
12031	17-2	4.2	14.3	1.99
12032	17-10	12.3	15.9	1.07
12033	17-11	1.1	4.7	2.55
12034	17-21	3.1	13.4	1.01
12035	17-30	3.9	9.2	1.73
12036	17-31	1.2	3.5	2.44
12037	17-40	3.8	7.4	2.01
12038	17-41	11.8	2.9	2.24
12070	18-1	0.6	4.0	2.78
12071	18-2	8.1	33.0	1.19
12072	18-5	4.6	16.2	2.21
12073	18-6	0.8	2.9	2.58
12074	19-3	0.7	5.3	1.89
12075	19-1	0.9	8.5	2.22
12077	20-1	1.2	3.0	1.73

Sample number	Locality and unit number	eU (ppm)	eTh (ppm)	eK (pct)
12078	20-2	0.6	2.4	0.79
12080	22-3	2.7	12.0	2.30
12081	22-2	1.6	2.9	2.26
12082	22-1	3.8	12.9	1.95
12083	23-2	3.1	6.8	2.31
12084	23-3	7.7	14.4	2.25
12085	24-1	2.1	6.6	1.41
12086	25-2	2.7	7.9	1.91
12088	27-1	4.3	10.1	1.64
12089	27-1	1.8	6.8	2.47
12090	28-1	4.6	15.0	1.55
12091	28-2	0.9	3.8	2.80
12092	29-1	1.5	5.0	1.31
12093	29-2	2.7	14.0	1.68
12094	30-1	3.5	11.5	1.76
12095	31-1	0.9	5.4	2.34
12096	32-1	4.4	17.4	2.03
12097	32-2	2.5	9.3	2.65
12098	32-3	0.5	0.8	0.96
12124	33-2	1.8	3.9	2.60
12125	33-1	8.7	27.7	3.49
12126	34-1	2.8	13.9	1.89
12127	35-1	2.0	10.9	1.83
12128	36-2	1.3	3.8	1.43
12129	36-3	2.2	7.9	2.71
12130	37-1	4.3	14.2	2.69
12131	37-2	4.7	13.6	2.96
12132	37-3	4.5	11.0	2.66
12133	37-5	9.5	12.7	2.78
12135	39-2	3.5	23.3	2.80
12136	40-1	2.4	15.1	2.37
12137	50-1	6.4	25.1	3.93
12138	50-3	5.9	24.0	3.52
12139	50-4	4.9	31.7	1.58
12140	51-2	4.8	24.3	5.31
12141	51-1	5.1	24.8	2.72
12142	52-1	5.3	18.4	1.01
12143	52-2	4.3	18.9	3.64
12148	57-1	5.6	18.8	4.85
12149	57-2	8.7	11.7	1.77
12150	58-2	5.2	17.4	3.95
12151	58-3	2.0	7.8	1.68
12152	59-1	4.3	11.3	2.22
12153	59-2	5.7	15.7	0.72
12154	60-7	4.6	13.1	2.81
12155	60-6	1.5	7.2	2.14

APPENDIX B (continued)

Sample number	Locality and unit number	eU (ppm)	eTh (ppm)	eK (pct)
12156	60-5	3.2	38.2	0.87
12157	60-4	2.6	7.2	1.89
12158	60-3	4.8	16.5	0.87
12159	61-1	4.8	20.6	3.68
12160	61-2	5.7	21.5	4.49
12161	61-3	4.9	12.7	1.67
12162	62-1	9.5	19.4	0.80
12163	62-2	7.2	16.6	2.41
12164	63-2	16.6	33.1	1.68
12165	63-3	7.0	35.7	1.00
12166	63-1	11.6	15.8	1.07
12167	64-2	5.5	17.2	2.78
12262	41-2	4.6	11.4	0.94
12263	41-3	13.6	16.5	1.65
12265	43-1	4.2	17.3	1.41
12266	43-2	3.8	19.4	3.08
12267	44-1	2.0	8.8	3.64
12268	45-1	2.6	13.7	2.98
12269	65-3	5.4	13.0	3.47
12270	65-4	2.1	8.1	2.31
12271	66-1	3.4	8.9	3.35
12272	67-3	2.2	13.6	1.21
12273	67-4	2.2	13.3	2.18
12274	67-6	18.8	3.3	2.00
12275	68-1	0.7	2.3	2.50
12276	69-1	7.5	31.0	1.11
12277	70-1	2.1	3.0	2.25
12278	71-1	1.1	2.3	2.88

