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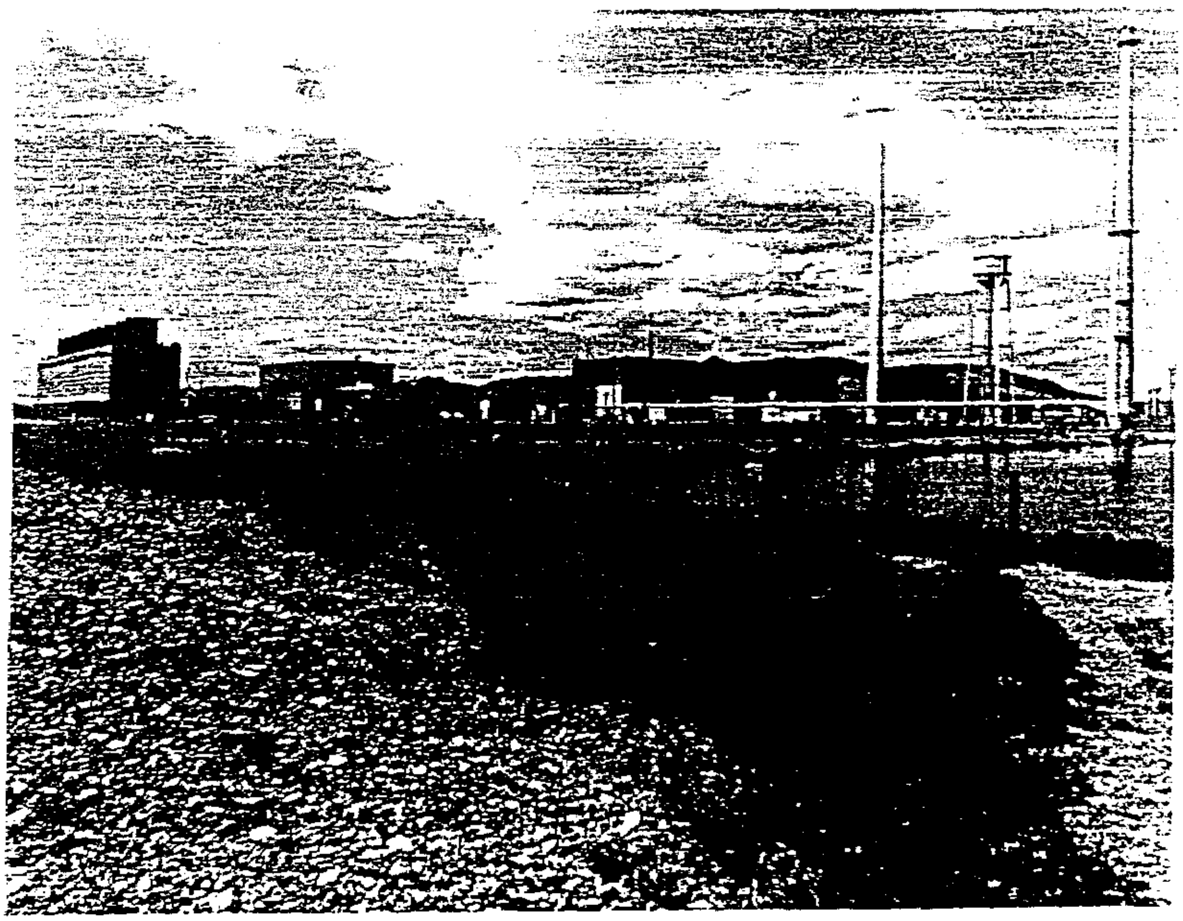
# Stratigraphy of the Unsaturated Zone and Uppermost Part of the Snake River Plain Aquifer at the Idaho Chemical Processing Plant and Test Reactors Area, Idaho National Engineering Laboratory, Idaho

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 91-4010



Prepared in cooperation with
the U.S. Department of Energy

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By S.R. Anderson

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U.S. DEPARTMENT OF ENERGY

Idaho Falls, Idaho
January 1991

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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## CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS FOR UNITS

| Multiply | By | To obtain |
| --- | --- | --- |
| foot (ft) | 0.3048 | meter |
| mile (mi) | 1.609 | kilometer |
| square mile ($mi^2$) | 2.590 | square kilometer |
| gallon (gal) | 3.785 | liter |
| curie (Ci) | $3.70 \times 10^{10}$ | becquerel |
| pound (lb) | 4.536 | kilogram |

Sea Level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated unit used in report: mg/L (milligram per liter).

# STRATIGRAPHY OF THE UNSATURATED ZONE AND UPPERMOST PART OF THE SNAKE RIVER PLAIN AQUIFER AT THE IDAHO CHEMICAL PROCESSING PLANT AND TEST REACTORS AREA, IDAHO NATIONAL ENGINEERING LABORATORY, IDAHO

By

S.R. Anderson

## ABSTRACT

A complex sequence of basalt flows and sedimentary interbeds underlies the Idaho Chemical Processing Plant and Test Reactors Area at the Idaho National Engineering Laboratory in eastern Idaho. Wells drilled to a depth of 700 feet penetrate a sequence of 23 basalt-flow groups and 15 to 20 sedimentary interbeds that range in age from about 200,000 to 640,000 years. The 23 flow groups consist of about 40 separate basalt flows and flow units. Each flow group is made up of one to three petrographically similar basalt flows that erupted from related source areas during periods of less than 200 years. Sedimentary interbeds consist of fluvial, lacustrine, and eolian deposits of clay, silt, sand, and gravel that accumulated during periods of volcanic inactivity ranging from thousands to hundreds of thousands of years. Multiple flow groups and sedimentary interbeds of similar age and source form seven composite stratigraphic units with distinct upper and lower contacts. Composite units older than about 350,000 years were tilted, folded, and fractured by differential subsidence and uplift. Basalt and sediment of this sequence are unsaturated to a depth that ranges from 430 to 480 feet below land surface. Basalt and sediment in the lower part of the sequence are saturated and make up the uppermost part of the Snake River Plain aquifer. Stratigraphic relations in the lowermost part of the aquifer below a depth of 700 feet are uncertain. This undifferentiated sequence of basalt and sediment is penetrated by only 17 of the 79 wells in the area and has not been evaluated for stratigraphic properties because of insufficient data. Only one well may penetrate the effective base of the aquifer at a depth of 1,200 feet below land surface.

The areal extent of basalt-flow groups and sedimentary interbeds in the upper 700 feet of the unsaturated zone and aquifer was determined from

geophysical logs, lithologic logs, and well cores. Basalt flows in the cores were evaluated for potassium-argon ages, paleomagnetic properties, and petrographic characteristics. Stratigraphic control was provided by a sequence of basalt flows with reversed paleomagnetic polarity and high emission of natural-gamma radiation compared to other flows; the control was supplemented by distinct changes in natural-gamma radiation across the contacts of each of the seven composite stratigraphic units. Natural-gamma logs were used as a primary tool for stratigraphic correlations. Natural-gamma emissions generally are uniform in related, petrographically similar basalt flows and generally increase or decrease between petrographically dissimilar flows of different age and source.

## INTRODUCTION

The ICPP (Idaho Chemical Processing Plant) and TRA (Test Reactors Area) are in the southern part of the INEL (Idaho National Engineering Laboratory) in eastern Idaho (fig. 1). The ICPP, which is used for reprocessing of spent nuclear fuel rods, is 8 mi north of the southern boundary of the INEL and covers about 0.15 $mi^2$. The TRA, which is used for nuclear research, is 2 mi northwest of the ICPP and covers about 0.10 $mi^2$. The area covered by this report encompasses about 6.5 $mi^2$ and includes the ICPP, TRA, and adjacent areas in which stratigraphic information has been collected from numerous wells (fig. 2). As used in this report, a well refers to any drill hole, core hole, borehole, or water well from which geologic and geophysical information has been collected.

Radioactive and chemical waste has been discharged to disposal wells and unlined percolation ponds at the ICPP and TRA for several decades (Pittman and others, 1988). From 1953 to 1984, prior to construction of the ponds, the ICPP discharged low-level radioactive and chemical waste directly to the Snake River Plain aquifer through well CPP DISP (fig. 2), a 600-ft deep disposal well. From 1974 to 1985, 445 million gal/year of wastewater containing an average of 287 Ci/year of radioactivity were discharged to the well and ponds at the ICPP; nearly 99 percent of the radioactivity was from

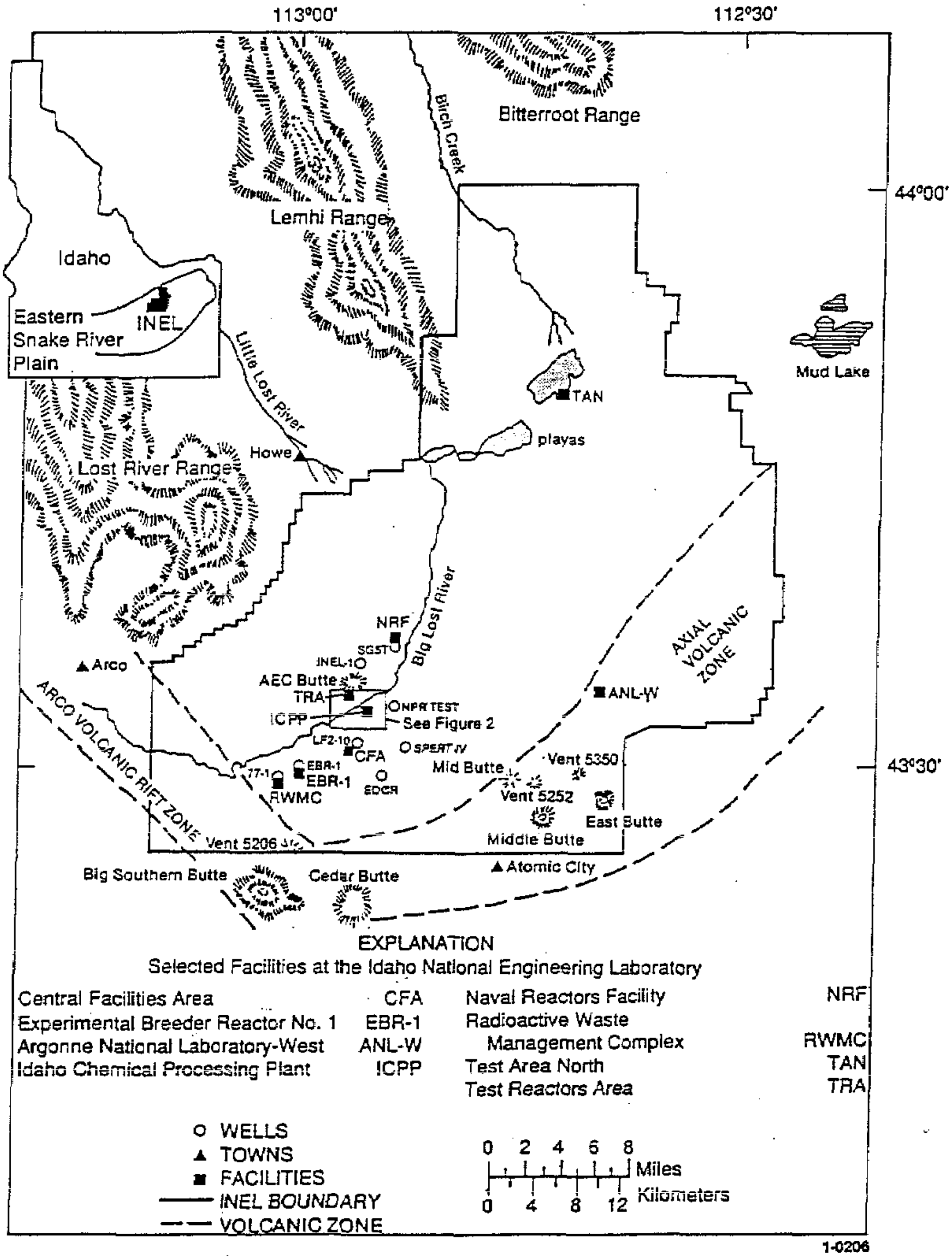


Figure 1.--Location of the Idaho Chemical Processing Plant, Test Reactors Area, and selected features at and near the Idaho National Engineering Laboratory.

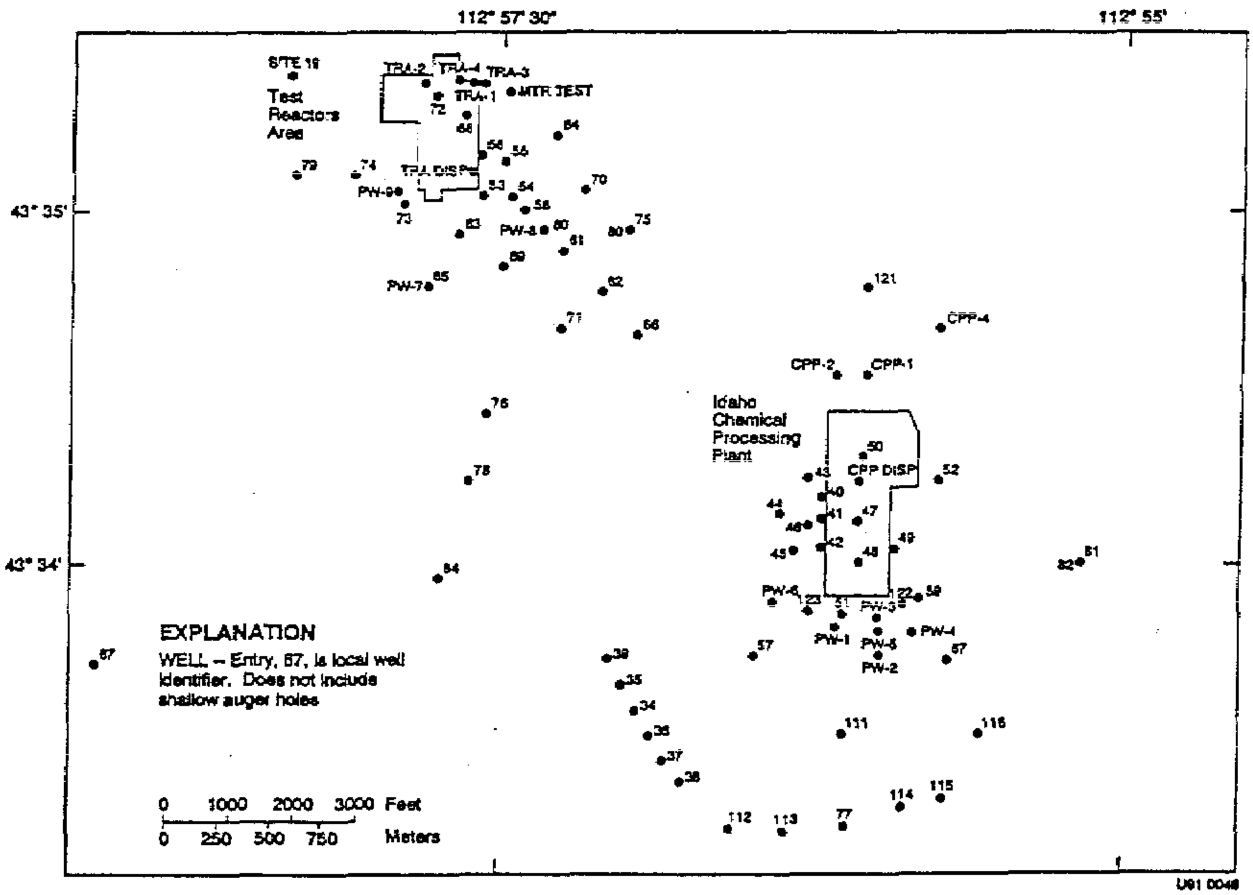


Figure 2.--Location of wells at the Idaho Chemical Processing Plant and Test Reactors Area.

tritium. An average of 0.06 Ci/year of strontium-90 also was discharged to percolation ponds at the ICPP from 1982 to 1985 (Pittman and others, 1988).

A 1,275-ft deep well, TRA DISP (fig. 2), was used to dispose of about 250 million gal/year of nonradioactive wastewater at the TRA from 1964 to 1982; for several years, discharge to the well included hexavalent chromium at an average concentration of about 2.2 mg/L (Pittman and others, 1988). Nonradioactive liquid waste consisting mainly of sulfate and sodium has been discharged to a percolation pond at the TRA since 1962. From 1982 to 1985, an average of about 527,000 lb of sulfate and 84,000 lb of sodium were discharged annually to the pond at concentrations of about 9,200 mg/L and 1,500 mg/L, respectively. From 1959 to 1985, discharge of radioactive waste to percolation ponds at the TRA averaged about 189 million gal/year. From 1974 to 1979, aqueous radioactive waste contained about 2,250 Ci/year of activation and fission products; this amount was reduced to about 288 Ci/year from 1980 to 1985. Tritium, which comprised about 10 percent of the radioactive waste discharged to ponds at the TRA from 1974 to 1975, comprised about 90 percent of the total radioactive discharge from 1981 to 1985 (Pittman and others, 1988).

Concern about the potential for migration of radioactive and chemical waste from the ICPP and TRA to the underlying Snake River Plain aquifer has prompted numerous subsurface investigations of the area. From October 1949 to May 1990, 79 wells (fig. 2) were drilled to evaluate the geologic, geohydrologic, and geochemical characteristics of the unsaturated zone and aquifer (Keys, 1963; Chase and others, 1964; Walker, 1964; Morris and others, 1965; Bagby and others, 1984). These wells were completed to depths ranging from 80 to 1,275 ft below land surface and have an aggregate depth of 36,720 ft. Samples from the wells indicate that radioactive and chemical waste is present in the subsurface (Pittman and others, 1988), but additional data collection and study are needed to evaluate the extent of the contamination. In 1989, the U.S. Geological Survey, in cooperation with the U.S. Department of Energy, began an investigation of the stratigraphy of the unsaturated zone and uppermost part of the Snake River Plain aquifer at the ICPP and TRA. The investigation was undertaken to determine stratigraphic relations that may affect the potential for migration of radioactive and chemical waste from the ICPP and TRA to the Snake River Plain aquifer.