APPENDIX C

SEMIQUANTITATIVE EMISSION SPECTROSCOPIC ANALYSES OF SELECTED ROCK SAMPLES

APPENDIX C

SEMIQUANTITATIVE EMISSION SPECTROSCOPIC ANALYSES OF SELECTED ROCK SAMPLES

Sample number	Locality and unit number	Al	As	B	Ba	Be	Ca	Co	Cr
12004	2-2	>10	0.0300	0.0010	0.1000	0.0003	1.0000	0	0.0010
12005	2-1	10.0000	0	0.0010	0.1500	0.0001	1.5000	0	0.0005
12009	6-1	10.0000	0	0.0010	0.1000	0.0002	1.0000	0	0
12010	6-2	>10	0	0.0020	0.1500	0.0004	1.5000	0	0.0010
12015	11-11	1.5000	0	0.0010	0.1500	0.0001	>10	0	0.0010
12021	13-1	3.0000	0	0.0005	0.2000	0	0.3000	0	0
12022	13-2	>10	0	0.0010	0.1500	0.0006	1.0000	0	0.0002
12023	13-3	8.0000	0	0.0006	0.2500	0.0001	0.7000	0	0
12024	13-3	>10	0	0.0010	0.2000	0.0007	0.7000	0	0
12029	16-1	9.0000	0	0.0010	0.1500	0.0002	1.0000	0	0
12030	16-2	>10	0	0.0030	0.0500	0.0004	0.6000	0	0.0010
12032	17-10	>10	0	0.0050	0.0300	0.0002	0.7000	0.0040	0.0010
12033	17-11	4.0000	0	0.0010	0.2000	0	0.7000	0	0
12034	17-21	>10	0	0.0030	0.0200	0.0001	0.2000	0	0.0010
12035	17-30	9.0000	0	0.0050	0.0500	0.0002	3.0000	0.0010	0.0010
12036	17-31	9.0000	0	0.0010	0.2500	0.0002	1.0000	0	0
12037	17-40	>10	0	0.0080	0.5000	0.0003	4.0000	0	0.0020
12038	17-41	6.0000	0	0.0010	0.1500	0.0002	1.5000	0	0
12071	18-2	3.0000	0	0.0030	0.0300	0.0007	1.0000	0.0010	0.0020
12072	18-5	9.0000	0	0.0030	0.0500	0.0005	3.0000	0.0010	0.0030
12073	18-6	3.0000	0	0.0010	0.1500	0.0002	1.0000	0	0.0010
12086	25-2	8.0000	0	0.0010	0.1000	0.0004	3.0000	0.0020	0.0010
12096	32-1	10.0000	0	0.0080	0.2000	0.0006	1.5000	0.0010	0.0030
12097	32-2	>10	0	0.0050	0.1500	0.0010	4.0000	0.0030	0.0030
12130	37-1	10.0000	0	0.0040	0.0800	0.0001	5.0000	0	0.0010
12131	37-2	>10	0	0.0030	0.2500	0.0004	3.0000	0	0.0010
12135	39-2	10.0000	0	0.0010	0.2000	0.0005	2.0000	0.0010	0
12140	51-2	0.8000	0	0	0.2500	0.0002	0.8000	0	0
12141	51-1	5.0000	0	0	0.0100	0.0004	1.0000	0	0
12154	60-7	10.0000	0	0.0050	0.1000	0.0004	2.0000	0	0.0010
12155	60-6	7.0000	0	0.0010	0.2000	0.0002	1.5000	0	0
12156	60-5	6.0000	0	0.0030	0.0300	0.0003	1.5000	0.0010	0.0010
12162	62-1	4.0000	0	0.0050	0.0100	0.0005	1.0000	0.0010	0.0010
12163	62-2	10.0000	0	0.0050	0.1500	0.0010	1.0000	0.0030	0.0010
12164	63-2	2.0000	0	0.0020	0.1500	0.0005	10.0000	0.0060	0
12165	63-3	1.0000	0	0.0010	0.1500	0.0004	6.0000	0.0060	0
12166	63-1	8.0000	0	0.0050	0.1500	0.0006	9.0000	0.0070	0.0020
12167	64-2	>10	0	0.0030	0.2000	0.0005	4.0000	0.0010	0

Note: Element concentration in percent. "0" means below limit of detection for that element (see Appendix D for limit of detection of trace elements).

Sample number	Locality and unit number	Cu	Fe	Ga	K	Li	Mg	Mn	Na
12004	2-2	0.0030	4.0000	0.0001	2.5000	0.0010	0.4000	0.0100	0.7000
12005	2-1	0.0010	0.5000	0.0001	2.5000	0	0.2000	0.0100	2.5000
12009	6-1	0.0020	0.8000	0.0001	2.5000	0.0005	0.3000	0.0100	2.5000
12010	6-2	0.0030	3.0000	0.0010	2.0000	0.0020	0.7000	0.0400	2.5000
12015	11-11	0.0030	0.6000	0	2.0000	0	0.2000	0.3000	0.5000
12021	13-1	0.0010	0.4000	0	2.0000	0	0.2000	0.0200	0.6000
12022	13-2	0.0030	2.0000	0.0010	2.5000	0.0003	0.5000	0.0500	2.0000
12023	13-3	0.0020	0.6000	0.0001	2.0000	0	0.2000	0.0200	1.0000
12024	13-3	0.0050	2.5000	0.0008	2.0000	0	0.4000	0.1000	1.0000
12029	16-1	0.0020	0.7000	0.0001	2.0000	0	0.2000	0.0300	1.5000
12030	16-2	0.0060	2.0000	0.0010	1.5000	0.0005	0.8000	0.0100	0.4000
12032	17-10	0.0080	1.5000	0.0003	1.0000	0.0006	0.3000	0.0400	0.3000
12033	17-11	0.0010	0.4000	0.0001	1.5000	0.0001	0.2000	0.0100	0.7000
12034	17-21	0.0050	5.0000	0.0010	1.0000	0.0005	0.6000	0.1000	0.3000
12035	17-30	0.0040	4.0000	0.0010	0.8000	0.0004	1.5000	0.5000	0.2000
12036	17-31	0.0020	0.4000	0.0001	2.5000	0.0001	0.2000	0.0200	3.0000
12037	17-40	0.0020	3.0000	0.0005	2.0000	0.0010	1.0000	1.0000	2.0000
12038	17-41	0.0010	0.5000	0.0001	2.0000	0	0.2000	0.1500	1.0000
12071	18-2	0.0030	1.0000	0.0007	1.5000	0.0005	0.3000	0.0200	0.3000
12072	18-5	0.0030	2.0000	0.0004	2.0000	0.0005	0.4000	0.0300	0.4000
12073	18-6	0.0010	0.4000	0.0001	1.5000	0.0001	0.1000	0.0070	1.0000
12086	25-2	0.0050	2.0000	0.0005	1.5000	0.0001	0.6000	0.0500	1.5000
12096	32-1	0.0010	1.5000	0.0010	1.0000	0.0020	0.5000	0.0100	2.0000
12097	32-2	0.0010	5.0000	0.0008	3.0000	0.0080	1.0000	0.0200	2.5000
12130	37-1	0.0040	1.0000	0.0001	2.5000	0.0010	0.3000	0.0300	0.8000
12131	37-2	0.0030	1.5000	0.0001	2.0000	0.0010	0.3000	0.0200	2.0000
12135	39-2	0.0020	1.0000	0.0003	2.0000	0	0.3000	0.0300	0.6000
12140	51-2	0.0010	0.3000	0.0001	2.5000	0	0.1000	0.0600	0.3000
12141	51-1	0.0030	1.0000	0.0003	2.0000	0	0.2000	0.0100	0.3000
12154	60-7	0.0020	1.0000	0.0001	2.0000	0	0.3000	0.0200	0.7000
12155	60-6	0.0010	0.6000	0.0001	1.5000	0	0.2000	0.0100	0.7000
12156	60-5	0.0040	1.0000	0.0003	0.4000	0	0.3000	0.0200	0.3000
12162	62-1	0.0030	1.0000	0.0001	0.4000	0	0.2000	0.0100	0.2000
12163	62-2	0.0040	1.5000	0.0005	1.0000	0	0.2000	0.0100	1.0000
12164	63-2	0.0020	1.0000	0.0001	1.0000	0	0.2000	0.1500	0.5000
12165	63-3	0.0010	0.5000	0	0.8000	0	0.1000	0.0500	0.3000
12166	63-1	0.0030	4.0000	0.0001	0.8000	0.0030	0.3000	0.0200	0.4000
12167	64-2	0.0040	2.0000	0.0001	1.0000	0	0.5000	0.0300	1.0000

Note: Element concentration in percent. "0" means below limit of detection for that element (see Appendix D for limit of detection of trace elements).

APPENDIX C (CONTINUED)

Sample number	Locality and unit number	Nb	Ni	P	Pb	Rb	Sc	Si	Sn
12004	2-2	0	0.0010	0	0.0010	0	0	>10	0
12005	2-1	0	0	0	0.0003	0	0	>10	0
12009	6-1	0.0010	0	0	0.0004	0	0	>10	0
12010	6-2	0.0010	0.0020	0	0.0020	0	0	>10	0.0005
12015	11-11	0	0	>1	0.0001	0	0	>10	0
12021	13-1	0	0	0	0.0001	0	0	>10	0
12022	13-2	0	0.0010	0	0.0010	0	0	>10	0.0003
12023	13-3	0	0	0	0.0002	0	0	>10	0
12024	13-3	0	0.0020	>1	0.0002	0	0	>10	0
12029	16-1	0	0	0	0.0002	0	0	>10	0
12030	16-2	0	0.0030	0.0500	0.0020	0	0.0010	>10	0.0003
12032	17-10	0	0.0030	0.0500	0.0070	0	0	>10	0
12033	17-11	0	0	0	0.0001	0	0	>10	0
12034	17-21	0.0010	0.0020	0	0.0008	0	0	>10	0.0002
12035	17-30	0	0.0010	0.0800	0.0007	0	0	>10	0
12036	17-31	0	0	0.0500	0.0003	0	0	>10	0
12037	17-40	0	0.0020	0.7000	0.0002	0	0	>10	0.0008
12038	17-41	0	0	0.5000	0.0003	0	0	>10	0
12071	18-2	0	0.0030	0	0.0010	0	0	>10	0
12072	18-5	0	0.0030	0	0.0010	0	0	>10	0
12073	18-6	0	0	0	0.0005	0	0	>10	0
12086	25-2	0	0.0020	0	0.0008	0	0	>10	0
12096	32-1	0	0.0010	0	0.0010	0	0	>10	0
12097	32-2	0	0.0010	0	0.0010	0.0100	0	>10	0
12130	37-1	0	0.0020	0	0.0005	0	0	>10	0
12131	37-2	0.0020	0.0010	0.0500	0.0003	0	0	>10	0
12135	39-2	0.0040	0.0010	0.0500	0.0010	0	0.0010	>10	0
12140	51-2	0	0	0	0.0002	0	0	>10	0
12141	51-1	0.0020	0	0	0.0003	0	0	>10	0
12154	60-7		0.0010		0.0001	0	0	>10	0
12155	60-6	0	0	0	0.0001	0	0	>10	0
12156	60-5	0	0.0050	0	0.0005	0	0	>10	0
12162	62-1	0	0.0020	0	0.0004	0	0	>10	0
12163	62-2	0.0040	0.0020	0	0.0010	0	0.0010	>10	0
12164	63-2	0	0.0020	>1	0.0020	0	0	>10	0
12165	63-3	0	0.0010	>1	0.0001	0	0	>10	0
12166	63-1	0	0.0050	>1	0.0003	0	0	>10	0
12167	64-2	0	0.0020	0.1000	0.0005	0	0	>10	0

Note: Element concentration in percent. "0" means below limit of detection for that element (see Appendix D for limit of detection of trace elements).

APPENDIX C (CONTINUED)

Sample number	Locality and unit number	Sr	Ti	V	Y	Yb	Zn	Zr
12004	2-2	0.0300	0.6000	0.0100	0.0030	0	0.0100	0.0200
12005	2-1	0.0500	0.0800	0.0010	0	0	0	0.0070
12009	6-1	0.0400	0.2000	0.0010	0.0020	0	0	0.0100
12010	6-2	0.0500	0.3000	0.0060	0.0050	0.0001	0.0100	0.0200
12015	11-11	0.0500	0.0200	0.0030	0	0	0.0100	0.0030
12021	13-1	0.0050	0.0500	0	0	0	0	0.0080
12022	13-2	0.0600	0.5000	0.0050	0.0020	0	0.0200	0.0100
12023	13-3	0.0400	0.1000	0.0010	0	0	0	0.0060
12024	13-3	0.0400	0.3000	0.0090	0.0030	0	0	0.0080
12029	16-1	0.0500	0.0600	0.0010	0	0	0	0.0070
12030	16-2	0.0030	0.3000	0.0070	0.0040	0.0001	0.0100	0.0080
12032	17-10	0.0030	0.2000	0.0020	0.0050	0	0.0100	0.0070
12033	17-11	0.0200	0.0400	0	0	0	0	0.0040
12034	17-21	0	0.4000	0.0040	0.0030	0.0001	0.0200	0.0100
12035	17-30	0.0080	0.3000	0.0060	0.0010	0	0.0100	0.0070
12036	17-31	0.0600	0.0300	0.0010	0	0	0	0.0080
12037	17-40	0.0400	0.2500	0.0200	0.0020	0	0.0100	0.0030
12038	17-41	0.0400	0.0400	0.0100	0	0	0	0.0060
12071	18-2	0	0.5000	0.0040	0.0050	0.0001	0.0100	0.0100
12072	18-5	0.0200	0.5000	0.0050	0.0030	0.0001	0.0100	0.0100
12073	18-6	0.0700	0.0700	0.0010	0	0	0	0.0080
12086	25-2	0.0800	0.7000	0.0070	0.0040	0	0.0200	0.0200
12096	32-1	0.0600	0.6000	0.0030	0.0040	0.0001	0.0200	0.0600
12097	32-2	0.1000	0.5000	0.0200	0.0030	0.0001	0.0200	0.0200
12130	37-1	0.0500	0.3000	0.0030	0.0020	0.0001	0.0100	0.0200
12131	37-2	0.0300	0.3000	0.0030	0.0030	0.0001	0.0100	0.0300
12135	39-2	0.0300	0.3000	0.0010	0.0040	0.0001	0	0.0300
12140	51-2	0	0.1000	0	0.0040	0.0001	0	0.0300
12141	51-1	0	0.2000	0	0.0050	0.0003	0.0100	0.0600
12154	60-7	0.0400	0.2500	0.0030	0.0020	0	0	0.0080
12155	60-6	0.0700	0.2500	0.0010	0.0020	0	0	0.0080
12156	60-5	0.0050	0.2500	0.0040	0.0030	0	0.0100	0.0300
12162	62-1	0	0.3500	0.0050	0.0070	0.0003	0.0100	0.0400
12163	62-2	0	0.5000	0.0070	0.0060	0.0003	0.0200	0.0500
12164	63-2	0.0500	0.1500	0.0040	0.0080	0.0003	0.0100	0.0100
12165	63-3	0.0100	0.1000	0.0010	0.0050	0.0004	0	0.0080
12166	63-1	0.1000	0.2000	0.0080	0.0040	0.0001	0.0100	0.0100
12167	64-2	0.0500	0.4000	0.0030	0.0050	0.0001	0.0100	0.0200