## Purpose and Scope

This report describes the stratigraphic framework of the unsaturated zone and uppermost part of the Snake River Plain aquifer at the ICPP and TRA, using geologic and geophysical data collected through May 1990. Data collected for this and previous studies indicate there are numerous basalt flows and sedimentary interbeds in the subsurface at the ICPP and TRA. This report describes the stratigraphic relations between groups of related basalt flows and major sedimentary interbeds in the unsaturated zone and uppermost part of the aquifer to a depth of about 700 ft below land surface. The stratigraphic framework described in this report is an extension of the framework first described by Kuntz and others (1980) and Anderson and Lewis (1989) at the RWMC (Radioactive Waste Management Complex) (fig. 1). The reader is referred to reports by Kuntz and others (1980), Champion and others (1981, 1988), and Anderson and Lewis (1989) for information concerning the ages and physical characteristics of individual basalt flows and the criteria used for subdividing stratigraphic units in the subsurface. The altitude, thickness, and distribution of stratigraphic units are shown on figures 3-22 and table 1 at the end of this report. Geophysical logs used to differentiate stratigraphic units are presented in a report by Bartholomay (1990).

## Approach

This report contains geologic sections, maps, and tables that describe the stratigraphic characteristics of the subsurface at the ICPP and TRA (figs. 3-22; table 1); stratigraphic data presented in this report are referenced to altitude above sea level and depth below land surface. The data shown on geologic sections, maps, and tables were interpreted from geophysical logs, lithologic logs, and well cores. Cores from the RWMC and from wells 80, 81, and NPR TEST were used as the basis for stratigraphic correlations; cores were obtained from wells 121 and 123 but have not yet been evaluated (figs. 1 and 2). Potassium-argon ages and paleomagnetic properties were determined for cores from the RWMC and from wells 80 and NPR TEST; cores from the RWMC also were evaluated for petrographic characteristics and those from well 81 only for paleomagnetic properties (Kuntz and others, 1980; Champion and others, 1981, 1988; D.E. Champion and M.A. Lanphere, U.S. Geological Survey, written commun., 1989). Stratigraphic units in the cores were correlated with stratigraphic units in 40 other wells at the RWMC (Anderson and Lewis, 1989) and 77 other wells at the ICPP and TRA (figs. 1 and 2) by graphical inspection of natural-gamma logs. These logs are sensitive to small changes in potassium-oxide content and natural-gamma radiation that occur between basalt flows and sedimentary interbeds of different age and source (Anderson and Bartholomay, 1990). A straight-line interpolation was used to extend interpreted stratigraphic contacts from well to well on geologic sections (figs. 3-8). Contours of altitude and thickness of stratigraphic units were interpolated between wells to the nearest 10 or 25 ft (figs. 9-22) from the data shown on table 1.

Basalt flows underlying the ICPP and TRA were formed by lavas that issued from at least 23 different source vents. Correlation of the flows with exposed and buried source vents was accomplished by two methods. Selected basalt flows in wells at the RWMC and in wells 80 and NPR TEST near the TRA and ICPP (figs. 1 and 2) were correlated with probable source vents on the basis of outcrop relations, geologic ages, paleomagnetic properties, and petrographic characteristics of the flows (Kuntz and others, 1980; Champion and others, 1988; Kuntz and others, 1990; M.A. Lanphere, U.S. Geological Survey, written commun., 1989). These vents are referred to as AEC Butte, Mid Butte, and vents 5206, 5252, and 5350 (fig. 1). All basalt flows underlying the ICPP and TRA to a depth of 700 ft below land surface were correlated with probable source vents on the basis of outcrop relations (Kuntz and others, 1990) and areal distribution and thickness of the flows interpreted from natural-gamma logs (Anderson and Lewis, 1989). Most of these vents are referred to as unidentified vents and are not shown on figure 1 because the correlations are preliminary. Correlations of selected flows underlying the ICPP and TRA with AEC Butte and vents 5206 and 5350 appear reasonable on the basis of these two methods. Other correlations of flows with probable source vents will require additional verification.

## Acknowledgments

Data from wells and core holes drilled near the ICPP during this investigation were provided by Chris J. Martin, Westinghouse Idaho Nuclear Company, Environmental Compliance and SIS Operations. R. David Hovland, State of Idaho, Department of Health and Welfare, Division of Environmental Quality, reviewed the report and provided many helpful suggestions concerning its content and organization. Technical assistance and data from past geologic investigations were obtained from Mel A. Kuntz, Duane E. Champion, and Marvin A. Lanphere, U.S. Geological Survey, Geologic Division.

## GEOHYDROLOGIC SETTING

The INEL is on the west-central part of the eastern Snake River Plain, a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide (fig. 1). The INEL is underlain by a layered sequence of Tertiary and Quaternary volcanic rocks and sedimentary interbeds that is more than 10,000 ft thick (Doherty and others, 1979; Whitehead, 1986; Rightmire and Lewis, 1987). Volcanic rocks of this sequence consist mainly of basaltic lava flows, ash, and cinders in the upper part, and rhyolitic ash flows and tuff in the lower part; in places, the rocks are intruded by rhyolite domes that are elevated by as much as 2,000 ft above the surface of the plain. Basaltic rocks, which underlie the INEL to a depth of more than 2,000 ft, are interbedded with fluvial, lacustrine, and eolian deposits of clay, silt, sand, and gravel. Basalt and sediment locally are overlain by or interbedded with rhyolite and latite. Basalt, rhyolite, and latite source vents are concentrated on the axial volcanic zone (fig. 1) and numerous rift zones, such as the Arco volcanic rift zone (fig. 1), that trend perpendicular to the long axis of the plain (Kuntz, 1978; Kuntz and others, 1990; R.P. Smith and W.R. Hackett, EG&G Idaho, Inc., written commun., 1990).

Basalt and sediment are saturated at depth and together form the Snake River Plain aquifer. Depth to water in the aquifer ranges from about 200 ft below land surface in the northern part of the INEL to about 900 ft in the southern part; the general direction of ground-water flow is from northeast to southwest. The effective base of the aquifer at the INEL likely coincides with the top of a thick and widespread sequence of clay, silt, sand, and basalt (Anderson, 1990). The top of this sequence is at a depth of 1,220 ft below land surface in well INEL-1 (fig. 1) (Mann, 1986) and at depths ranging from 800 to 1,500 ft elsewhere. If this interpretation is correct, the effective saturated thickness of the aquifer ranges from about 600 to 800 ft in most places because the probable effective base of the aquifer slopes from northeast to southwest nearly parallel with the slope of the water table. Hydraulic properties of the aquifer differ considerably from place to place, depending on saturated thickness and the characteristics of the basalt and sediment. In places, basalt and sediment in the uppermost part of the aquifer yield thousands of gallons per minute of water to wells, with negligible drawdown (D.J. Ackerman, U.S. Geological Survey, written commun., 1990). Hydraulic data for basalt, sediment, ash, and tuff underlying the Snake River Plain aquifer are sparse, but data for a 10,365-ft test well, INEL-1 (fig. 1), indicates that these rocks and sediment are relatively impermeable compared with those that comprise the aquifer (Mann, 1986). Localized zones of perched ground water, which are attributed mainly to infiltration from unlined percolation ponds and recharge from the Big Lost River, are present in basalt and sediment overlying the regional aquifer (Rightmire and Lewis, 1987; Pittman and others, 1988).

The ICPP and TRA are underlain by numerous basalt flows, basalt-flow units, and basalt-flow groups to a depth of at least 1,275 ft. A basalt flow is a solidified body of rock that was formed by a lateral, surficial outpouring of molten lava from a vent or fissure (Bates and Jackson, 1980). The term flow is used informally in this report to include a basalt-flow unit, which is a separate, distinct lobe of basalt that was formed by lava issued from the main body of a lava flow (Bates and Jackson, 1980). A basalt-flow group is a sequence of one or more petrographically similar flows or flow units that were formed by lava extruded from the same vent or magma source within the course of a single eruption or multiple eruptions during a relatively short interval of time (Kuntz and others, 1980).

Wells drilled to a depth of 700 ft at the ICPP and TRA penetrate a sequence of basalt-flow groups that ranges in age from about 200,000 to 640,000 years, on the basis of correlation of the flows with those of known age in wells at the RWMC and in wells 80 and NPR TEST near the TRA and ICPP (figs. 1 and 2) (Kuntz and others, 1980; Champion and others, 1981, 1988; Anderson and Lewis, 1989; M.A. Lanphere, U.S. Geological Survey, written commun., 1989). Basalt-flow groups consist of single or multiple flows that were formed during eruptive events of less than 200 years (Kuntz and others, 1980). Individual flows consist mainly of medium- to dark-gray beds of vesicular to dense olivine basalt. Individual flows are as much as 175 ft thick and, in places, are interbedded with cinders and thin layers of sediment.

Basalt-flow groups unconformably overlie older flow groups or are separated from older flow groups by sedimentary interbeds of variable thickness. These interbeds are the result of sediment accumulations on the ancestral land surface during long intervals of volcanic inactivity ranging from thousands to hundreds of thousands of years (Kuntz and others, 1980). Sedimentary interbeds are as much as 50 ft thick and consist of well to poorly sorted deposits of clay, silt, sand, and gravel. In places the interbeds contain cinders and basalt rubble.

Interpreted stratigraphic relations between basalt-flow groups and sedimentary interbeds in the upper 700 ft of the unsaturated zone and aquifer are shown in figures 3-8. Stratigraphic relations below a depth of 700 ft are not evaluated in this report because of insufficient data. Because many wells at the ICPP and TRA are completed in the upper 300 ft of the unsaturated zone, relations in this zone are better defined that those between 300 and 700 ft. Basalt and sediment generally are unsaturated to a depth that ranges from 430 to 480 ft; basalt and sediment penetrated by wells below this depth are saturated and make up the uppermost part of the Snake River Plain aquifer (figs. 3-8). In 1989 and 1990, depth to water ranged from 432 to 479 ft in 35 wells that penetrate the upper 17 to 812 ft of the aquifer. The deepest well, TRA DISP (figs. 2 and 6), may penetrate the effective base of the aquifer at a depth of 1,200 ft below land surface. Perched ground water has been identified in numerous wells in the unsaturated zone at depths ranging from 60 to 376 ft (figs. 3-8). Zones of perched ground water probably occur elsewhere in the area but cannot be determined from water-level measurements in wells.

## STRATIGRAPHY OF THE UNSATURATED ZONE AND UPPERMOST PART OF THE SNAKE RIVER PLAIN AQUIFER

The unsaturated zone and the uppermost part of the Snake River Plain aquifer at the ICPP and TRA consist of about 40 basalt flows from the land surface to a depth of 700 ft. The basalt sequence is interbedded with 15 to 20 sedimentary layers, and is overlain by a veneer of surficial sediment. The basalt flows comprise 23 separate basalt-flow groups that erupted from source vents north, east, south, and west of the area. Seven composite stratigraphic units consisting of multiple basalt flows and sedimentary interbeds of similar age and source are used to describe the geologic relations in the subsurface. The units are bounded by distinct geologic contacts, are present throughout the area, and provide control for stratigraphic correlations.

### Surficial Sediment

Basalt flows at the ICPP and TRA are overlain by a veneer of surficial sediment that is fully penetrated by all 79 wells (figs. 3-9; table 1). In these wells, the base of surficial sediment is at a depth of 2 to 73 ft and ranges in altitude from 4,854 to 4,917 ft. Thickness of surficial sediment ranges from 2 to 73 ft, averages 38 ft, and is greatest south of the TRA and west of the ICPP. In this report, description of the distribution of surficial sediment is considered approximate because it excludes data from auger holes and does not reflect changes in sediment thickness that have occurred from the construction of waste ponds and other manmade features.

## Basalt-Flow Groups and Sedimentary Interbeds

Twenty-three basalt-flow groups consisting of about 40 separate basalt flows underlie the ICPP and TRA to a depth of 700 ft. Each flow group is assigned an informal alphabetical designation of B through I, from youngest to oldest, corresponding to its stratigraphic sequence from the land surface to the uppermost part of the aquifer. Additional flow groups, A and AB, are present in the subsurface in areas adjacent to the ICPP and TRA (Anderson and Lewis, 1989). Flow groups are interbedded with 15 to 20 sedimentary layers that are not named because many consist of multiple layers that cannot be clearly correlated on the basis of geologic data. The interpreted stratigraphic relations between basalt-flow groups and sedimentary interbeds at the ICPP and TRA are shown in figures 3-8.

Basalt-flow groups B, C, D, E, F, and G are equivalent to flow groups B through G described by Kuntz and others (1980) and Anderson and Lewis (1989) at the RWMC about 7 mi southwest of the ICPP (fig. 8). Flow groups FG, H, and I are equivalent to flow groups FG, H, and I identified by Anderson and Lewis (1989) at the RWMC. Flow groups BC, CD, DE2, DE3, DE4, DE5, DE8, F, G, and H are equivalent to basalt-flow groups A through I described by Champion and others (1988) at well NPR TEST, about 3 mi northeast of the ICPP (fig. 8). Flow groups in well NPR TEST have been correlated with flow groups at the RWMC, TRA, and ICPP, and are assigned new informal names on the basis of their relation to flows at the RWMC. Flow groups DE1, DE3-4(W), DE3-4(E), DE5-6, DE6, DE7, and EF are additional flow groups identified during this investigation that are not present in wells at the RWMC or in well NPR TEST.

All flow groups at the ICPP and TRA are named to reflect their stratigraphic relation to previously named flows and sedimentary interbeds at the RWMC (Kuntz and others, 1980; Anderson and Lewis, 1989). Flow groups DE1 through DE8 are intermediate in age between flow groups D and E and are named after the sedimentary interbed that lies between flow groups D and E at the RWMC. Flow groups CD and EF also are named after equivalent-age sedimentary interbeds at the RWMC. Flow groups DE3-4(W) and DE3-4(E) are intermediate in age between flow groups DE3 and DE4 and erupted from source vents northwest of the TRA and east of the ICPP, respectively. Flow groups DE3-4(W) and DE3-4(E) are so named because they are similar in age to flow groups DE3 and DE4 and, in places, are difficult to differentiate from the younger and older flows; flow group DE5-6 is assigned a similar name because of its stratigraphic relation to flow groups DE5 and DE6. Flow group DE1 is a thick basalt-flow group of limited areal extent. Although flow group DE1 occupies a similar depth interval to flow groups C, CD, and D, the latter flows are clearly younger and are named to reflect these age relations.

Basalt-flow groups B through I make up about 85 percent of the upper 700 ft of the subsurface at the ICPP and TRA; the remaining 15 percent of the sequence consists of sediment (figs. 3-8). The average thickness of individual flow groups fully penetrated by wells in the upper 700 ft ranges from 11 ft for flow group C to 56 ft for flow group DE4. The thickness of flow group I ranges from 85 to 271 ft in 17 wells that fully penetrate the unit below a depth of 700 ft. Surface relief of individual flow groups ranges from 34 ft for flow group BC to more than 424 ft for flow group I, which is tilted and folded (figs. 3-8). Only flow groups DE5 and I extend completely across the area; all other flow groups either pinch out or were not deposited in some places as a result of depositional or structural relief on older flow surfaces. Flow groups B through DE8 are in the unsaturated zone throughout most of the area. Flow groups E through I are generally below the water table in the southeastern part of the area and make up the uppermost part of the Snake River Plain aquifer. Flow groups E through I are partly to fully within the unsaturated zone in the northern and western parts of the area.

Ages of basalt-flow groups B through I at the ICPP and TRA were determined by correlating the flows with those of known age in wells at the RWMC and in wells NPR TEST and 80 near the ICPP and TRA (figs. 1 and 2). Ages of flow groups B, C, D, and E at the RWMC (fig. 8) range from about 200,000 to 515,000 years (Kuntz and others, 1980). Flow group F, which is uniquely characterized by reversed paleomagnetic polarity, is assigned an age of about 565,000 years (Champion and others, 1988), on the basis of measurements of the flow in well 77-1 at the RWMC and in well NPR TEST northeast of the ICPP (fig. 8). Other dated flows in well NPR TEST include flow groups

BC, CD, DE2, DE3, DE4, DE5, DE8, G, H, and the uppermost part of I (fig. 8); measured ages of these flows range from about 230,000 to 640,000 years (Champion and others, 1988). Measured ages of flows in well 80 east of the TRA (fig. 3) range from about 420,000 to 640,000 years and agree with ages of flows in the bottom half of well NPR TEST (M.A. Lanphere, U.S. Geological Survey, written commun., 1989). Basalt flows in well 80 include flow groups DE5, DE5-6, DE8, and the uppermost part of I (fig. 3). If the correlations made between the RWMC, wells 80 and NPR TEST, and other wells at the ICPP and TRA are correct (figs. 3-8), the ages of flows assigned to flow groups B through I in the area range from about 200,000 to 640,000 years. The ages of individual flows in any one flow group probably differ by less than 200 years (Kuntz and others, 1980).

Probable ages of flow groups at the ICPP and TRA include:

- flow group B - 95,000±50,000 to 200,000 years
- flow group BC - 233,000±34,000 years
- flow groups C and CD - 233,000±34,000 to 230,000±85,000 years
- flow group D - 230,000±85,000 years
- flow group DE1 - 230,000±85,000 to 350,000±40,000 years
- flow groups DE2 and DE3 - 350,000±40,000 years
- flow groups DE3-4(W), DE3-4(E), and DE4 - 350,000±40,000 to 419,000±33,000 years
- flow group DE5 - 419,000±33,000 to 441,000±77,000 years
- flow group DE5-6 - 461,000±24,000 years
- flow groups DE6 and DE7 - 461,000±24,000 to 491,000±80,000 years
- flow group DE8 - 491,000±80,000 years
- flow group E - 515,000±85,000 years
- flow group EF - 515,000±85,000 to 565,000±14,000 years
- flow group F - 565,000±14,000 years
- flow group FG - 565,000±14,000 to 580,000±93,000 years
- flow groups G and H - 580,000±93,000 years
- flow group I - 641,000±55,000 years

Probable ages of flow groups B, C, D, E, and F are based on potassium-argon ages of basalt cores from wells at the RWMC. Probable ages of flow groups BC, DE2, DE3, DE5, DE5-6, DE8, G, H, and I are based on potassium-argon ages of basalt cores from wells 80 and NPR TEST near the TRA and ICPP. Probable ages of flow groups CD, DE1, DE3-4(W), DE3-4(E), DE4, DE6, DE7, EF, and FG are based on stratigraphic position of the flows with respect to dated flows of younger and older age (Kuntz and others, 1980; Champion and others, 1981, 1988; Anderson and Lewis, 1989; M.A. Lanphere, U.S. Geological Survey, written commun., 1989). However, these ages and the stratigraphic relations they imply will require verification by analysis of basalt cores from wells 121 and 123 at the ICPP and by additional test drilling and evaluation of cores at the TRA.