Note: Element concentration in percent. "0" means below limit of detection for that element (see Appendix D for limit of detection of trace elements).

APPENDIX D

AVERAGE CONCENTRATIONS OF TRACE ELEMENTS IN SAMPLES ANALYZED BY EMISSION SPECTROSCOPY

APPENDIX D

AVERAGE CONCENTRATIONS OF TRACE ELEMENTS IN SAMPLES ANALYZED BY EMISSION SPECTROSCOPY

Element	No. of samples in which element detected (total no. spls = 38)	Parts per million, semiquantitative: Minimum amount detected	Mean[a]	Std. dev.[a]
As	1	300	300	-
B	36	5	27	21
Ba	38	200	1400	930
Be	36	1	4	2
Co	15	10	26	22
Cr	23	2	13	8
Cu	38	10	28	16
Ga	35	1	4	4
Li	20	1	12	18
Mg	38	1000	3800	2900
Mn	38	100	800	1800
Nb	7	10	21	14
Ni	25	10	20	11
P	14	500	see note b	
Pb	38	1	8	12
Rb	1	100	100	-
Sc	3	10	10	0
Sn	5	2	4	2
Sr	32	30	423	257
Ti	38	200	2700	1800
V	34	10	50	47
Y	29	10	38	16
Yb	18	1	2	1
Zn	23	100	130	45
Zr	38	30	170	150

a/ Statistic pertains to that group of samples in which that element (or elements) named were detected.

b/ Greater than 10,000 ppm for 5 samples; 500-700 ppm for 9 samples; less than 500 ppm for 23 samples.

APPENDIX E

PETROGRAPHIC ANALYSES OF SELECTED SAMPLES

APPENDIX E

PETROGRAPHIC ANALYSES OF SELECTED SAMPLES

SAMPLE 12015

Locality 11. Spring Valley

Rock name: granitic conglomeratic sandstone

quartz	27%	subrounded in shape; both single and polycrystalline varieties observed
K-feldspar	3%	subrounded in shape; microcline (D), perthite (S), orthoclase (T); moderate alteration to sericite
plagioclase	1%	subrounded in shape; moderate alteration to kaolinite/sericite; signs of sauseritization
plutonic rock fragments	63%	subrounded in shape; granitic in composition; consists of (2 or more) plagioclase, K-feldspar, quartz, muscovite, and epidote; feldspars are altered
mica minerals	tr	detrital flakes of muscovite and chlorite
cement	5%	a mixture of silica, clays, hematite, and pyrite (hematite and pyrite often coat grains)
zircon	tr	subangular; detrital

SAMPLE 12074

Locality 19. Little Butte

Rock name: feldspathic quartz sandstone

quartz	56%	subangular to subrounded single grain dominant polycrystalline minor volcanic features minor inclusions: muscovite, zircon, rutile
K-feldspar	15%	subangular to subrounded orthoclase minor microcline dominant alteration and degree: moderate alteration to kaolinite/sericite inclusions: muscovite, apatite
plagioclase	tr	subangular An-content: can not be determined alteration and degree: moderate to kaolinite
plutonic rock fragments	4%	subangular to subrounded composition: granitic; quartz, feldspar, muscovite alteration and degree: extensive to kaolinite/sericite
chalcedony	tr	pore-filling (cement)
chlorite		authigenic with matrix
muscovite	2%	detrital
garnet	tr	
opaques	tr	interstitial
matrix	22%	siliceous dominant clayey trace chloritic minor

SAMPLE 12075

Locality 19. Little Butte

Rock name: quartz sandstone

quartz	82%	subangular to subrounded single grain minor polycrystalline dominant secondary overgrowths, traces of silica inclusions: muscovite, zircon, opaques
K-feldspar	8%	subangular to subrounded perthite dominant alteration and degree: trace to kaolinite/sericite inclusions: quartz, micas, opaques
plutonic rock fragment	5%	composition: granitic quartz, feldspars, muscovite, biotite alteration and degree: feldspars (traces) to kaolinite/sericite
chlorite	tr	authigenic
muscovite	tr	detrital
zircon	tr	
opaques	tr	various interstitial
cement	4%	siliceous, traces of clay within

SAMPLE 12078

Locality 20. Big Willow Creek east

Rock name: volcanic sandy siltstone

Extensive alteration of this sample makes a semiquantitative modal analysis of mineral components impossible.

Glass shards are present as are volcanic rock fragments and this sample is possibly pyroclastic.

SAMPLE 12098

Locality 32. Cove Road

Rock name: feldspathic quartz sandstone

quartz	74%	subangular to subrounded single grain dominant polycrystalline minor secondary overgrowths - silica inclusions: muscovite, zircon, rutile
K-feldspar	8%	subangular to subrounded orthoclase dominant microcline minor perthite trace alteration and degree: trace to kaolinite/sericite inclusions: muscovite, quartz, apatite
plagioclase	4%	An-content: oligoclase-andesine alteration and degree: trace to kaolinite inclusions: muscovite and apatite
plutonic rock fragments	1%	subangular to subrounded composition: granitic - quartz, feldspars, muscovite alteration and degree: feldspars trace to kaolinite/sericite
chalcedony	12%	pore-filling (cement)
muscovite	tr	detrital
opaques	tr	interstitial
cement		see chalcedony

SAMPLE 12124

Locality 33. Wilson Cemetery

Rock name: arkosic sandstone

quartz	35%	subangular to subrounded single grain dominant polycrystalline trace inclusions: apatite, zircon
K-feldspar	15%	subangular to subrounded orthoclase dominant microcline minor perthite minor alteration and degree: trace to sericite inclusions: zircon, mica
plagioclase	23%	subangular to subrounded An-content: oligoclase - andesine zoned trace alteration and degree: moderate to kaolinite/sericite inclusions: apatite and zircon
plutonic rock fragments	25%	subrounded composition: granitic - quartz, K-spar, plagioclase, muscovite, biotite, hornblende myrmekitic texture trace graphic texture trace alteration and degree: moderate feldspars to kaolinite/sericite
volcanic rock fragments	tr	subrounded aphanitic groundmass phenocryst composition: plagioclase replacement and degree: silicified
chert	tr	subrounded
chlorite	tr	detrital
biotite	1%	detrital
muscovite	tr	detrital
hornblende	tr	green
zircon	tr	
opaques	tr	interstitial

SAMPLE 12126

Locality 34. Reynolds Valley

Rock name: arkosic sandstone

quartz	38%	subangular single grain dominant polycrystalline trace volcanic features trace inclusions: apatite, muscovite
K-feldspar	10%	subangular alteration and degree: trace to sericite inclusions: zircon, apatite, mica
plagioclase	20%	subangular replacement and degree: trace to epidote; trace to kaolinite/sericite inclusions: zircon, apatite, mica
plutonic rock fragments	20%	subangular to subrounded composition: granitic - quartz, K-spar, plagioclase, biotite, muscovite, hornblende, chlorite myrmekitic texture trace
chlorite	tr	detrital
biotite	5%	
muscovite	tr	
hornblende	tr	
pyroxene	tr	
opatite	tr	
epidote	tr	
sphene	1%	
opaques	tr	
matrix	5%	siliceous minor clayey dominant

SAMPLE 12130

Locality 37. Hart Creek

Rock name: tuffaceous sandstone/tuff

quartz	1%	anhedral dominant volcanic features
plagioclase	1%	anhedral dominant zoned trace alteration and degree: dominant to kaolinite
biotite	tr	subhedral dominant
muscovite	tr	subhedral dominant
pyroxene	tr	subhedral dominant
volcanic rock fragments	2%	angular extremely altered
opaques	tr	
glass shards	95%	typical shapes some fresh; mostly extensively altered to clays due to extensive alteration, some grains called shards could possibly be some other mineral or rock fragment

APPENDIX E (continued)

SAMPLE 12131

Locality 37. Hart Creek

Rock name: volcanic conglomerate

quartz	10%	anhedral dominant volcanic features minor
Plagioclase	2%	subhedral dominant An-content: too altered zoned trace alteration and degree: moderate to kaolinite/sericite
biotite	tr	subhedral
muscovite	tr	subhedral
volcanic rock fragments	30%	volcanic dominant sedimentary trace subrounded aphanitic groundmass with and altered abundant laths of feldspars mafics, some silicified rhyolites, sedimentary quartzites (quartz arenites)
matrix	36%	phaneritic extremely unaltered, most likely feldspars and glass
zircon	tr	
opaques	1%	
glass shards	20%	various degrees of alteration

SAMPLE 12132

Locality 37. Hart Creek

Rock name: tuffaceous siltstone/ altered tuff

quartz	10%	anhedral dominant volcanic features
Plagioclase	3%	subhedral dominant alteration and degree: moderate to kaolinite/sericite
biotite	tr	subhedral
muscovite	tr	subhedral
opaques	1%	
glass	85%	altered glass, clay, feldspars

SAMPLE 12136

Locality 40. Perjue Canyon

Rock name: oölite

quartz	tr	angular single grain
sedimentary rock fragments	tr	subrounded composition: carbonate clasts, mudstones
oölites	89%	rounded cores of volcanic rock fragments, plutonic rock fragments, quartz, plagioclase, K-spar, biotite, hornblende
opaques	tr	
cement	10%	carbonate

APPENDIX E (continued)

SAMPLE 12137

Locality 50. State line

Rock name: vitric tuff/tuffaceous siltstone

quartz	6%	anhedral dominant volcanic features dominant
plagioclase	tr	subhedral minor euhedral dominant alterations and degree: moderate to kaolinite
biotite	tr	subhedral dominant
glass	95%	altered clasts, silica cement silicified and altered to clays

vitroclastic texture

SAMPLE 12138

Locality 50. State line

Rock name: ferruginous tuffaceous sandstone/ferruginous tuff

quartz	8%	anhedral dominant volcanic features dominant
plagioclase	3%	subhedral dominant alteration and degree: dominant to kaolinite/sericite
volcanic rock fragments	15%	subangular
matrix	10%	result of breakdown of other components mixture of clay, silicia, iron oxides
glass shards	63%	various degrees of alteration

SAMPLE 12140

Locality 51. Upper Sucker Creek

Rock name: tuffaceous siltstone/tuff

quartz	4%	
plagioclase	2%	
biotite	tr	subhedral extensively altered and replaced
muscovite	tr	subhedral
opaques	tr	
glass	93%	silica, altered minerals and clasts

vitroclastic texture

SAMPLE 12151

Locality 58. French John Hill

Rock name: conglomeratic tuffaceous sandstone/tuff

Sample is too altered to identify or estimate percentages of minerals.

SAMPLE 12154

Locality 60. Little Squaw Creek

Rock name: siltstone/tuff (based on field examination)

Too altered to make mineral identification, estimates of percentages, or positive rock identification.