Stratigraphic relations between individual basalt-flow groups and sedimentary interbeds indicate a complex stratigraphy consisting of thin to thick, continuous to discontinuous flow groups, flows, and sedimentary interbeds at the ICPP and TRA (figs. 3-8). The stratigraphic relations between flow groups C, CD, and D and related sediment at the ICPP and between flow groups DE2, DE3, DE3-4(W), and DE3-4(E) at the TRA are extremely complex, as are those between flow groups E, EF, F, FG, G, and H in the entire area. The locations of many geologic contacts in these intervals are not precisely known and may require verification by additional test drilling and evaluation of basalt cores.

On the basis of geologic data, only 2 of 23 flow groups and the surficial sediment extend completely across the ICPP and TRA in the upper 700 ft of the unsaturated zone and aquifer (figs. 3-8). The remaining 21 flow groups and sedimentary interbeds are absent in some or many wells. Eleven to sixteen flow groups and three to nine sedimentary interbeds can be identified locally in wells that fully penetrate the unsaturated zone. Stratigraphic relations in the uppermost part of the aquifer above the base of flow group I are more uniform. Stratigraphic relations in the lowermost part of the aquifer below the base of flow group I are uncertain. This undifferentiated sequence of basalt and sediment is penetrated by only 17 of the 79 wells in the area and has not been evaluated for stratigraphic properties because of insufficient data. Only one well, TRA DISP (figs. 2 and 6), may penetrate the effective base of the Snake River Plain aquifer at a depth of 1,200 ft below land surface.

## Composite Stratigraphic Units

Composite stratigraphic units consisting of multiple basalt-flow groups and related sedimentary interbeds of similar age and source are used in this report to describe the subsurface stratigraphy of the ICPP and TRA. The units are bounded by distinct geologic contacts that provide control for stratigraphic correlations. Seven composite stratigraphic units have been identified in the upper 700 ft of the unsaturated zone and aquifer. They include flow groups B and BC and related sediment; flow groups C, CD, D, DE1 and related sediment; flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment; flow groups DE4 and DE5 and related sediment; flow groups DE5-6, DE6, DE7, and DE8 and related sediment; flow groups E, EF, F, FG, G, and H and related sediment; and flow group I and related sediment. Composite stratigraphic units are bounded by eight distinct geologic contacts that include the base of the surficial sediment, the base of flow group BC, the combined bases of flow groups DE1 and D, the top of flow group DE4, the base of flow group DE5, the base of flow group DE8, the top of flow group I, and the base of flow group I. Generalized stratigraphic relations based on correlation of these contacts indicate a relatively uniform layering of basalt and sediment sequences of similar age and source across the area, except where deformed north and east of the TRA. The interpreted stratigraphic relations between composite units are shown in figures 9-22 and table 1.

Composite stratigraphic units are dominated by basalt and are nearly horizontal to steeply inclined at the ICPP and TRA (figs. 9-22 and table 1). The average thickness of units below the base of the surficial sediment ranges from 44 ft for flow groups C, CD, D, and DE1 and related sediment to 166 ft for flow group I and related sediment. Average sediment content of units ranges from less than 1 percent for flow group I and related sediment to 27 percent for flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment. Surface relief of composite units ranges from 34 ft for flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment to 424 ft for flow group I and related sediment. All composite stratigraphic units from the land surface to the base of flow group DE5 are in the unsaturated zone; those below the base of flow group DE5 are in the unsaturated zone north and east of the TRA but are partly or completely below the water table elsewhere and make up the uppermost part of the Snake River Plain aquifer.

Flow groups B and BC and related sediment.--Flow groups B and BC and related sediment make up the uppermost composite stratigraphic unit at the ICPP and TRA (figs. 3-8 and 10-12; table 1). Flow group B consists of one to two flows that erupted from vent 5206 (fig. 1) about 3 mi southeast of the RWMC on the Arco volcanic rift zone (Kuntz, 1978; Kuntz and others, 1980; Anderson and Lewis, 1989; Kuntz and others, 1990). Flow group B pinches out south of the ICPP. Flow group BC, which extends across most of the area, consists of two flows from an unidentified source vent on the axial volcanic zone (fig. 1) southeast of the ICPP. A previous correlation of flow group BC with the vent at Mid Butte (fig. 1) southeast of the ICPP (Champion and others, 1988) is doubtful, on the basis of stratigraphic correlations made from natural-gamma logs. The composite unit of flow groups B and BC and related sediment ranges in age from 95,000±50,000 to 233,000±34,000 years, on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies flow groups C, CD, D, and DE1 and related sediment and is overlain by the surficial sediment.

The top of this composite stratigraphic unit, which is penetrated by 74 wells, is at a depth of 2 to 73 ft and ranges in altitude from 4,854 to 4,916 ft (table 1). The base of the unit, which is penetrated by 71 wells, is at a depth of 79 to 133 ft and ranges in altitude from 4,794 to 4,847 ft. On the basis of data from fully penetrating wells, thickness of flow groups B and BC and related sediment ranges from 26 to 109 ft, averages 61 ft, and is greatest south of the ICPP. Sediment content ranges from 0 to 16 percent and averages 2 percent in wells that fully penetrate the unit; the number of sedimentary interbeds in these wells ranges from none to two.

Flow groups C, CD, D, and DE1 and related sediment.--Flow groups C, CD, D, and DE1 and related sediment form a complex composite stratigraphic unit that consists mainly of thick basalt flows at the TRA and thin layers of interbedded basalt and sediment at the ICPP (figs. 3-8 and 12-14; table 1). Flow groups C and D each consist of one flow from unidentified source vents near the RWMC and Arco volcanic rift zone (fig. 1) (Anderson and Lewis, 1989). Flow group CD consists of one flow from an unidentified source vent on the axial volcanic zone (fig. 1) southeast of the ICPP. A previous correlation of flow group CD with vent 5350 (fig. 1) southeast of the ICPP (Champion and others, 1988) is doubtful, on the basis of stratigraphic correlations made from natural-gamma logs. Flow group DE1 consists of one to two flows from an unidentified source vent northwest of the TRA. The composite unit of flow groups C, CD, D, and DE1 and related sediment ranges in age from 233,000±34,000 to 350,000±40,000 years, on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment and is overlain in most places by flow groups B and BC and related sediment. The unit is overlain by surficial sediment in wells 74 and 79 west of the TRA.

The top of this composite stratigraphic unit, which is penetrated by 73 wells, is at a depth of 15 to 133 ft and ranges in altitude from 4,794 to 4,917 ft (table 1). The base of the unit, which is penetrated by 60 wells, is at a depth of 120 to 173 ft and ranges in altitude from 4,765 to 4,799 ft. On the basis of data from fully penetrating wells, thickness of flow groups C, CD, D, and DE1 and related sediment ranges from 17 to 121 ft, averages 44 ft, and is greatest in wells 74 and 79 west of the TRA. Sediment content ranges from 0 to 100 percent and averages 21 percent in wells that fully penetrate the unit; the number of sedimentary interbeds in these wells ranges from none to two.

<u>Flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment.</u>--Flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment form a complex composite stratigraphic unit that consists of thick basalt flows interbedded with thin sedimentary layers at the ICPP and thick sedimentary layers interbedded with thin basalt flows at the TRA (figs. 3-8 and 14-16; table 1). Flow group DE2 consists of one to two flows from an unidentified source vent on the axial volcanic zone (fig. 1) northeast of the ICPP. Flow group DE3 consists of one to two flows from vent 5252 (fig. 1) on the axial volcanic zone southeast of the ICPP (Champion and others, 1988). Flow groups DE2 and DE3 include four flows in well NPR TEST that previously were

correlated with vent 5252 (Champion and others, 1988); however, stratigraphic correlations made from natural-gamma logs indicate that only the lowermost two flows of the sequence in the well are from this source. Flow group DE3-4(W) consists of one flow from an unidentified source vent northwest of the TRA. Flow group DE3-4(E) consists of one to two flows from an unidentified source vent on the axial volcanic zone (fig. 1) east of the ICPP. The composite unit of flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment ranges in age from 350,000±40,000 to 419,000±33,000 years, on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies flow groups DE4 and DE5 and related sediment and is overlain by flow groups C, CD, D, and DE1 and related sediment. Flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment are tilted, folded, and fractured in places.

The top of this composite stratigraphic unit, which is penetrated by 60 wells, is at a depth of 120 to 173 ft and ranges in altitude from 4,765 to 4,799 ft (table 1). The base of the unit, which is penetrated by 52 wells, is at a depth of 176 to 271 ft and ranges in altitude from 4,643 to 4,740 ft. On the basis of data from fully penetrating wells, thickness of flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment ranges from 45 to 130 ft, averages 91 ft, and is greatest southeast of the ICPP. Sediment content ranges from 0 to 90 percent and averages 27 percent in wells that fully penetrate the unit; the number of sedimentary interbeds in these wells ranges from none to four.

Flow groups DE4 and DE5 and related sediment.--Flow groups DE4 and DE5 and related sediment form an extensive composite stratigraphic unit that consists of thick basalt flows interbedded with thin sedimentary layers at the ICPP and TRA (figs. 3-8 and 16-18; table 1). Flow groups DE4 and DE5 each consist of one to three flows from unidentified source vents on the axial volcanic zone (fig. 1) southeast of the ICPP and RWMC. The composite unit of DE4 and DE5 and related sediment ranges in age from 350,000±40,000 to 441,000±77,000 years on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies flow groups DE5-6, DE6, DE7, and DE8 and related sediment and is overlain by flow groups

DE2, DE3, DE3-4(W) and DE3-4(E) and related sediment. Flow groups DE4 and DE5 and related sediment are tilted, folded, and fractured in places.

The top of this composite stratigraphic unit, which is penetrated by 55 wells, is at a depth of 41 to 271 ft and ranges in altitude from 4,643 to 4,876 ft (table 1). The base of the unit, which is penetrated by 53 wells, is at a depth of 54 to 396 ft and ranges in altitude from 4,514 to 4,864 ft. On the basis of data from fully penetrating wells, thickness of flow groups DE4 and DE5 and related sediment ranges from 10 to 158 ft, averages 111 ft, and is greatest southeast of the ICPP. Sediment content ranges from 0 to 20 percent and averages 5 percent in wells that fully penetrate the unit; the number of sedimentary interbeds in these wells ranges from none to two.

Flow groups DE5-6, DE6, DE7, and DE8 and related sediment.--Flow groups DE5-6, DE6, DE7, and DE8 and related sediment form a complex composite stratigraphic unit that consists of thin basalt flows interbedded with thin sedimentary layers at the ICPP and TRA; parts of the unit pinch out north and east of the TRA (figs. 3-8 and 18-20; table 1). Flow group DE5-6 consists of one flow from an unidentified source vent that probably is buried by younger flows and sediment near well 80 east or northeast of the TRA. Flow groups DE6, DE7, and DE8 are from unidentified source vents near the Arco volcanic rift zone (fig. 1) west and northwest of the RWMC; each flow group consists of one to two flows at the ICPP and TRA. The composite unit of flow groups DE5-6, DE6, DE7, and DE8 and related sediment ranges in age from 461,000±24,000 to 491,000±80,000 years, on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies flow groups E, EF, F, FG, G, and H and related sediment and is overlain by flow groups DE4 and DE5 and related sediment. Basalt and sediment of the unit are tilted, folded, and fractured in places.

The top of this composite stratigraphic unit, which is penetrated by 53 wells, is at a depth of 54 to 396 ft and ranges in altitude from 4,514 to 4,864 ft (table 1). The base of the unit, which is penetrated by 51 wells, is at a depth of 160 to 481 ft and ranges in altitude from 4,439 to 4,757 ft. On the basis of data from fully penetrating wells, thickness of flow groups DE5-6, DE6, DE7, and DE8 ranges from 22 to 136 ft, averages 86 ft, and is greatest southwest of the ICPP. Sediment content ranges from 0 to 54 percent and averages 19 percent in wells that fully penetrate the unit; the number of sedimentary interbeds in these wells ranges from none to three.

Flow groups E, EF, F, FG, G, and H and related sediment.--Flow groups E, EF, F, FG, G, and H and related sediment form a wedge-shaped composite stratigraphic unit that consists mainly of thin, discontinuous basalt flows underlain by a widespread sedimentary interbed; the flows and sediment lap against the west, south, and east-sloping surface of flow group I, and parts of the unit pinch out north and east of the TRA and north of the ICPP (figs. 3-8 and 20-22; table 1). Flow groups E and EF each consist of one to two flows from unidentified source vents southeast and northwest of the RWMC, respectively (Anderson and Lewis, 1989). Flow groups F, FG, G, and H each consist of one flow at the ICPP and TRA. Flow groups F and G are from unidentified source vents near the RWMC, flow group FG from an unidentified source northwest of the RWMC, and flow group H from an unidentified vent southeast of the RWMC (Anderson and Lewis, 1989). Source vents of flow groups E through G are on and near the Arco volcanic rift zone (fig. 1); the vent for the reversed polarity flows of flow group F likely is buried by younger flows and sediment near the RWMC. The source vent for flow group H is on the axial volcanic zone (fig. 1). The composite unit of flow groups E through H and related sediment ranges in age from 515,000±85,000 to 580,000±93,000 years on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies flow group I and related sediment and is overlain by flow groups DE5-6, DE6, DE7, and DE8 and related sediment. The lowermost part of the unit includes a widespread sedimentary interbed that overlies flow group I in most wells. Flow groups E through H and related sediment are tilted, folded, and fractured in places.

The top of this composite stratigraphic unit, which is penetrated by 51 wells, is at a depth of 160 to 481 ft and ranges in altitude from 4,439 to 4,757 ft (table 1). The base of the unit, which is penetrated by 35 wells, is at a depth of 178 to 600 ft and ranges in altitude from 4,316 to 4,740 ft. Thickness of flow groups E through H and related sediment ranges from 8 to at least 142 ft, averages more than 80 ft, and is greatest south and southeast of the ICPP where many wells only partially penetrate the unit. Sediment content ranges from 0 to 100 percent and averages 18 percent in wells that fully penetrate the unit; the number of sedimentary interbeds penetrated in these wells ranges from none to two.

Flow group I and related sediment.--Flow group I and related sediment form a massive composite stratigraphic unit that consists mainly of thick basalt flows at the ICPP and TRA (figs. 3-8 and 22; table 1). On the basis of stratigraphic correlations made from natural-gamma logs, these flows underlie all but the northern and extreme southeastern parts of the INEL. Flow group I consists of two or more flows from AEC Butte (fig. 1) immediately north of the TRA (Champion and others, 1988; Anderson and Lewis, 1989; Kuntz and others, 1990). The age of flow group I and related sediment is 641,000±55,000 years, on the basis of correlations between the RWMC, well NPR TEST, and wells at the ICPP and TRA. The unit overlies undifferentiated basalt and sediment and is overlain by flow groups E through H and related sediment. Flow group I and related sediment are tilted, folded, and fractured in places.

The top of this composite stratigraphic unit, which is penetrated by 35 wells, is at a depth of 178 to 600 ft and ranges in altitude from 4,316 to 4,740 ft. The base of the unit, which is penetrated by 17 wells, is at a depth of 645 to 720 ft and ranges in altitude from 4,205 to 4,267 ft. On the basis of data from fully penetrating wells, thickness of flow group I and related sediment ranges from 85 to 271 ft, averages 166 ft, and is greatest near the TRA. Sediment content ranges from 0 to 3 percent and averages less than 1 percent in wells that fully penetrate the unit; the number of sedimentary interbeds in these wells ranges from none to one.

## Stratigraphic and Depositional Relations

Stratigraphic and depositional relations in the unsaturated zone and uppermost part of the aquifer are the result of 23 major cycles of volcanism and sediment deposition during the past 640,000 years. Brief volcanic eruptions from at least 23 different source vents resulted in periodic inundation of the area by basaltic lava flows, ash, and cinders. Intervals of volcanic inactivity were marked by the accumulation of sediment in stream channels, flood plains, playas, and dunes. Although the past 640,000 years were dominated by sedimentary processes, the cumulative depositional volume of basalt was much greater than that of sediment, resulting in a stratigraphic sequence made up largely of basalt.

Figures 3-22 illustrate known and inferred stratigraphic relations in the subsurface of the ICPP and TRA, on the basis of data collected through May 1990. General relations indicate a relatively consistent pattern of alternating basalt flows and sedimentary interbeds with depth, except in the area north and east of the TRA, where the flows and interbeds are deformed. Only flow groups DE5 and I underlie the entire area. Flow groups BC and DE2 through G are widespread throughout the area but are absent in some wells. Flow groups B, C, CD, and D are present mainly at the ICPP, and flow groups DE1 and H are present mainly at the TRA. Numerous flows are absent north and east of the TRA and north of the ICPP as a result of the depositional and structural relief of flow group I. Many flows and related sedimentary interbeds in these areas pinch out against the surface of flow group I, which slopes in all directions away from AEC Butte (fig. 1) and wells 70, 75, and 80 (fig. 2). Flow groups BC through I are present in the subsurface north of AEC Butte, and some of the flows are much thicker north of AEC Butte than at the TRA.

The lavas of flow group I erupted from AEC Butte (fig. 1), a double vent north of the TRA (Kuntz and others, 1990). The lavas flowed away from AEC Butte in all directions and spread throughout all but the northern and extreme southeastern parts of the INEL. The thickest flows of the unit are penetrated by wells at the TRA (figs. 3-8 and table 1). The flows are massively bedded and contain little sediment. On the basis of stratigraphic correlations made from natural-gamma logs, the flows are thicker near their source than any other flows in the upper 1,000 ft of the subsurface at the INEL. Flow group I at the TRA is slightly thicker than flow group B southeast of the RWMC and many times thicker than the flows deposited on and near the INEL during the past 150,000 years. Flow group I was tilted and folded repeatedly by differential subsidence and uplift from about 350,000 to

640,000 years ago. AEC Butte remained elevated with respect to other parts of flow group I during that period providing a base of enormous relief on which younger flows and sediment were deposited. The altitude of the top of flow group I in the area of well EBR-1 (fig. 8) is more than 1,000 ft below the altitude of AEC Butte (fig. 1).

The lavas of flow groups E through H erupted from source vents located on and near the Arco volcanic rift zone (fig. 1). The lavas flowed from northwest through southeast of the RWMC into the ICPP and TRA and lapped against the earliest deformed surface of flow group I (figs. 3-8 and 20-22). The flows were deposited during or following the deformation of flow group I between the Arco volcanic rift zone and AEC Butte. Flow groups E through H later were deformed by younger structural movements. Some of the flows thin and pinch out in the area of wells 70, 75, 80, and 121. Sediment is scarce between the flows, except for a widespread layer of clay and silt between the base of the flows and the top of flow group I.