SAMPLE 12167

Locality 64. Chalk Hills north

Rock name: ferruginous sandstone

quartz	20%	subangular to subrounded
K-feldspar	7%	subangular to subrounded orthoclase dominant microcline trace alteration and degree: moderate to kaolinite sanidine
plagioclase	17%	subangular to subrounded an-content: oligoclase-andesine alteration and degree: variable trace to moderate, kaolinite/sericite
plutonic rock fragments	2%	composition: granitic - quartz and feldspars alteration and degree: feldspar moderate to kaolinite/sericite
volcanic rock fragments	40%	subangular to subrounded phaneritic groundmass trace aphanitic groundmass dominant silicified phenocryst composition: quartz, plagioclase, hornblende, pyroxene alteration and degree: dominant to kaolinite/sericite (feldspars) replacement and degree: dominant to silica
sedimentary rock fragments	1%	subrounded siltstones
chalcedony	tr	detrital
biotite	tr	
muscovite	tr	
hornblende	1%	
pyroxene	tr	subangular
apatite	tr	

SAMPLE 12167 (continued)

opaques	tr	
cement	10%	ferruginous dominant

SAMPLE 12270

Locality 65. Flat Top Butte

Rock name: feldspathic quartz sandstone

quartz	80%	subrounded single grain dominant polycrystalline trace inclusions: mica, apatite
K-feldspar	5%	subrounded orthoclase dominant microcline trace alteration and degree: moderate to to kaolinite/sericite inclusions: apatite
plagioclase	10%	subrounded An-content: oligoclase - andesine alteration and degree: moderate to kaolinite/sericite inclusions: apatite
sedimentary rock fragments	tr	texture: clastic composition: micrite rock suite: carbonate
chert	tr	
chlorite	tr	detrital
biotite	tr	detrital
muscovite	tr	detrital
apatite	tr	
epidote	tr	
zircon	tr	
opaques	tr	cement
cement	4%	siliceous dominant secondary carbonate trace secondary

SAMPLE 12275

Locality 68. Schiller Creek

Rock name: arkosic granitic sandstone

quartz	40%	subrounded to subangular single grain dominant polycrystalline minor inclusions: mica, rutile, apatite
K-feldspar	15%	subrounded orthoclase dominant microcline minor perthite trace alteration and degree: trace to sericite inclusions: apatite
Plagioclase	10%	subrounded An-content: oligoclase - andesine alteration and degree: trace to sericite inclusions: apatite
plutonic rock fragments	32%	composition: granitic myrmekitic texture trace alteration and degree: trace to kaolinite/sericite
sedimentary rock fragments	tr	subrounded texture: elastic composition: quartz, K-spar, silica cement rock suite: arenite
chlorite	tr	detrital
biotite	tr	detrital
muscovite	tr	detrital
zircon	tr	
opaques	tr	
matrix	tr	clayey dominant
cement	2%	siliceous secondary

SAMPLE 12276

Locality 69. Anderson Creek

Rock name: clay/tuff

quartz	tr	
plagioclase	1%	anhedral dominant an-content: oligoclase - andesine alteration and degree: moderate to clay
muscovite	tr	
chlorite	tr	anhedral dominant
opaques	5%	disseminated in matrix
matrix	90%	clay and glass dust
glass shards	3%	

vitroclastic texture

APPENDIX F

URANIUM ANALYSES OF WATER SAMPLES

APPENDIX F

URANIUM ANALYSES OF WATER SAMPLES

Sample number	Locality number (App. A)	U_3O_8 (ppb)
12025	13	1
12076	19	1
12079	21	0.3
12087	26	0.7
12134	38	0.4
12144	53	0.9
12145	54	0.2
12146	55	1.7
12147	56	1.1
12264	42	1.8

APPENDIX G

LIST OF WATER WELLS

APPENDIX G
LIST OF WATER WELLS

Well number	Location	Owner or tenant	Estimated elevation (ft)	Drilled by
37	NW¼NE¼ sec. 33, T. 6 S., R. 8 E.	U.S. Corps of Engineers	3,020	Core Drilling Co., 1959
38	NW¼NE¼ sec. 10, T. 3 N., R. 2 E.	State of Idaho	2,700	Lukehart Drilling and Pump, 1962
39	SE¼SW¼ sec. 5, T. 12 N., R. 4 W.	H. Lacey	2,800	B & M Well Drilling, 1966
40	SW¼NW¼ sec. 33, T. 11 N., R. 5 W.	City of Weiser	2,120	Joe Eilworth, 1966
41	SE¼NW¼ sec. 33, T. 11 N., R. 4 W.	William Brummett	2,350	Joe Eilsworth, 1966
42	SE¼SE¼ sec. 24, T. 7 N., R. 5 W.	R. J. Brown	2,430	Cope Drilling Company, 1971
43	E½ sec. 26, T. 7 N., R. 1 E	Gatfield Farms	2,700	B & M Equipment, 1965
44	NE¼SW¼ sec. 27, T. 7 N., R. 2 E.	M. Renfro	2,600	Orval Harden, 1963
45	SE¼SE¼ sec. 6, T. 5 N., R. 2 W.	C. L. Shawyer	2,580	B & M Drilling, 1972
46	NW¼NW¼ sec. 36, T. 4 N., R. 1 E.	Boise Water Corps.	2,680	Russel Cowe, 1968
47	NE¼NE¼ sec. 5, T. 3 N., R. 4 W.	Bruce Bartlett	2,460	B & M Drilling, 1970
48	SE¼SE¼ sec. 9, T. 3 N., R. 2 W.	Amalgamated Sugar Company	2,470	A. A. Durand and Son, 1953
49	SE¼NE¼ sec. 2, T. 3 N., R. 1 E.	Boise Water Corporation	2,700	Cope Drilling Company, 1972
50	SE¼SE¼ sec. 22, T. 3 N., R. 2 E.	Boise Water Corporation	2,750	Cope Drilling Company, 1971
51	NW¼NE¼ sec. 36, T. 3 N., R. 2 E.	Idaho Power Company	2,900	Kenneth Witt, 1966
52	SW¼NE¼ sec. 36, T. 3 N., R. 2 E.	J. A. Terteling and Sons	2,900	Cope Drilling Company, 1972
53	SE¼NW¼ sec. 22, T. 2 N., R. 3 W.	Walter Russell	2,790	Cope Drilling Company, 1972
54	SE¼SW¼ sec. 34, T. 2 N., R. 2 W.	Jay C. Neider	2,810	Cope Drilling Company, 1972
55	NE¼SW¼ sec. 28, T. 2 N., R. 3 E.	State Highway Department	3,480	Wayne E. Stevens, 1967
56	NW¼NE¼ sec. 12, T. 1 N., R. 4 W.	Gust Collis	2,350	Harold A. Steiner, 1960

APPENDIX G (continued)

Well number	Location	Owner or tenant	Estimated elevation (ft)	Drilled by
57	NE¼NW¼ sec. 13, T. 1 N., R. 3 W.	Elmer Tiegs	2,680	A. E. Hosack and Son, 1956
58	SW¼SW¼ sec. 9, T. 1 S., R. 4 E.	U. S. Corps of Engineers	3,240	R. V. Strasser Drilling Co., 1959
59	NE¼NE¼ sec. 5, T. 2 S., R. 12 E.	Calarco, Inc.	5,080	Smith Drilling and Pump Co., 1973
60	Center sec. 15, T. 1 S., R. 13 E.	Lee Barron	5,050	Cope Drilling Company, 1968
61	NW¼SE¼ sec. 9, T. 1 S., R. 14 E.	LDS Church - Fairfield	5,060	Clarence Cole, 1954
62	SW¼NE¼ sec. 5, T. 1 S., R. 15 E.	W. D. Simon	5,050	Clarence Cole, 1953
63	NE¼NW¼ sec. 3, T. 2 S., R. 2 W.	John Foster	2,400	?
64	SE¼NE¼ sec. 23, T. 2 S., R. 1 E.	Leonard T. Hult	3,120	E. E. Luhdorff Company, 1968
65	NE¼NE¼ sec. 2, T. 2 S., R. 4 E.	J. R. Simplot	3,160	Hiddleston, 1970
66	NW¼NW¼ sec. 23, T. 2 S., R. 4 E.	Ernest Lewandowski	3,080	Hiddleston, 1971
67	NE¼SE¼ sec. 11, T. 2 S., R. 5 E.	Fred R. Hickey	3,280	Carl Hickey, 1970
68	SE¼SE¼ sec. 5, T. 3 S., R. 2 W.	Brian Branzell	1,300	Vernon E. Johnstone, 1970
69	SE¼SE¼ sec. 7, T. 3 S., R. 1 W.	Lester Mitchell	3,200	Harold A. Steiner, 1957
70	NE¼SW¼ sec. 2, T. 3 S., R. 6 E.	Dave Ireland	3,300	Hiddleston, 1973
71	NE¼SW¼ sec. 13, T. 3 S., R. 6 E.	Aquirre and Sons	3,210	George Gailey, 1966
72	SE¼NE¼ sec. 26, T. 3 S., R. 6 E.	City of Mountain Home	3,160	John O'Connor
73	SW¼SW¼ sec. 23, T. 3 S., R. 18 E.	Judson Timm	4,600	Smith Drilling and Pump Co., 1970
74	SE¼SW¼ sec. 25, T. 4 S., R. 1 W.	John Salove	2,900	Kenneth Witt, 1972
75	SW¼ sec. 29, T. 4 S., R. 1 E.	T. G. Adcock	2,700	Elmer Johnston, 1959
76	SW¼NE¼ sec. 19, T. 4 S., R. 2 E.	U. S. Army Corp of Engineers	2,690	Core Drilling, Inc., 1958

APPENDIX G (continued)

Well number	Location	Owner or tenant	Estimated elevation (ft)	Drilled by
77	NW¼SW¼ sec. 10, T. 4 S., R. 5 E.	Oscar J. Streeter	3,100	B. B. Gailey
78	SE¼NW¼ sec. 5, T. 4 S., R. 6 E.	William Hepworth	3.160	Harry King Drilling Co., 1970
79	NE¼SE¼ sec. 35, T. 4 S., R. 6 E.	W. D. Hennis	3,060	Robert Denton, 1968
80	NW¼SE¼ sec. 33, T. 4 S., R. 17 E.	Rock Creek, Inc.	4,120	Claude Nicholson Well Drilling, 1969
81	SE¼NW¼ sec. 10, T. 5 S., R. 1 E.	E. P. Lawrence	2,640	Harold Steiner, 1963
82 a/	SE¼NE¼ sec. 13, T. 5 S., R. 2 E.		2,580	Emory Ratliff and Associates, 1957
83	NW¼SW¼ sec. 15, T. 5 S., R. 3 E.	L. A. Haolst	2,380	? , 1953
84	SW¼NE¼ sec. 25, T. 5 S., R. 6 E.	Jim Batt	2,840	Hiddleston and Son, 1971
85	SW¼NE¼ sec. 6, T. 5 S., R. 11 E.	William W. Knox	2,700	Irvin E. Glineski, 1966
86	NW¼NE¼ sec. 3, T. 5 S., R. 12 E.	Carl Anderson	3,100	Boley, Henry, Weeolt, 1971
87	SW¼SW¼SW¼ sec. 11, T. 6 S., R. 3 E.	Smith and Hinton	2,600	?
88	SE¼SE¼ sec. 10, T. 6 S., R. 5 E.	Errol F. Black	2,600	
89 a/	SW¼NW¼ sec. 24, T. 6 S., R. 5 E.		2,580	George Hutchinson
90 a/	SW¼SE¼ sec. 29, T. 6 S., R. 5 E.		2,580	Perle Davis and Sons, 1957
91 a/	SE¼NW¼ sec. 32, T. 6 S., R. 6 E.		2,600	Albert Black, 1953
92	SE¼NE¼ sec. 25, T. 6 S., R. 12 E.	Anderson-Kelly Ranch	3,280	Smith Drilling and Pump Company, 1974
93	SW¼SE¼ sec. 6, T. 6 S., R. 13 E.	?	3,220	?
94	NW¼NW¼ sec. 13, T. 6 S., R. 14 E.	Ernest Fields	3,700	C. B. Enton and Sons, Inc., 1965
95	SW¼SE¼ sec. 22, T. 6 S., R. 17 E.	Bureau of Land Management	4, 150	Boley, Henry and Weech, 1968
96	NE¼NE¼ sec. 13, T. 7 S., R. 2 E.	Paul Black	3,300	Vernon E. Johnston, 1967

a/ Information from Littleton and Crosthwaite (1957).