Flow group DE5-6 likely is from a buried source vent near well 80. The lavas flowed mainly northward from the vent and, therefore, are scarce at the ICPP and TRA; flow group DE5-6 is present only in wells 70, 75, 80, TRA DISP, TRA-1, TRA-2, TRA-3, and TRA-4 at the TRA (figs. 3 and 6). The lavas of flow groups DE6, DE7, and DE8 erupted from multiple source vents near the Arco volcanic rift zone (fig. 1) west and northwest of the RWMC. The lavas of flow groups DE6, DE7, and DE8 flowed into the ICPP and TRA from the southwest, lapped against flow groups E through I, and thinned and pinched out in the area near wells 70, 75, 80, and 121 (figs. 3-8 and 18-20). The lavas were deposited on the deformed surfaces of flow groups E through I and later were deformed by younger structural movements. Sediment, which overlies and underlies flow group DE6 in most places, is abundant in this composite unit.

The lavas of flow groups DE4 and DE5 each erupted from multiple source vents on the axial volcanic zone (fig. 1) southeast of the ICPP and RWMC. The lavas of flow group DE5 flowed northwestward across the ICPP and TRA and buried all older flows and sediment except for AEC Butte. Flow group DE5 and older layers subsequently were tilted and folded and then buried, in places, by the northwest-flowing lavas of flow group DE4 (figs. 3-8 and 16-18). Structural relief was too great to allow deposition of the lavas of flow group DE4 north and east of the TRA. Flow groups DE4 and DE5 were interbedded with thin layers of sediment throughout most of the area.

The lavas of flow groups DE2, DE3, and DE3-4(E) erupted from source vents on the axial volcanic zone (fig. 1) northeast through southeast of the ICPP and flowed westward across the area. The lavas of flow group DE3-4(W) flowed into the ICPP and TRA from a source vent northwest of the TRA. Flow groups DE2, DE3, DE3-4(W) and DE3-4(E) were deposited on the tilted and folded surfaces of flow groups DE4 through I and later were deformed by younger structural movements. Flow groups DE2 through DE3-4(E) thin, pinch out, and are interbedded with abundant sediment near the TRA (figs. 3-8 and 14-16). The thick accumulation of sediment near the TRA may have resulted from the formation of a basalt dam at AEC Butte and subsequent deposition of sediment from the Big Lost River in a playa behind the dam at the TRA. The younger lavas of flow group DE1 later buried the playa and probably forced the channel of the Big Lost River to the east of wells 66 and 84 (figs. 4-6). The altered course of the river likely provided the sediment for interbeds between flow groups C, CD, and D. The present-day channel of the Big Lost River is midway between the ICPP and TRA and east of AEC Butte (fig. 1).

The lavas of flow group DE1 flowed to the western edge of the ICPP from a source vent northwest of the TRA. The lavas of flow groups C and D and those of CD erupted from source vents near the RWMC and on the axial volcanic zone southeast of the ICPP, respectively, and lapped against flow group DE1 (figs. 3-8 and 12-14). Flow group C overlies flow group DE1 in wells 62, 64, and 84 (figs. 3, 5, and 6) but, elsewhere, lies beyond the eastern terminus of the older flow. Flow groups CD and D are confined to the ICPP. Flow groups C, CD, and D are interbedded with numerous sedimentary layers of nearly equal thickness; the sedimentary interbed between flow groups C and D south and southeast of the ICPP is equivalent to interbed CD at the RWMC (Anderson and Lewis, 1989). Flow groups C, CD, and D are highly fractured and filled with sediment from the interbeds.

The lavas of flow group BC erupted from a source vent on the axial volcanic zone southeast of the ICPP and flowed northwestward across the area. The lavas buried all older flows and sediment except for AEC Butte, flow group DE5 in wells 75 and 80, and flow group DE1 in wells 74 and 79 (figs. 3-8). The lavas, which spread beyond the area and accumulated southwest through northwest of the TRA, later were buried by younger flows. The younger lavas of flow group B erupted from vent 5206 on the Arco volcanic rift zone southeast of the RWMC (fig. 1) and spread northeastward to the southern and eastern edge of the ICPP; the lavas may have spread across flow groups BC and DE1 southwest through northwest of the TRA, but additional well data are needed to verify this probable relation. Flow groups B and BC are separated by a sedimentary interbed and overlain by 2 to 73 ft of surficial sediment. The interbeds above and below flow group BC south and southeast of the ICPP are equivalent to interbed BC at the RWMC (Anderson and Lewis, 1989).

The stratigraphic relations between flow groups B through I (figs. 3-22) are a common characteristic of basalt flows on the INEL and eastern Snake River Plain. The complex relations are a consequence of depositional overlap of flows caused by changes in basalt source areas through time. The lavas of flow groups DE5 and I spread across the entire ICPP and TRA. Most other lavas, such as those of flow groups BC and DE4, were restricted in their areal extent by depositional or structural relief on older surfaces, and the lavas flowed around the older surfaces into adjacent areas. Some lavas, such as those that formed flow groups B and DE1, merely flowed to the edge of the area and cooled. Each eruptive event was rapid compared with the time between earlier and later eruptions, and each flow hiatus was accompanied by a slow to rapid accumulation of sediment on older flow surfaces and sedimentary layers. Some areas beyond the reach of recurrent basalt eruptions accumulated abundant sediment for long periods of time. Conversely, areas inundated by repeated eruptions over a short period of time accumulated little sediment. In general, those areas most distant from basalt source vents were covered by abundant sediment, and those nearest the vents were covered by thick sequences of basalt. However, these relations are not true everywhere because the depositional relations between basalt flows and sedimentary interbeds also were affected by structural deformation. The most significant effect on the stratigraphic relations at the ICPP and TRA, disregarding structural deformation, was the distribution of basalt source vents. The eruption of flow group I from AEC Butte (fig. 1) was centered near the TRA and produced a remarkably thick sequence of flows throughout the area. Most other eruptions were concentrated on the Arco volcanic rift zone and axial volcanic zone 10 to 30 mi away from AEC Butte (fig. 1), and these lavas lapped against the tilted and folded surfaces of flow group I and other older flows. As a result, most of the basalt flows penetrated by wells above flow group I at the ICPP and TRA are medial to distal parts of flows that traveled long distances to reach their present location. These flows, which likely are more fractured and broken than they are near their source, may provide numerous potential pathways for the movement of water through the unsaturated zone and aquifer.

The stratigraphic and depositional relations presented in this report are uncertain, in places, because not enough test holes have been drilled nor cores evaluated to ensure the validity of all interpreted stratigraphic correlations between the ICPP, TRA, and RWMC. However, the combined data provided by numerous geophysical and lithologic logs from throughout the area and cores from the RWMC and from wells 80, 81, and NPR TEST allowed many correlations to be made with reasonable certainty. For example, flow group F is uniquely characterized by reversed paleomagnetic polarity and high emission of natural-gamma radiation compared with other flow groups (Anderson and Lewis, 1989). Flow group F, which is assigned to the Big Lost Reversed Polarity Subchronozone and Subchron (Champion and others, 1988), is present in cores from the RWMC and from well NPR TEST 10 mi northeast of the RWMC and 3 mi northeast of the ICPP. Flow group F, which was correlated from well to well at the ICPP and TRA on the basis of its distinctive natural gamma-log signature, provided stratigraphic control near the base of the unsaturated zone and uppermost part of the aquifer. Stratigraphic control elsewhere in the sequence was provided by distinct changes in natural-gamma radiation across the contacts of each of the seven composite stratigraphic units in the area.

Additional data from cores and surface flows will be required to verify the stratigraphic and depositional relations presented in this report. A determination of geologic ages, paleomagnetic properties, petrographic characteristics, and chemical composition of basalt flows in cores from wells 121 and 123 would greatly improve the interpretations of stratigraphic and depositional relations at the ICPP between wells 80 and NPR TEST (figs. 3-8). Additional test drilling and evaluation of cores at the TRA would provide quantitative data needed to ensure the validity of interpreted stratigraphic and depositional relations throughout the ICPP, TRA, RWMC, and adjacent areas.

## Structural Implications

Flow groups DE2 through I and related sediment are tilted and folded on the basis of interpreted stratigraphic relations between the ICPP, TRA, and RWMC (figs. 3-8 and 14-22). Deformation resulted from simultaneous subsidence and uplift distributed across areas of tens to hundreds of square miles. Subsidence was accompanied by basaltic volcanism and generally was greatest near clustered source vents of similar age. Uplift probably was related to the intrusion and doming of rhyolitic magmas beneath previously deposited basalt flows and sedimentary layers. Localized differential structural movements related to subsidence and uplift probably fractured older flows and sediment in places; some lavas extruded during deformation likely ponded in structural depressions that reached depths of several hundred feet (Anderson, 1990). Deformation and volcanism were episodic and shifted from place to place for irregular periods of time. Older structural features were modified by younger deformation and eventually were buried by basalt and sediment.

Stratigraphic relations between the ICPP, TRA, and RWMC indicate that this area was affected by three major periods of structural deformation from about 350,000 to 580,000 years ago (figs. 1-8 and 14-22). Each period of deformation was characterized by regional subsidence, localized uplift, and multiple eruptions of basalt. The first period of deformation occurred during the eruptions of flow groups E, EF, F, FG, G, and H from about 515,000 to 580,000 years ago. Subsidence and basalt eruptions were centered on and near the Arco volcanic rift zone northwest through southeast of the RWMC and coincided with uplift between the EBR-1 (Experimental Breeder Reactor-1) and NRF (Naval Reactors Facility) (fig. 1). The second period of deformation occurred during the eruptions of flow groups DE5-6, DE6, DE7, and DE8 from about 460,000 to 490,000 years ago. Subsidence and basalt eruptions were centered mainly on and near the Arco volcanic rift zone west through northwest of the RWMC and coincided with renewed uplift between the EBR-1 and NRF. The third period of deformation occurred during the eruptions of flow groups DE2, DE3, DE3-4(W), DE3-4(E), DE4, and DE5 from about 350,000 to 440,000 years ago. Subsidence and basalt eruptions were centered mainly on and near the axial volcanic zone southeast through northeast of the ICPP and coincided with a third uplift immediately north and east of the TRA near AEC Butte and well 80 (figs. 1 and 2).

Flow groups DE2 through I and related sediment were tilted, folded, and locally fractured by repeated subsidence and uplift during eruptions of the flows from about 350,000 to 580,000 years ago; flow groups E through I north of the RWMC and flow groups DE5 through I north and east of the TRA may have been displaced by faulting (figs. 3-8). Subsidence and uplift modified older structural and depositional features and controlled the distribution and thickness of younger basalt flows and sedimentary interbeds. Thick sequences of basalt and sediment accumulated in structural depressions formed by subsidence. Flows and sediment thinned and pinched out in areas of uplift. Maximum uplift and subsidence occurred near well 80 and AEC Butte and near well EBR-1, respectively, on the basis of interpreted relief on the top of flow group I (figs. 1-8 and 22). AEC Butte, which is the source of flow group I, lies at the land surface north of the TRA (fig. 1). The top of flow group I is penetrated by well 80 at a depth of about 200 ft below land surface (fig. 3). Flow group I is not penetrated by well EBR-1, which is completed to a depth of 1,075 ft below land surface (fig. 8). Relief of flow group I is about 1,000 ft between AEC Butte and well EBR-1, on the basis of estimated depth of flow group I beneath well EBR-1.

AEC Butte has remained elevated with respect to adjacent areas since the eruption of flow group I (figs. 1 and 3-8). The altitudes of the top and base of flow group I are lowest in an arcuate depression that extends from well EBR-1 northeast of the RWMC through wells EOCR and SPERT IV southeast of the ICPP to wells SG5T and INEL-1 south and southeast of the NRF, respectively (figs. 1 and 8). Relief on the top of flow group I averages about 940 ft between AEC Butte and the depression. Flow groups DE5 through I are faulted or dip steeply into the subsurface near AEC Butte and well 80 north and east of the TRA (fig. 3). Flow groups DE2 through I dip gently to steeply away from this area toward the depression south, east, and north of the TRA and ICPP (fig. 8). The dip and thickness of numerous basalt flows and sedimentary interbeds increase near the depression in all areas. The top and base of flow group I have the steepest dip, but the flows thin toward the depression. These relations are attributed to subsidence and uplift across a deeply buried composite rhyolite dome of large extent centered beneath AEC Butte. Evidence for subsidence and uplift is based on the interpreted deformation of basalt flows to a depth of 1,000 ft below land surface in the area. A buried rhyolite dome is postulated as the cause of uplift because the style of deformation is consistent with that observed near other rhyolite domes on the eastern Snake River Plain (Kuntz and Dalrymple, 1979; Spear and King, 1982; Kellogg and Embree, 1986). However, if this interpretation is correct, the dome lies more than 1,275 ft below land surface at the TRA because it is not penetrated by well TRA DISP (fig. 6). This well is the deepest well adjacent to AEC Butte, which is near the probable center of uplift (figs. 1-8).

The depression at well EBR-1 (fig. 8) was formed by repeated subsidence of unknown magnitude centered initially near the Arco volcanic rift zone and later in the area of north of the RWMC (fig. 1). About 400 ft of differential subsidence occurred between the RWMC and the depression during the eruptions of flow groups DE2 through DE8 from about 350,000 to 490,000 years ago (fig. 8). This subsidence coincided, in part, with uplift between the EBR-1 and NRF (fig. 1) and with a 285,000-year long depositional hiatus between flow groups D and E at the RWMC (Kuntz and others, 1980). The elevated positions of AEC Butte and flow group I in well 80 (figs. 1-3) are attributed to three separate uplifts coincident with subsidence in the depression near well EBR-1 and elsewhere. Two uplifts of unknown magnitude occurred in a 50-$mi^2$ area between AEC Butte and wells EBR-1, EOCR, SPERT IV, SG5T, and INEL-1 (fig. 1) during the eruptions of flow groups DE6 through H from about 460,000 to 580,000 years ago. A third uplift of much smaller extent occurred near well 80 and AEC Butte (fig. 3) during the eruptions of flow groups DE2 through DE4 from about 350,000 to 420,000 years ago. About 150 to 300 ft of differential uplift occurred between well 80 and other wells at the TRA, ICPP, and RWMC, on the basis of interpreted stratigraphic relations between flow groups DE5 and E in wells 80, TRA-3, 121, and 77-1 (figs. 1-8).

Preliminary stratigraphic correlations near four other rhyolite domes indicate a similar geologic history elsewhere on and near the INEL. Big Southern Butte, Middle Butte, East Butte, and an unnamed rhyolite dome between Middle and East Buttes (fig. 1) lie 10 to 15 mi south and southeast of the ICPP and TRA (Kuntz and others, 1990). Big Southern and Middle Buttes are capped by deformed basalt flows, and Middle and East Buttes may intrude the older unnamed rhyolite dome that lies between them. Ages of Big Southern, Middle, and East Buttes range from about 300,000 to 580,000 years; the unnamed rhyolite dome between Middle and East Buttes has a measured age of about 1.4 million years (Kuntz and others, 1990). A thick latite flow from Cedar Butte (fig. 1) also lies to the east of Big Southern Butte (Kuntz and others, 1990) and is interbedded between basalt-flow groups DE5 and DE6. The probable dome beneath the ICPP and TRA and the combined eruptions of Cedar, Big Southern, Middle, and East Buttes indicate that silicic volcanism was widespread throughout the southern half of the INEL from about 300,000 to 580,000 years ago. Silicic volcanism and uplift of rhyolite domes occurred in many areas of the INEL coincident with the eruption of basalt magmas and regional subsidence. The complex structural relations at the ICPP and TRA likely are a result of these differing and overlapping magmatic and structural processes.

Although the structural interpretations presented in this report are considered the most likely, other alternative interpretations can be made from the data. For example, a surface flow that overlies the flows assigned to flow groups B and BC in the subsurface immediately west of the TRA has a measured age of about 520,000 years at its source (Kuntz and others, 1990). The age of this surface flow was disregarded in favor of a younger stratigraphic age of about 200,000 years, on the basis of its position relative to flow groups B and BC. However, if the flows assigned to flow groups B and BC are correlated incorrectly and are older than 520,000 years, these and older flows may be tilted, folded, or faulted between the TRA and well NPR TEST rather than between well 80 and the TRA, as indicated in this report. These and other conflicting stratigraphic and structural interpretations can be resolved only by additional test drilling and evaluation of basalt cores and surface flows.

Further investigation of past structural deformation at the ICPP and TRA and elsewhere at the INEL is needed because regional subsurface stratigraphic correlations indicate a probable relation between present-day topographic relief and structural deformation of an age younger than about 230,000 years. The area between the axial volcanic zone and the Lost River and Lemhi Ranges (fig. 1) subsided about 400 ft during the last 230,000 years as indicated by preliminary correlations of basalt-flow group BC and younger flows. If this interpretation is correct, there is a potential for future structural deformation and volcanism at the ICPP and TRA and elsewhere at the INEL. Subsidence and uplift accompanied by basaltic and rhyolitic volcanism and tilting, folding, and fracturing of basalt and sediment have occurred repeatedly throughout the past 640,000 years at the INEL on the basis of interpreted stratigraphic relations.

## Hydrologic Implications

Stratigraphic, depositional, and structural relations in the unsaturated zone ultimately may affect the potential for migration of radioactive and chemical waste from the ICPP and TRA to the Snake River Plain aquifer. Although relatively impermeable, basalt flows contain numerous fractures, in places, that may provide unrestricted avenues for vertical and horizontal flow of contaminated water. Sedimentary interbeds may facilitate or retard vertical flow depending on grain size and sorting characteristics. Lateral flow and perching of water may take place along some clay and silt interbeds, and discontinuous interbeds may divert flow toward underlying or adjacent basalt flows. Lateral flow and perching of water is most likely in the zone from 100 to 200 ft where clay and silt within sedimentary interbeds and basalt fractures are abundant (figs. 3-8); flow within the zone may be diverted along bedding surfaces until it reaches open vertical fractures or wells open to deeper parts of the unsaturated zone and aquifer.

Vertical fractures related to differential structural movements may cut many basalt flows and sedimentary interbeds, especially in the area affected by uplift immediately north and east of the TRA (fig. 3). Where these fractures exist, they may provide unrestricted avenues for vertical flow of contaminated water through the unsaturated zone to the aquifer, and also may cause increased permeability in and near the fractures below the water table. Basalt and sediment probably are fractured, in places, from differential uplift between AEC Butte and wells EBR-1, EOCR, SPERT IV, SG5T, and INEL-1 (figs. 1 and 8). These fractures, which likely consist of radial and concentric segments, may provide preferential pathways for ground-water flow and movement of waste between the ICPP and TRA and the structural depression penetrated by wells EBR-1, EOCR, and SPERT IV (figs. 1 and 8).

Waste that reaches the aquifer where basalt and sediment are not fractured may accumulate between the water table and the top of flow group I. In these areas, the potential for ground-water flow through the massively bedded flows of flow group I is much less than that through the overlying thinly bedded layers of flow groups DE8, E, EF, F, FG, G, and H and related sediment. Mixing of ground water between the water table and the top of flow group I also may be greatly restricted by a widespread layer of clay and silt that overlies the top of flow group I in most places (figs. 3-8).

Additional evaluation of basalt and sediment characteristics is needed to determine the potential for migration of radioactive and chemical waste through the unsaturated zone and Snake River Plain aquifer at the ICPP and TRA. Factors that need further evaluation include: the lithology and distribution of individual basalt flows; the distribution and characterization of individual flow contacts, fractures, and vesicles; the lithology of sedimentary interbeds; and the distribution of basalt and sediment hydraulic properties. Determination of hydraulic properties by direct measurement and extrapolation of properties by indirect methods need to coincide with observed stratigraphic boundaries because log signatures of induced gamma radiation indicate numerous, layer-dependent density differences with depth.

Additional deep test wells will be needed to evaluate characteristics that may affect the movement of radioactive and chemical waste in the lowermost part of the Snake River Plain aquifer. Geologic data from well TRA DISP (figs. 2 and 6) suggest that the effective base of the aquifer is at a depth of 1,200 ft below land surface at the TRA. If this interpretation is correct, additional deep test wells completed to depths of at least 1,200 ft will be needed to evaluate characteristics in the lowermost part of the aquifer at the ICPP and TRA.

## SUMMARY AND CONCLUSIONS

Wells drilled to 700 ft at the ICPP and TRA penetrate a complex sequence of basalt flows and sedimentary interbeds that range in age from about 200,000 to 640,000 years. Twenty-three basalt-flow groups consisting of about 40 separate lava flows and flow units make up this sequence. Each flow group is made up of one to three petrographically similar flows that erupted from related source areas during periods of less than 200 years. Fifteen to twenty major sedimentary interbeds in the sequence consist of fluvial, lacustrine, and eolian deposits of clay, silt, sand, and gravel that accumulated during periods of volcanic inactivity ranging from thousands to hundreds of thousands of years. Multiple flow groups and sedimentary interbeds of similar age and source form seven composite stratigraphic units with distinct upper and lower contacts. Composite units older than about 350,000 years were tilted, folded, and fractured by differential subsidence and uplift. Basalt and sediment of this sequence are unsaturated to a depth that ranges from 430 to 480 ft below land surface. Basalt and sediment in the lower part of the sequence are saturated and make up the uppermost part of the Snake River Plain aquifer. Stratigraphic relations in the lowermost part of the aquifer below the base of flow group I are uncertain. This undifferentiated sequence of basalt and sediment is penetrated by only 17 of the 79 wells in the area and has not been evaluated for stratigraphic properties because of insufficient data. Only one well, TRA DISP, may penetrate the effective base of the aquifer at a depth of 1,200 ft below land surface.

The areal extent of flow groups and sedimentary interbeds was determined from geophysical logs, lithologic logs, and well cores. Basalt flows in the cores were evaluated for potassium-argon ages, paleomagnetic properties, and petrographic characteristics, Natural-gamma logs were used as a primary tool for stratigraphic correlations. Natural-gamma emissions generally are uniform in related, petrographically similar flows and generally increase or decrease between petrographically dissimilar flows of different age and source. Stratigraphic control was provided by flow group F, which is uniquely characterized by reversed paleomagnetic polarity and high emission of natural-gamma radiation compared to other flows. Additional control was provided by distinct changes in natural-gamma radiation across the contacts of each of the seven composite stratigraphic units.

Results of this investigation indicate a need for additional geologic data. Additional cores evaluated for geologic ages, paleomagnetic properties, petrographic characteristics, and chemical composition are needed to verify stratigraphic relations in the unsaturated zone and uppermost part of the aquifer. Verification of structural interpretations will require similar data from selected basalt outcrops in areas adjacent to the ICPP and TRA. Determination of stratigraphic relations in the lowermost part of the aquifer will require additional test holes to a depth of at least 1,200 ft below land surface. Positive identification of additional basalt flows in cores and outcrops will improve interpretations of stratigraphic relations at the ICPP and TRA and elsewhere on the INEL and eastern Snake River Plain.

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## EXPLANATION

C BASALT — Basalt-flow group composed of one or more related flows. Letter, C, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between basalt-flow groups. Locally includes cinders and basalt rubble.

GEOLOGIC CONTACT — Queried where uncertain

70 / 772 WELL — Entry, 70, is local well identifier. Dashed line indicates measured or estimated water level in aquifer in 1990. Lower arrow indicates measured water level in aquifer in 1989 or 1990. Upper arrow indicates measured water level of perched ground water in 1989 or 1990. Number 772, at bottom of well is total depth of well in feet below land surface

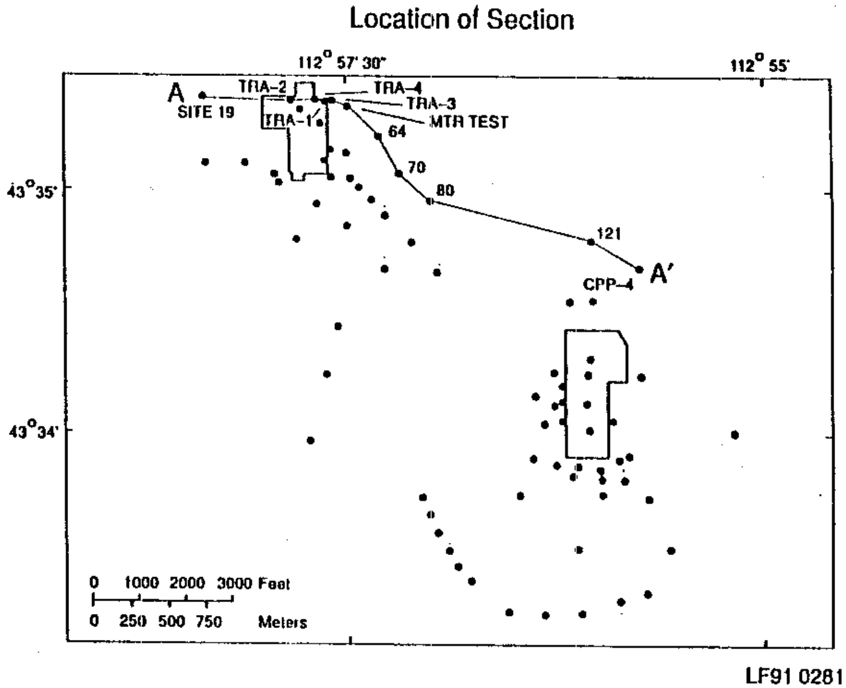



Figure 3.--Geologic section A-A' at the Idaho Chemical Processing Plant and Test Reactors Area.

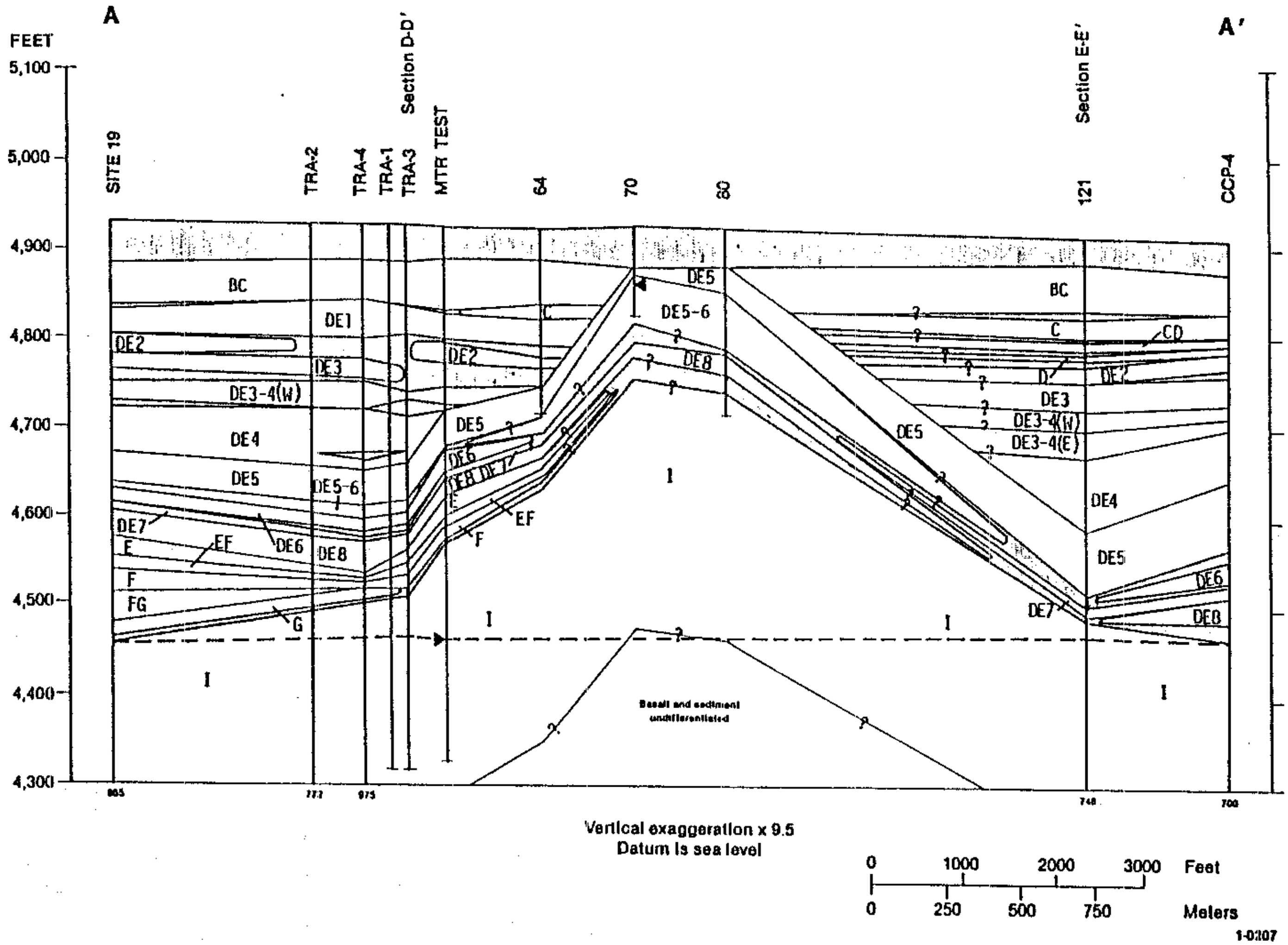



Figure 3.--Geologic section A-A' at the Idaho Chemical Processing Plant and Test Reactors Area.--Continued

EXPLANATION

B BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between basalt-flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

66 / 676 WELL — Entry, 66, is local well identifier. Dashed line indicates measured or estimated water level in aquifer in 1990. Lower arrow indicates measured water level in aquifer in 1989 or 1990. Upper arrow indicates measured water level of perched ground water in 1989 or 1990. Number, 676, at bottom of well is total depth of well in feet below land surface

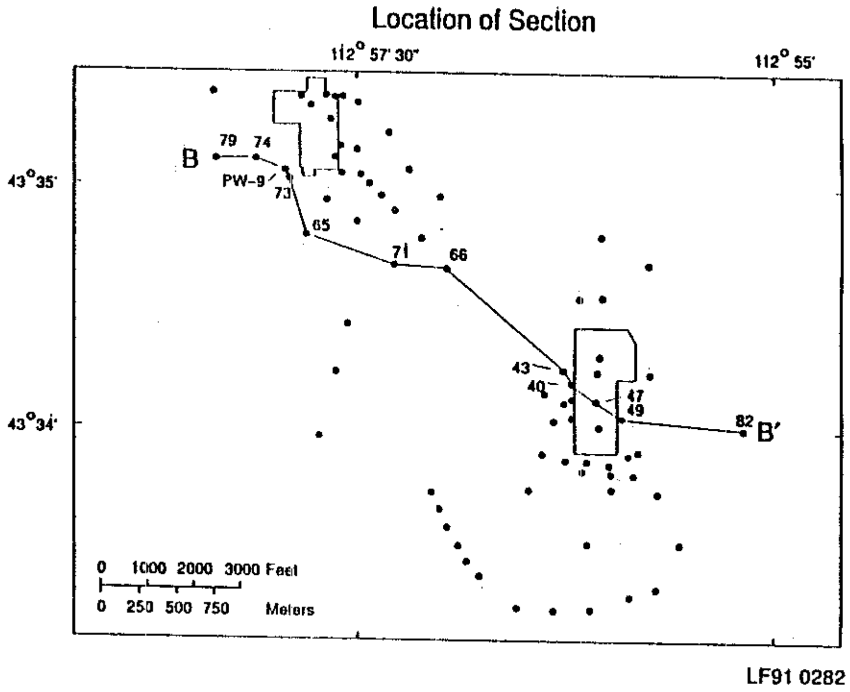



Figure 4.--Geologic section B-B' at the Idaho Chemical Processing Plant and Test Reactors Area.

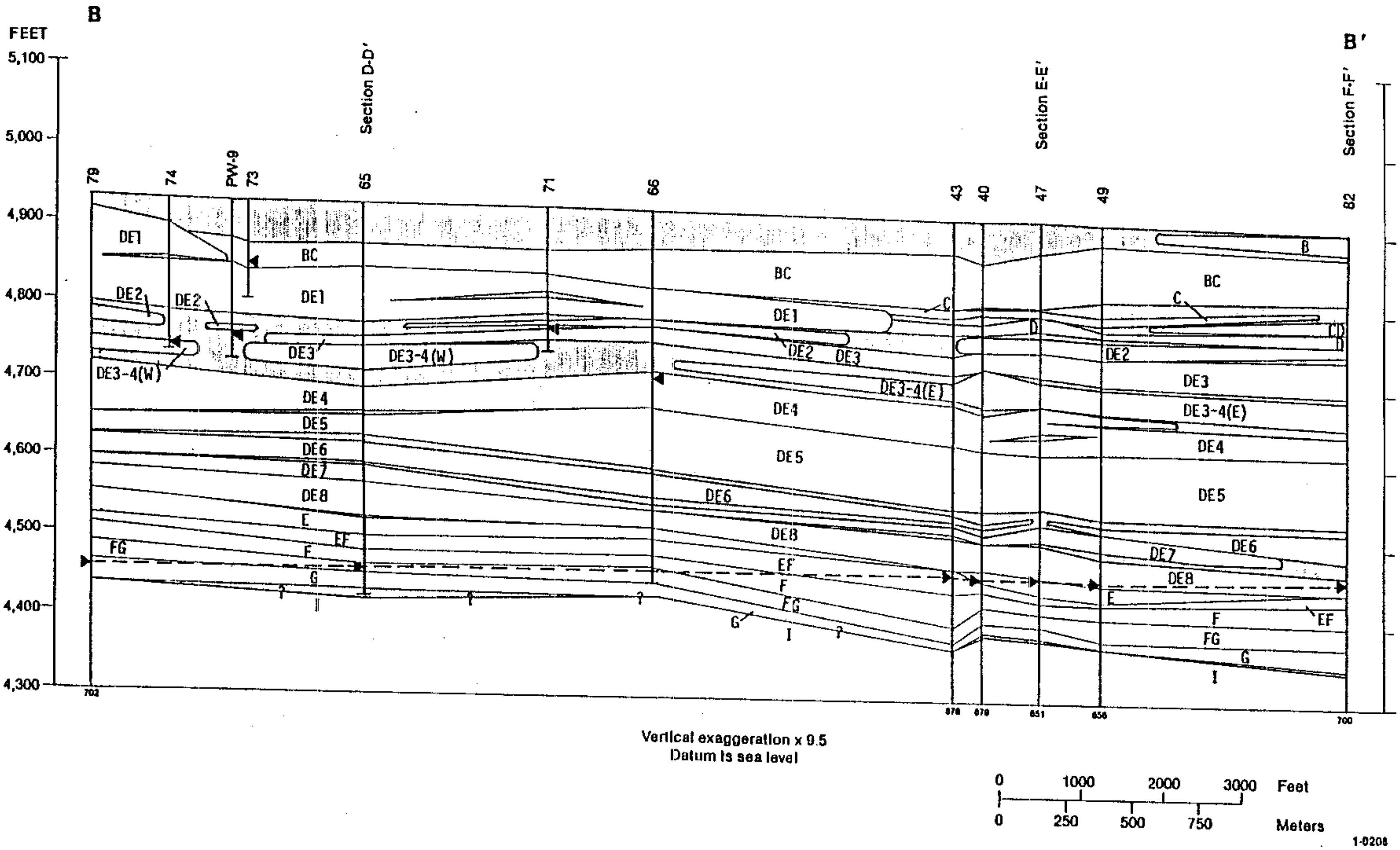



Figure 4.--Geologic section B-B' at the Idaho Chemical Processing Plant and Test Reactors Area.--Continued

EXPLANATION

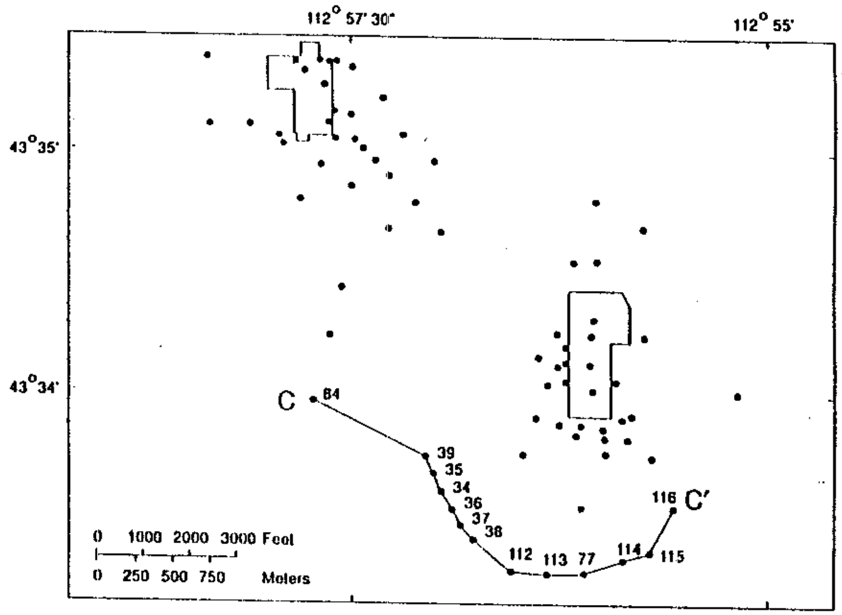
B — BASALT — Basalt–flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between basalt–flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

38 / 729 — WELL — Entry, 38, is local well identifier. Dashed line indicates measured or estimated water level in aquifer in 1990. Lower arrow indicates measured water level in aquifer in 1989 or 1990. Upper arrow indicates measured water level of perched ground water in 1989 or 1990. Number 729, at bottom of well is total depth of well in feet below land surface

Location of Section




LF91 0283

Figure 5.--Geologic section C-C' at the Idaho Chemical Processing Plant and Test Reactors Area.