APPENDIX G (continued)

Well number	Location	Owner or tenant	Estimated elevation (ft)	Drilled by
97	SE¼NE¼ sec. 4, T. 7 S., R. 3 E.	Bill Burghardt	2,990	Vernon E. Johnston, 1967
98[a]	SE¼NW¼ sec. 12, T. 7 S., R. 4 E.		2,690	Frank Faria, 1954
99[a]	SW¼SE¼ sec. 13, T. 7 S., R. 4 E.		2,690	Lauri Lahtinen, 1954
100[a]	SW¼NE¼ sec. 28, T. 7 S., R. 5 E.		2,800	Fred King, 1953
101	NE¼NW¼ sec. 15, T. 7 S., R. 6 E.	U. S. Government	2,600	?, 1957
102	NE¼NW¼ sec. 35, T. 7 S., R. 12 E.	W. J. Collins	3,400	Dale E. Gilbert, 1971
103	NW¼NW¼ sec. 1, T. 7 S., R. 13 E.	L. D. Woody	3,000	Smith Drilling and Pump Co., 1974
104	NW¼NE¼ sec. 26, T. 8 S., R. 12 E.	Earl Justice	3,500	Smith Drilling and Pump Co., 1969
105	NW¼NE¼ sec. 26, T. 8 S., R. 12 E.	Earl Justice	3,550	Arnold Elsing, 1968
106	SE¼SE¼ sec. 27, T. 8 S., R. 13 E.	Maurice Eckart	3,390	Ralph Denton, 1969
107	NE¼SE¼ sec. 36, T. 8 S., R. 14 E.	Frank Henslee	3,250	Mack Gray Well Drilling, 1968
108	NE¼SE¼ sec. 14, T. 8 S., R. 17 E.	Rosemary Hof McGonigal	4,200	J. Emmett Smith, 1968
109	NW¼SW¼ sec. 1, T. 9 S., R. 15 W.	Gary Moss	3,420	Dale Gilbert, 1968
110	NW¼NW¼ sec. 29, T. 9 S., R. 17 E.	Royal Catfish, Industries	3,150	Boley, Henry and Weech, 1970

[a] Information from Littleton and Crosthwaite (1957).

APPENDIX H

LIST OF PETROLEUM TEST WELLS

APPENDIX H

LIST OF PETROLEUM TEST WELLS

Well number	Company and well name	Location	Ground level elev. (ft)	Total depth (ft)	Date drilled	Type of log (s)	Lithologic log quality a/
1	Oroco Oil and Gas Co.; T.B. Carr #1	sec. 15, T. 11 N., R. 5 W.; Boise meridian; Washington County, Id.	2306	2,320	1955	lith	fair
2	Ohio Oil Co.; Kramlich #1	NW¼SW¼NW¼ sec 5, T. 9 N., R. 4 W.; Boise meridian; Payette County, Id.	2800 est.	4,011	1931	lith	fair
3	El Paso Natural Gas Co.; Assmussen #1	sec. 8, T. 9 N., R. 3 W.; Boise meridian; Payette County, Id.	2917	4,017	1956	lith, elect	fair
5	Oroco Oil and Gas Co.; B. Carpenter #1	SE¼NE¼ sec. 4, T. 8 N., R. 5 W.; Boise meridian; Payette County, Id.	2140	2,775	1955	lith, elect	poor
8	El Paso Natural Gas Co.; V. Johnson #2	center of SE¼ sec. 27, T. 8 N., R. 4 W.; Boise meridian; Payette County, Id.	2194	3,521	1955	lith, elect, gamma	fair
12	El Paso Natural Gas Co.; Webber-State #1	sec. 16, T. 5 N., R. 3 W.; Boise meridian; Canyon County, Id.	2443	4,528	1956	lith, elect, gamma	fair
13	Oroco Oil and Gas Co.; Richardson #1	sec. 19, T. 4 N., R. 3 W.; Boise meridian; Canyon County, Id.	2335	3,048	1955	lith, elect	fair
15	Boise Petroleum Co.; Well #1	sec. 27, T. 4 N., R. 2 E.; Boise meridian; Ada County, Id.	3050	1,625	1930	lith	fair
19	Oroco Oil and Gas Co.; Bolles #1	sec. 15, T. 17 S., R. 47 E.; Williamette meridian; Malheur County, Or.	2147	1,966	1955	lith, elect	poor
20	Ontario Cooperative Gas and Oil Company; Well #1	sec. 9, T. 18 S., R. 47 E.; Williamette meridian; Malheur County, Or.	2159	3,650	1908	lith	fair
21	H.K. Riddle; Kiesel Estate #1	sec. 8, T. 19 S., R. 47 E.; Williamette meridian; Malheur County, Or.	2177	5,137	1954	lith	good

a/ Good - usually a recent well with a detailed log
Fair - usually a recent well but log lacks detail
Poor - usually an old well for which the log lacks detail

APPENDIX H (continued)

Well number	Company and well name	Location	Ground level elev. (ft)	Total depth (ft)	Date drilled	Type of log (s)	Lithologic log quality[a/]
29	Helmerich and Payne, Inc.; Parker #1	SE¼NW¼NW¼ sec. 19, T. 6 S., R. 8 E.; Boise meridian; Owyhee County, Id.	2634	3,808	1950	lith	fair
31	Helmerich and Payne, Inc.; State #2	NW¼NW¼NW¼ sec. 16, T. 7 S., R. 9 E.; Boise meridian; Elmore County, Id.	3000 est.	2,068	1950	lith	fair
32	Company ?; Letha	SW¼SW¼NE¼ sec. 35, T. 7 N., R. 3 W.; Boise meridian; Gem County, Id.	2250 est.	758	1941	lith	fair
34	Griffith; Bostic #1-A	SE¼SW¼SW¼ sec. 25, T. 4 S., R. 8 E.; Boise meridian; Elmore County, Id.	3175	9,678	1973	lith, elect	good
35	Standard Oil Co. of Calif., Highland Livestock and Land #1	NE¼SE¼NW¼ sec. 24, T. 6 N., R. 5 W.; Boise meridian; Payette County, Id.	2631	11,963	1973	lith, elect	good
36	Roden Drilling Co.; Higgenson (Fee) #1	SW¼SW¼NW¼ sec. 9, T. 3 N., R. 1 W.; Boise meridian; Ada County, Id.	2525	3,610	1972	lith	good

a/ Good - usually a recent well with a detailed log
Fair - usually a recent well but log lacks detail
Poor - usually an old well for which the log lacks detail