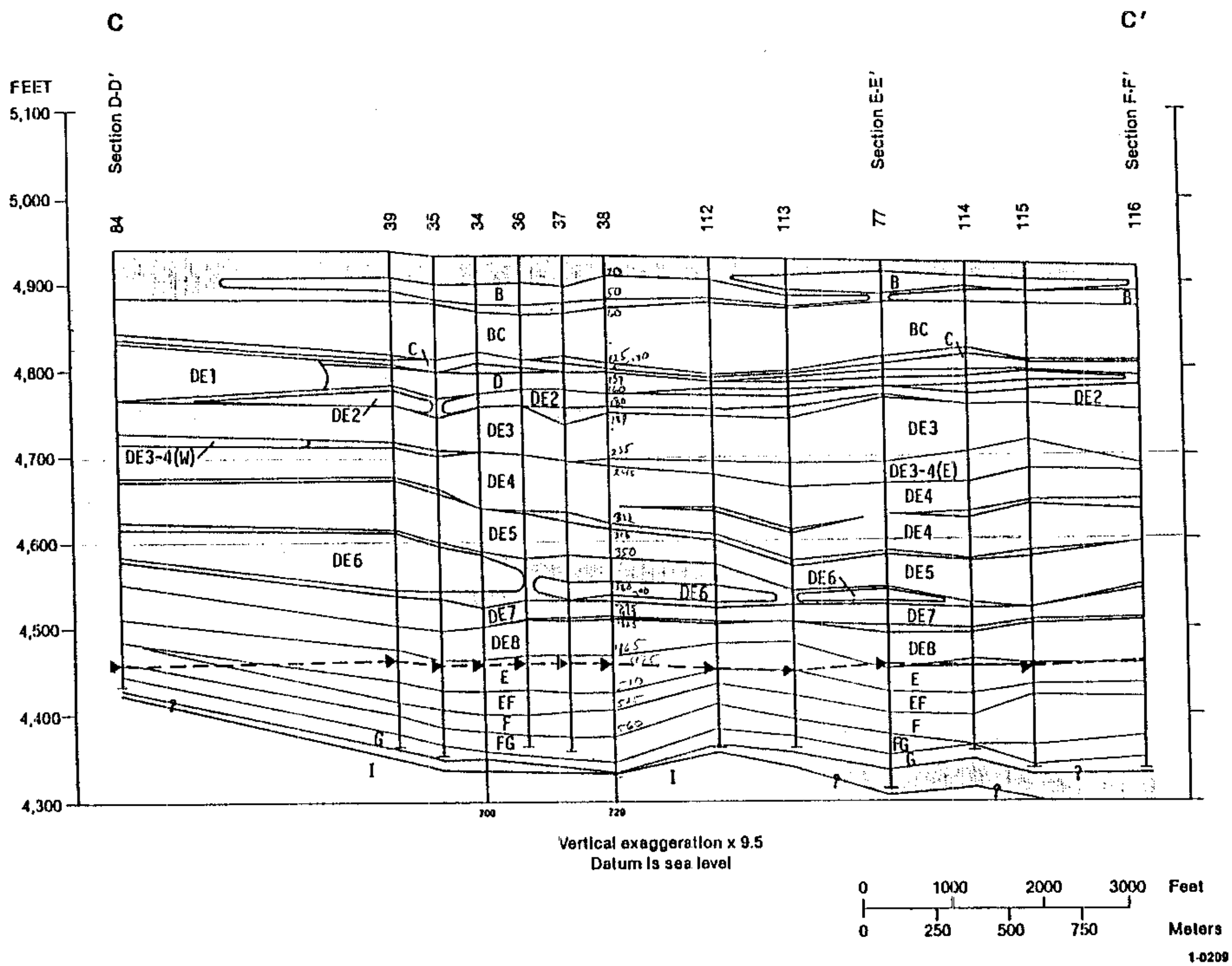
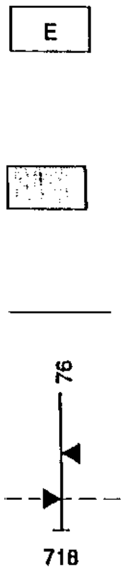



Figure 5.--Geologic section C-C' at the Idaho Chemical Processing Plant and Test Reactors Area.--Continued

EXPLANATION




BASALT — Basalt-flow group composed of one or more related flows. Letter, E, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between basalt-flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

WELL — Entry, 76, is local well identifier. Dashed line indicates measured or estimated water level in aquifer in 1990. Lower arrow indicates measured water level in aquifer in 1989 or 1990. Upper arrow indicates measured water level of perched ground water in 1989 or 1990. Number, 718, at bottom of well is total depth of well in feet below land surface

Location of Section

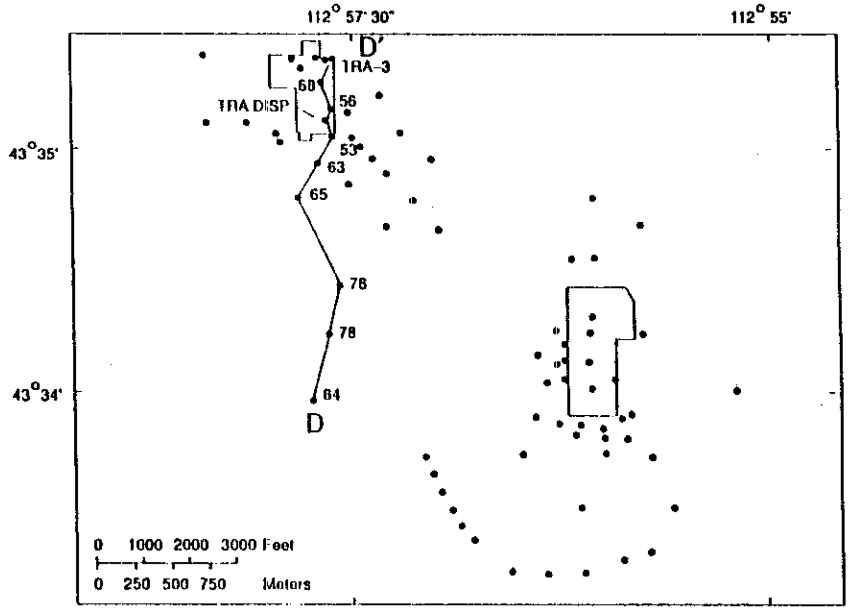



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Figure 6.--Geologic section D-D' at the Idaho Chemical Processing Plant and Test Reactors Area.

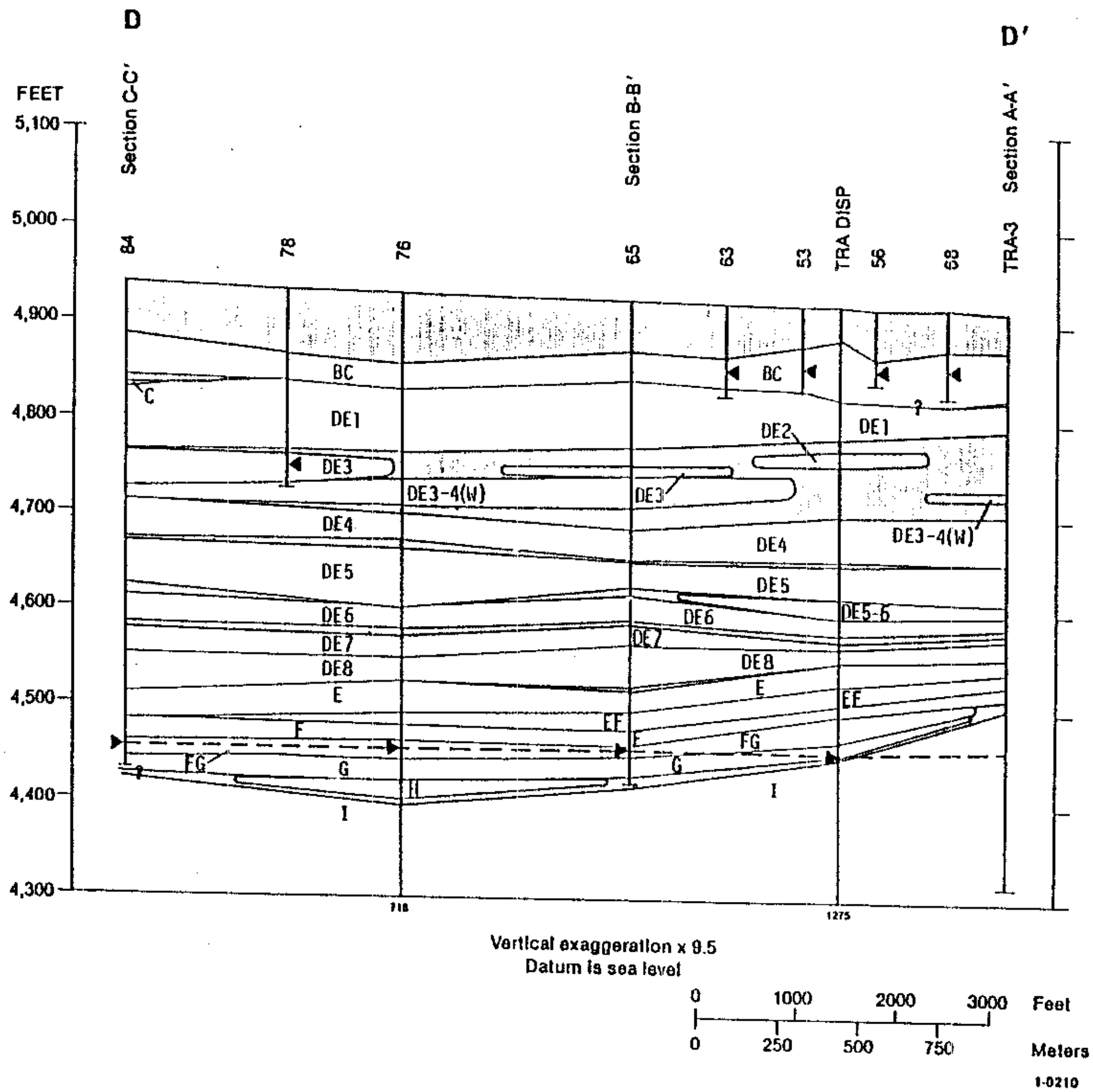


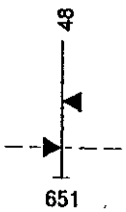

Figure 6.--Geologic section D-D′ at the Idaho Chemical Processing Plant and Test Reactors Area.--Continued

EXPLANATION

B — BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between basalt-flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain




WELL — Entry, 48, is local well identifier. Dashed line indicates measured or estimated water level in aquifer in 1990. Lower arrow indicates measured water level in aquifer in 1989 or 1990. Upper arrow indicates measured water level of perched ground water in 1989 or 1990. Number 651, at bottom of well is total depth of well in feet below land surface

Location of Section

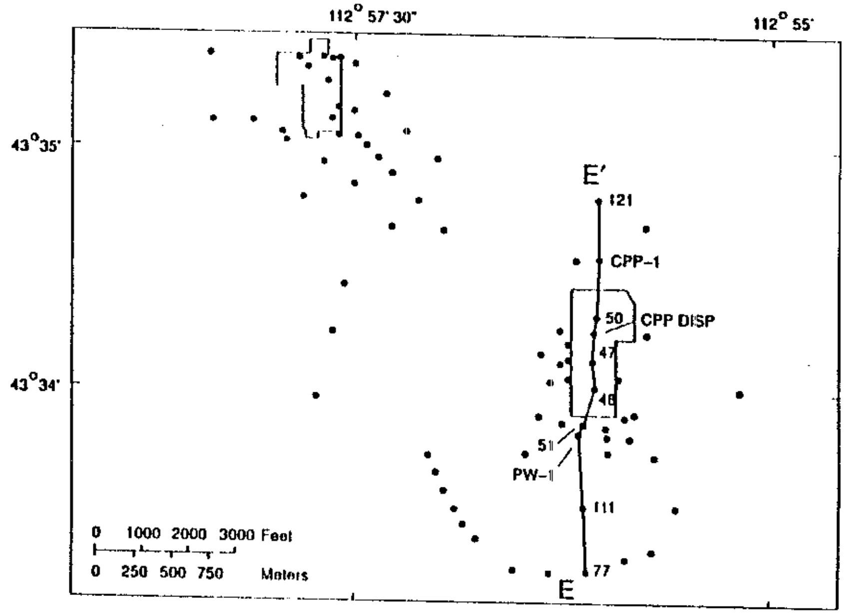



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Figure 7. Geologic section E-E' at the Idaho Chemical Processing Plant and Test Reactors Area.

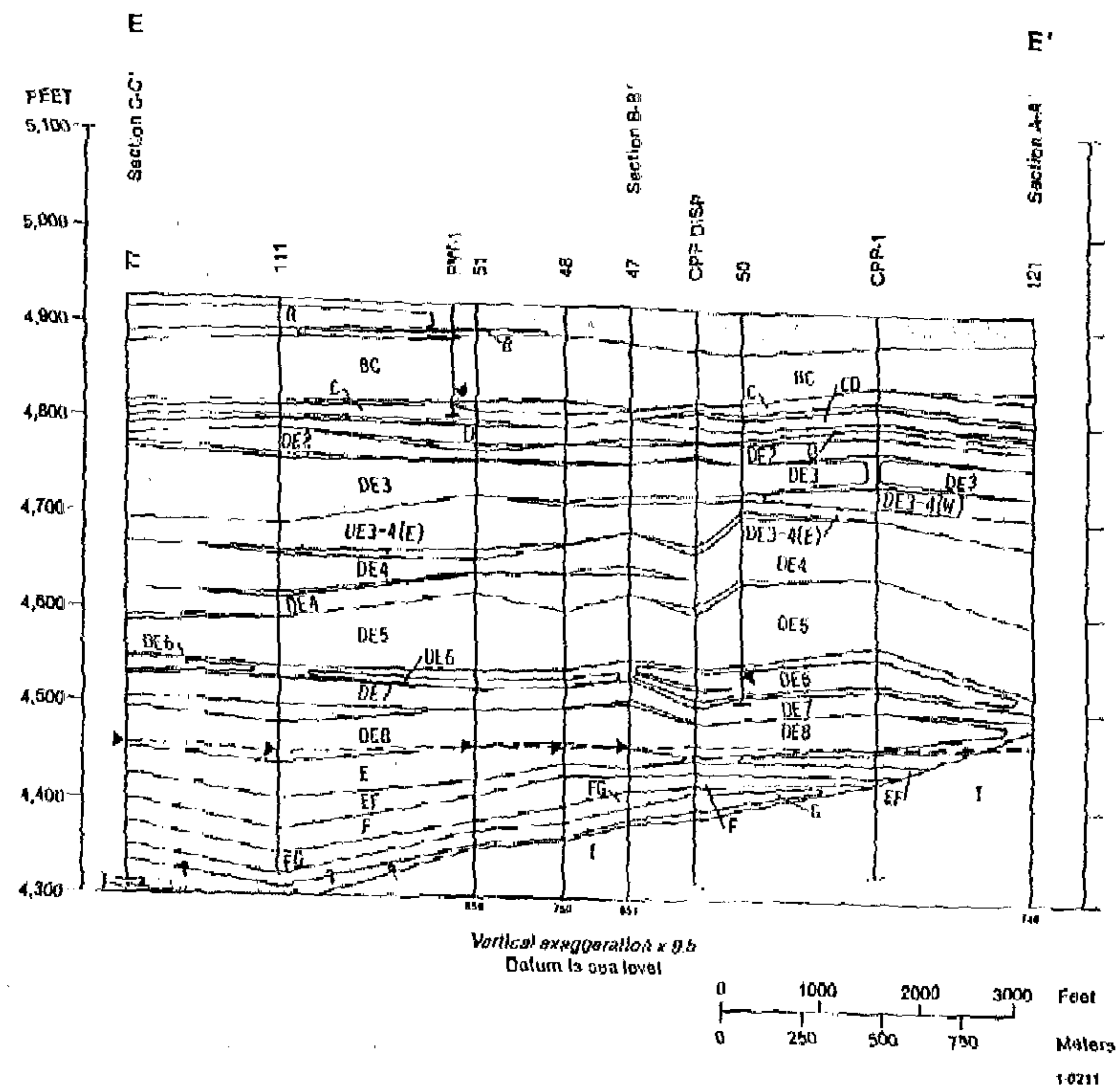



Figure 7. Geologic section E-E' at the Idaho Chemical Processing Plant and Test Reactors Area.--Continued

EXPLANATION

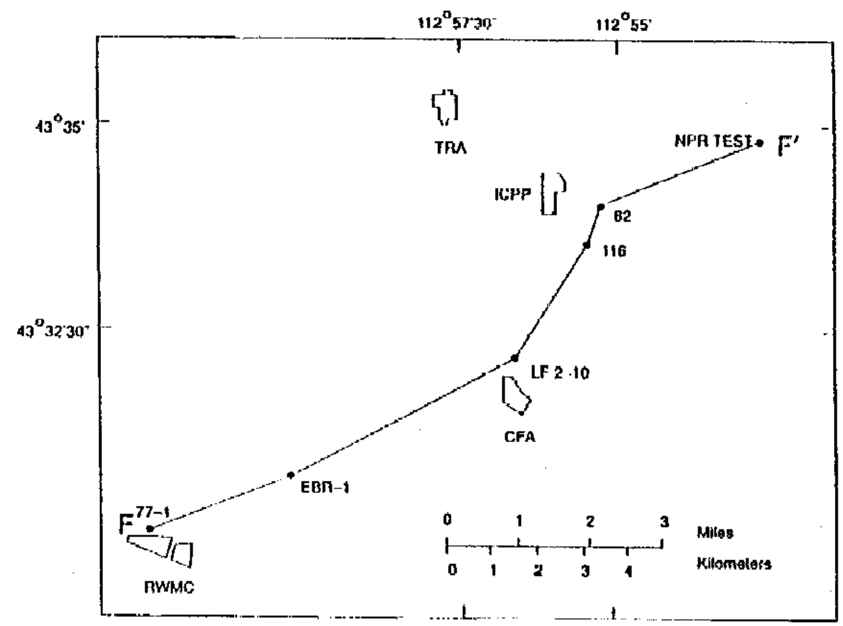
B — BASALT — Basalt-flow group composed of one or more related flows. Letter, B, indicates sequence of group from top to bottom of section. Locally includes cinders and thin layers of sediment

CLAY, SILT, SAND, AND GRAVEL — Major sedimentary interbed between basalt-flow groups. Locally includes cinders and basalt rubble

GEOLOGIC CONTACT — Queried where uncertain

82 / 820 — WELL — Entry, 82, is local well identifier. Dashed line indicates measured or estimated water level in aquifer in 1990. Lower arrow indicates measured water level in aquifer in 1989 or 1990. Upper arrow indicates measured water level of perched ground water in 1989 or 1990. Number 820, at bottom of well is total depth of well in feet below land surface.

Location of Section




LF91 0286

Figure 8.--Geologic section F-F' through the Radioactive Waste Management Complex, the Idaho Chemical Processing Plant, and well NPR TEST.

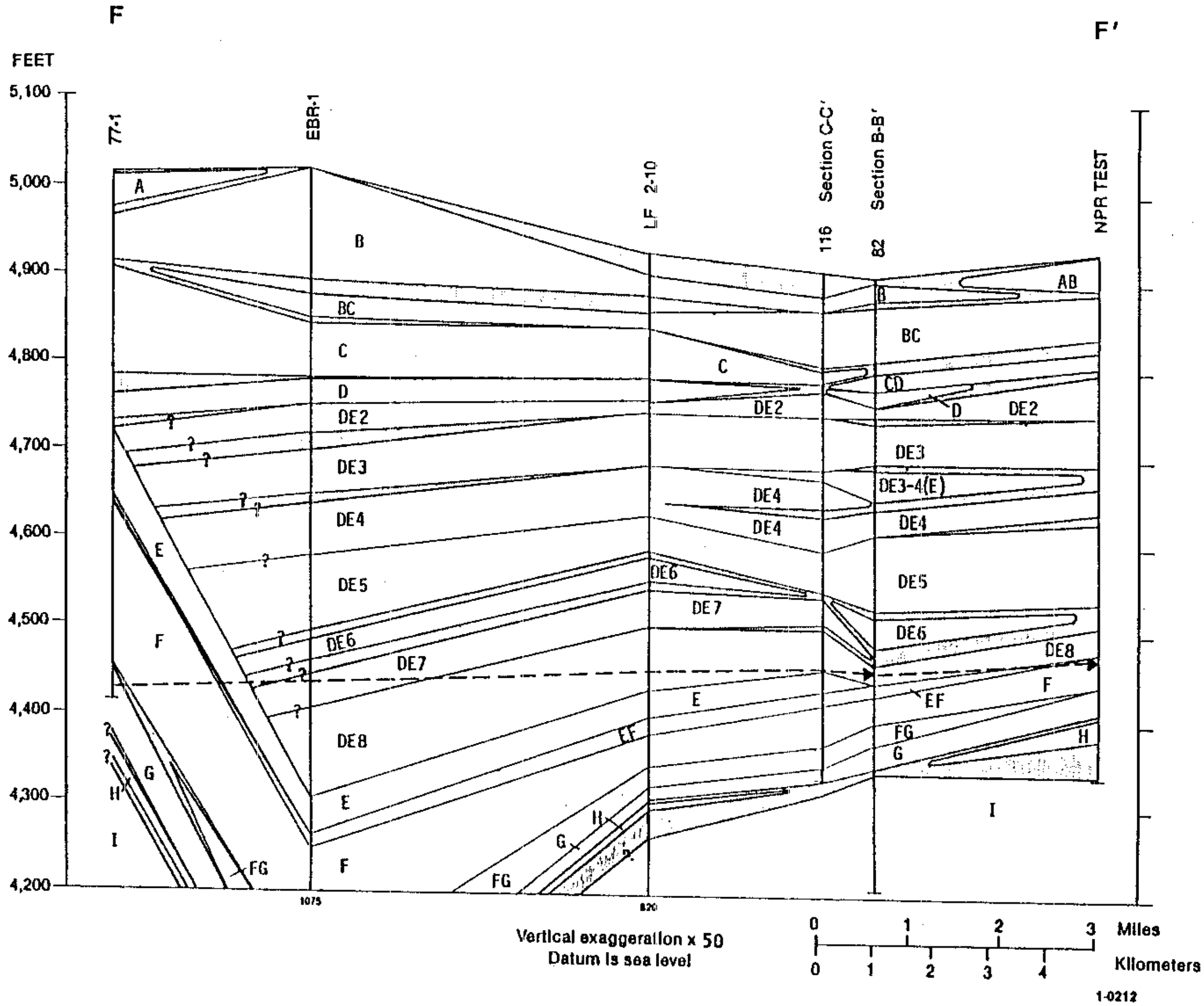



Figure 8.--Geologic section F-F' through the Radioactive Waste Management Complex, the Idaho Chemical Processing Plant, and well NPR TEST.--Continued

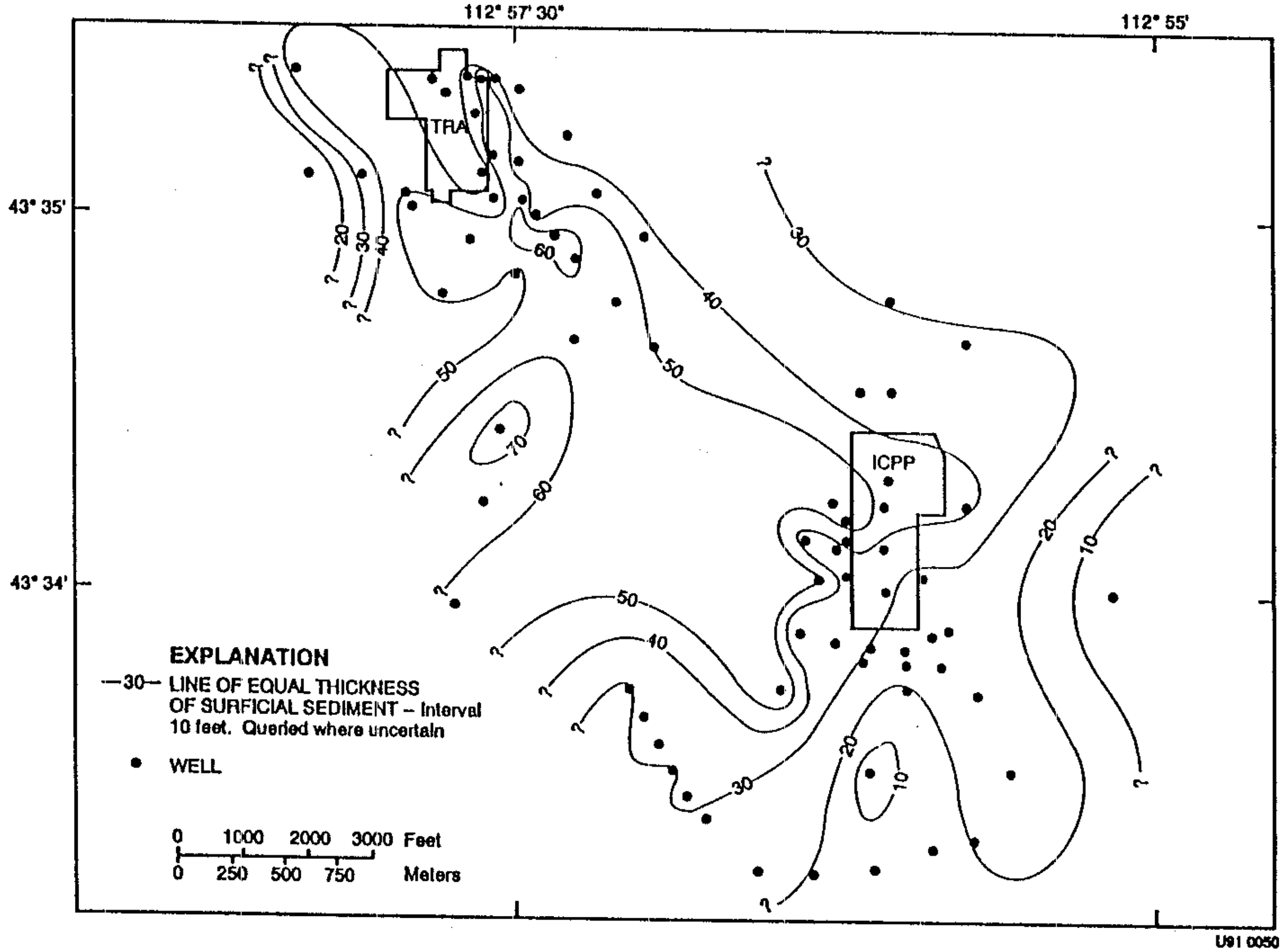



Figure 9.--Thickness of surficial sediment at the Idaho Chemical Processing Plant and Test Reactors Area.

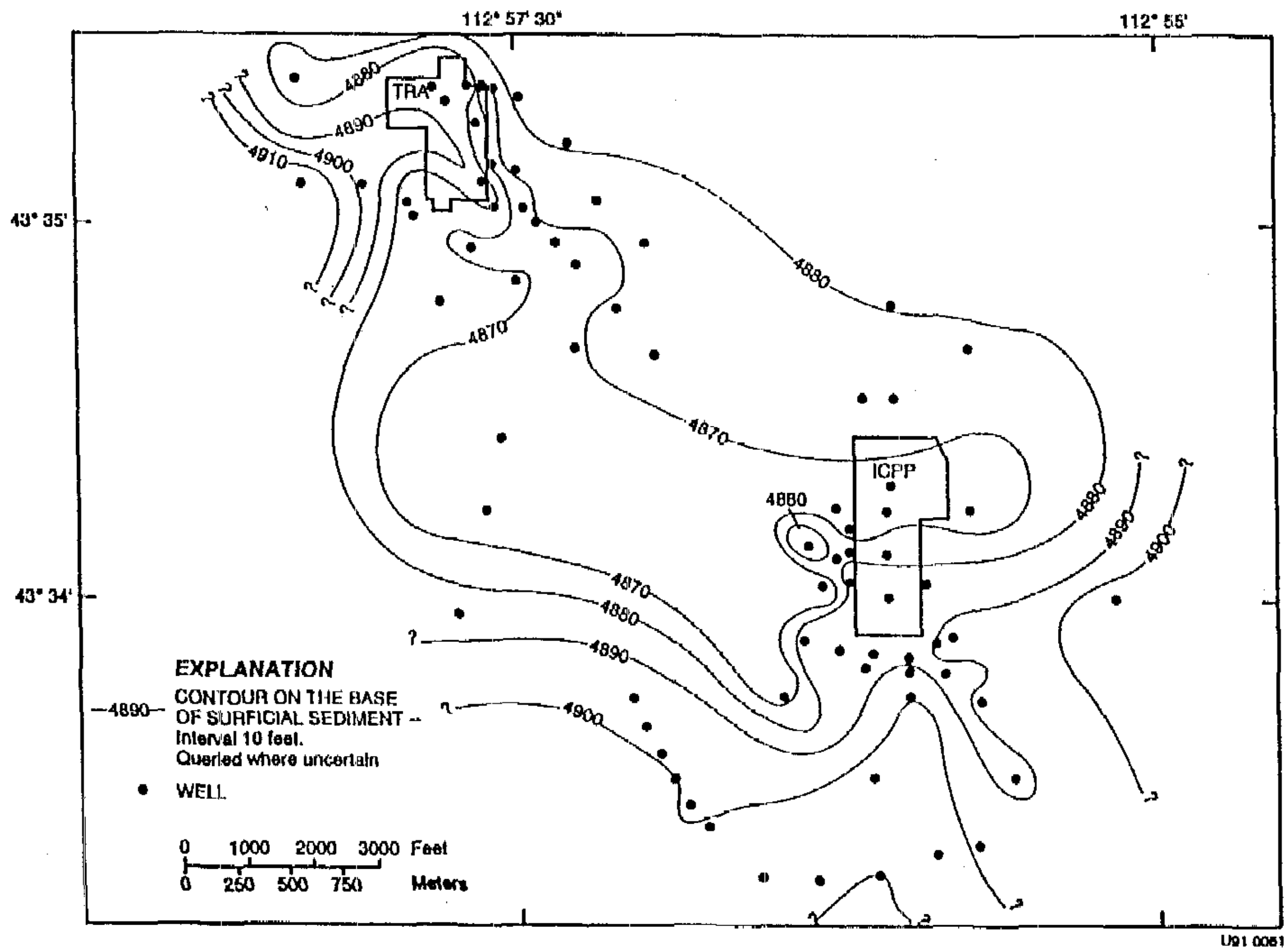



Figure 10.--Altitude of the base of surficial sediment at the Idaho Chemical Processing Plant and Test Reactors Area.

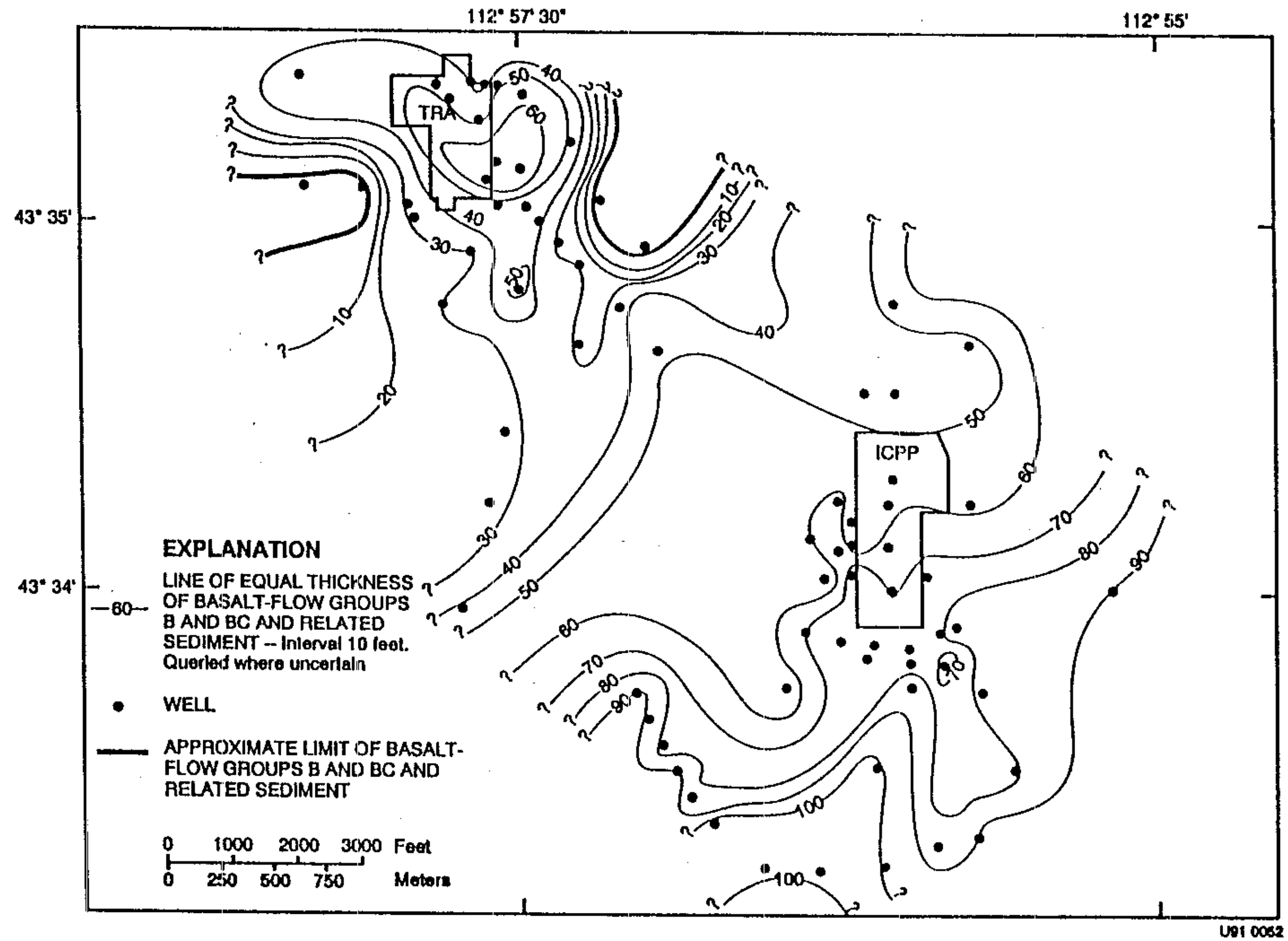



Figure 11.--Thickness of basalt-flow groups B and BC and related sediment at the Idaho Chemical Processing Plant and Test Reactors Area.

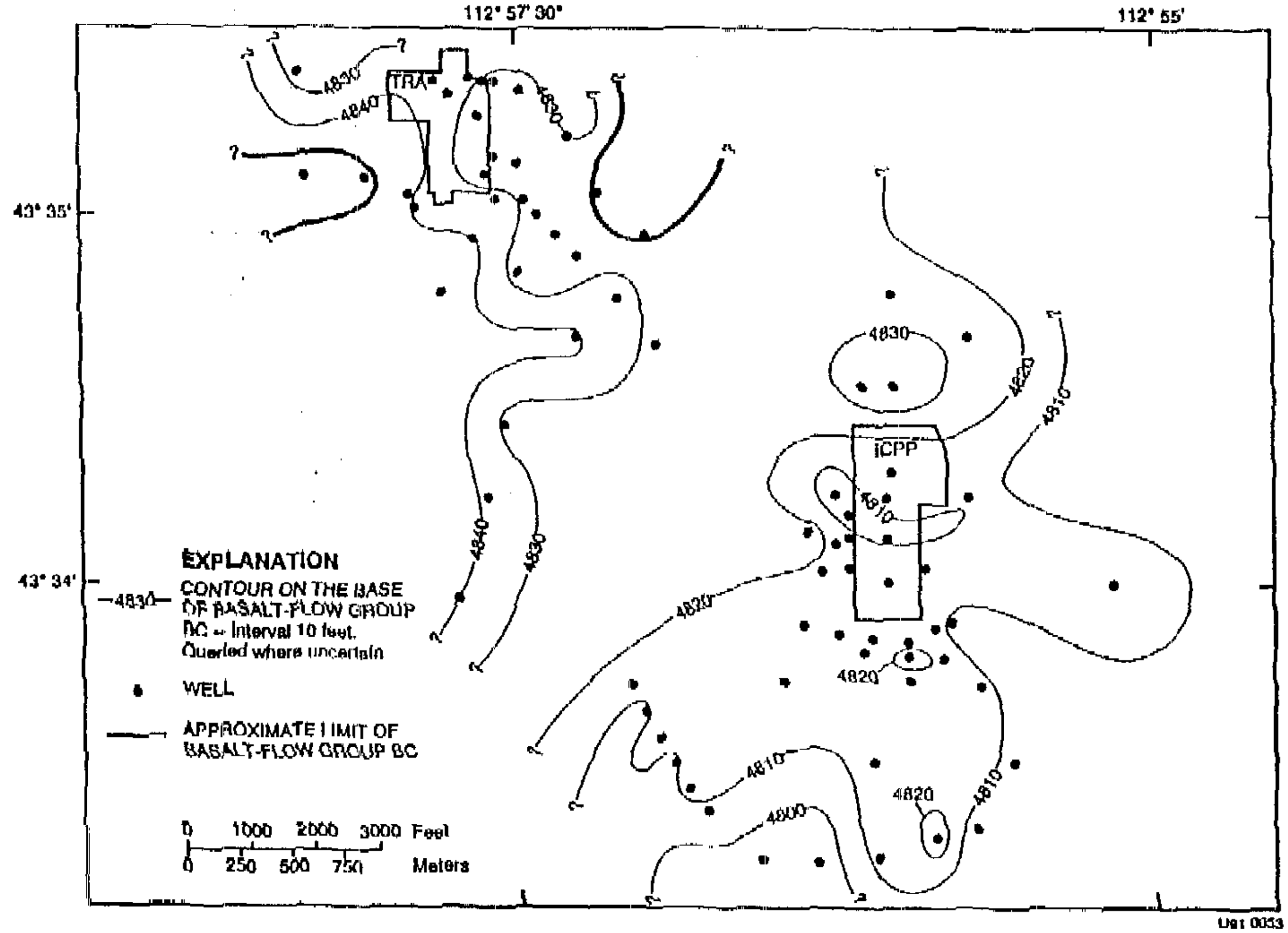



Figure 12.--Altitude of the base of basalt-flow group BC at the Idaho Chemical Processing Plant and Test Reactors Area.

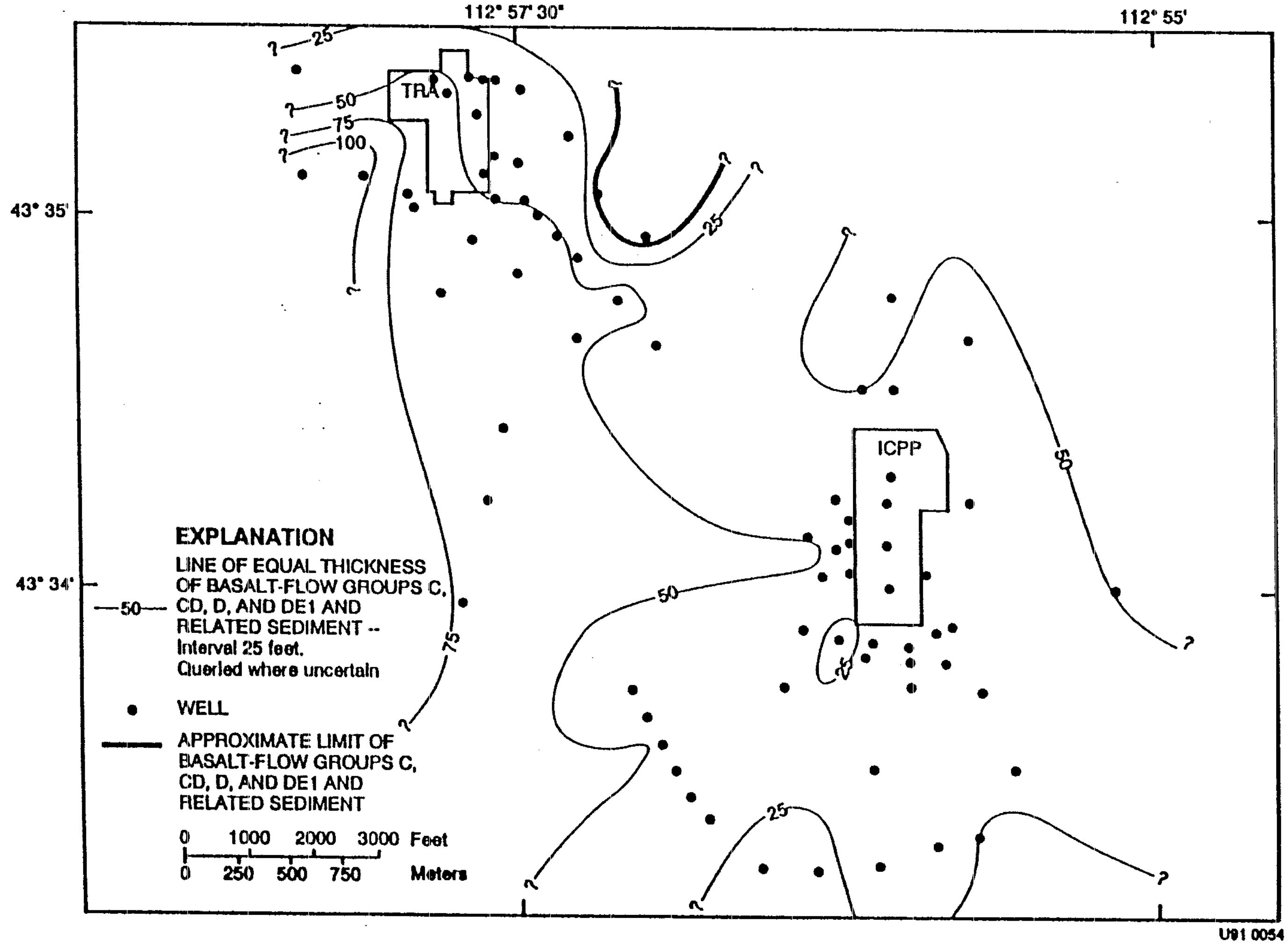



Figure 13.--Thickness of basalt-flow groups C, CD, D, and DE1 and related sediment at the Idaho Chemical Processing Plant and Test Reactors Area

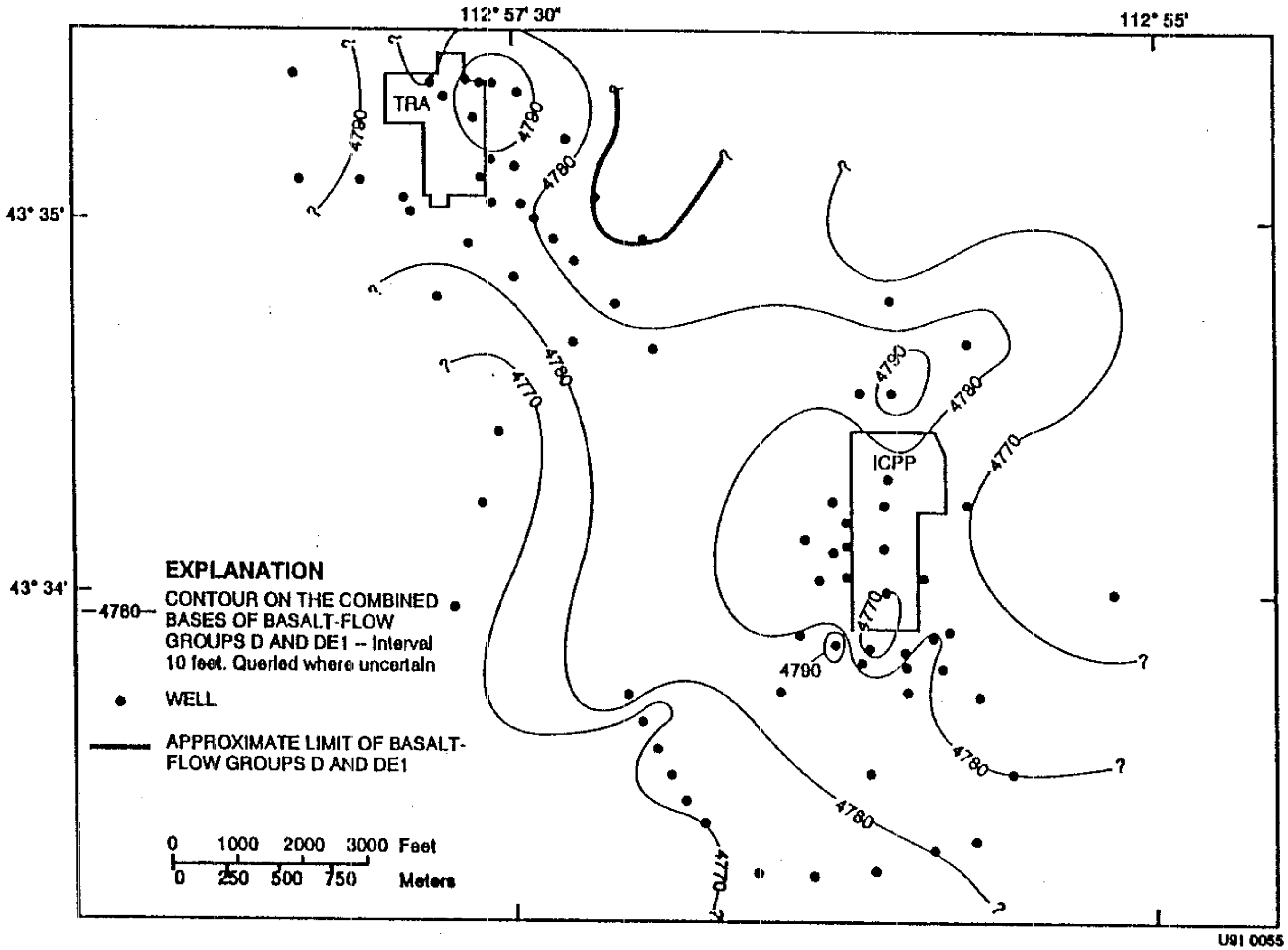



Figure 14.--Altitude of the combined bases of basalt-flow groups D and DE1 at the Idaho Chemical Processing Plant and Test Reactors Area.

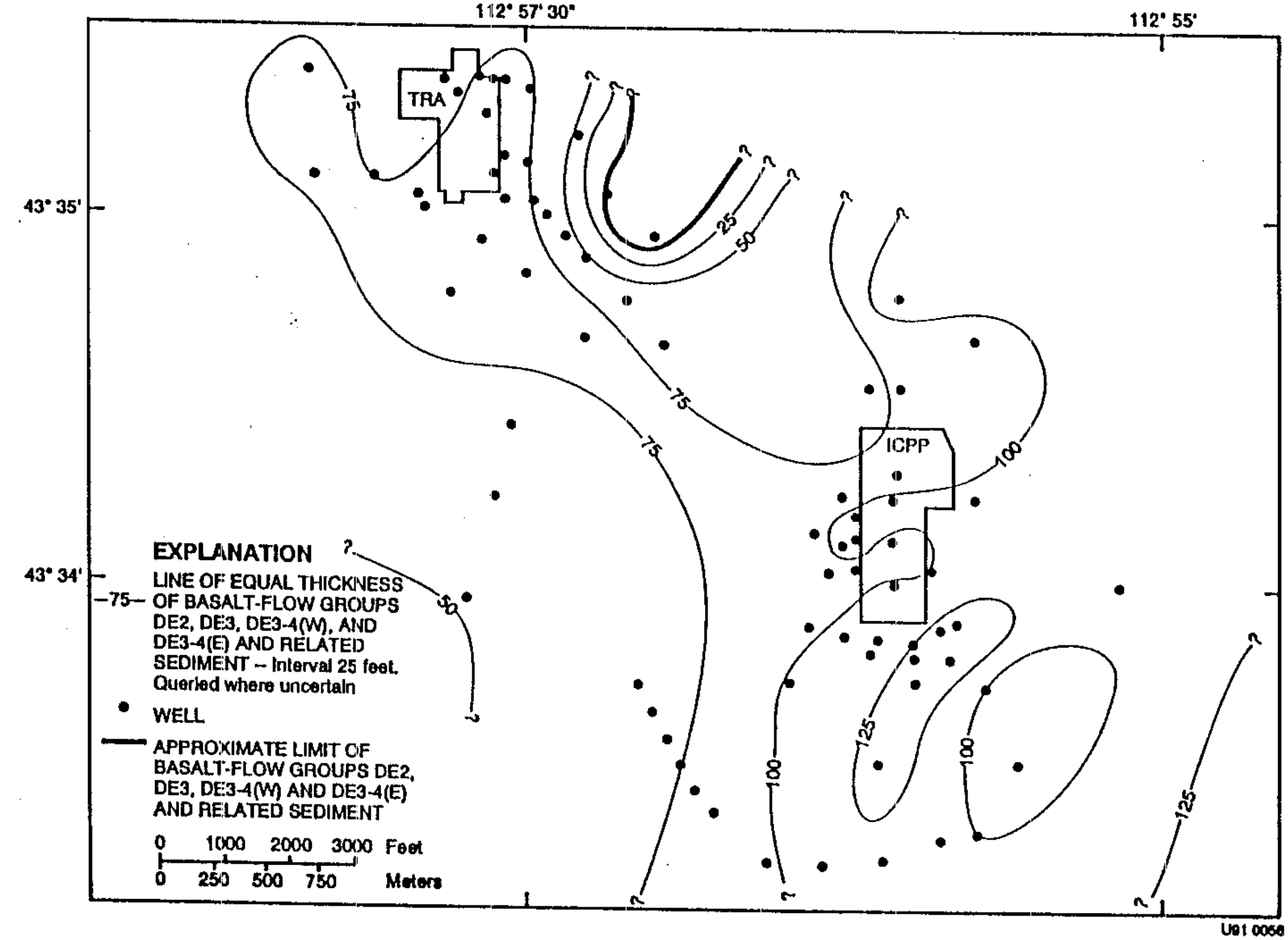



Figure 15.--Thickness of basalt-flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment at the Idaho Chemical Processing Plant and Test Reactors Area

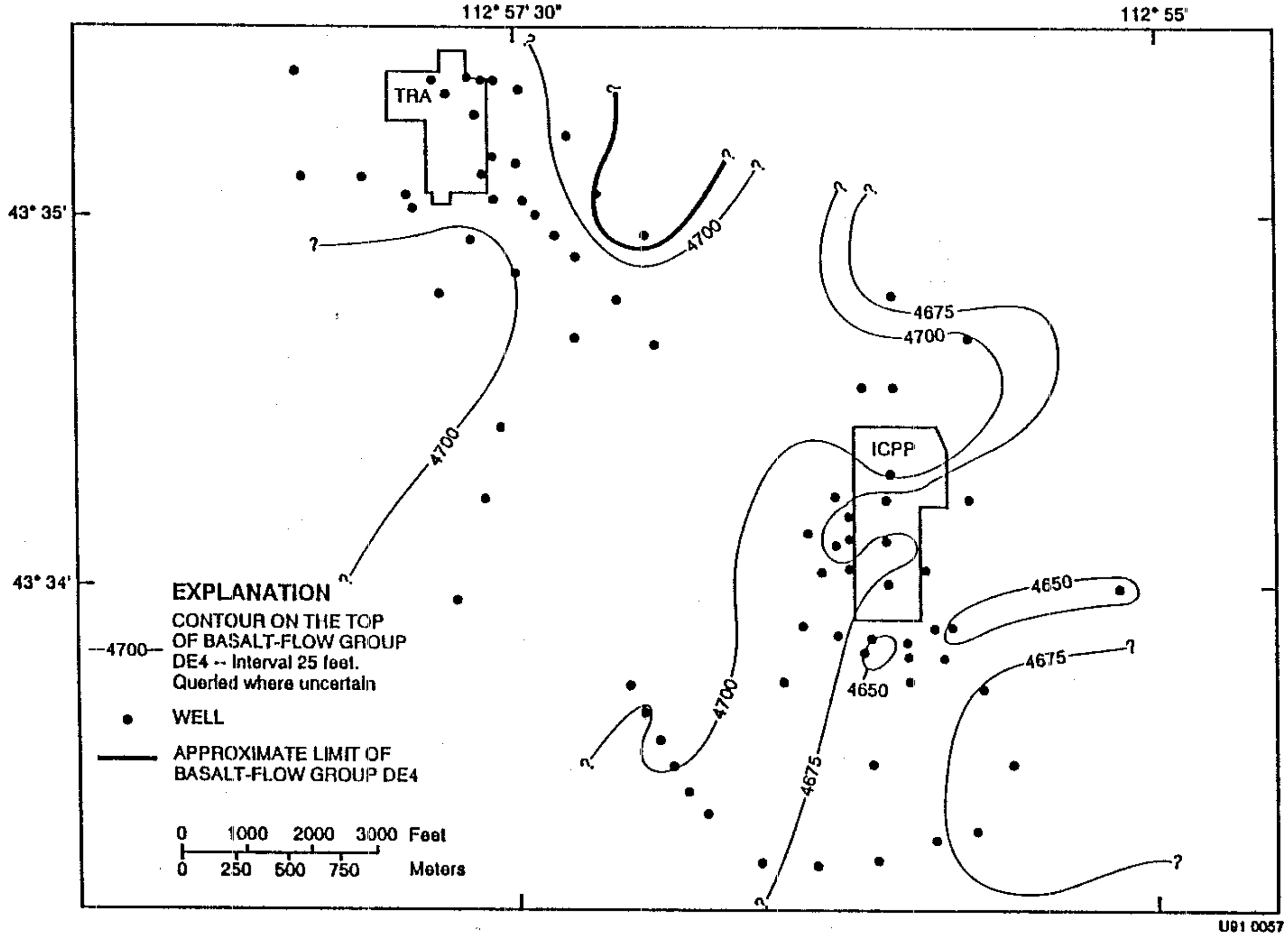



Figure 16.--Altitude of the top of basalt-flow group DE4 at the Idaho Chemical Processing Plant and Test Reactors Area.

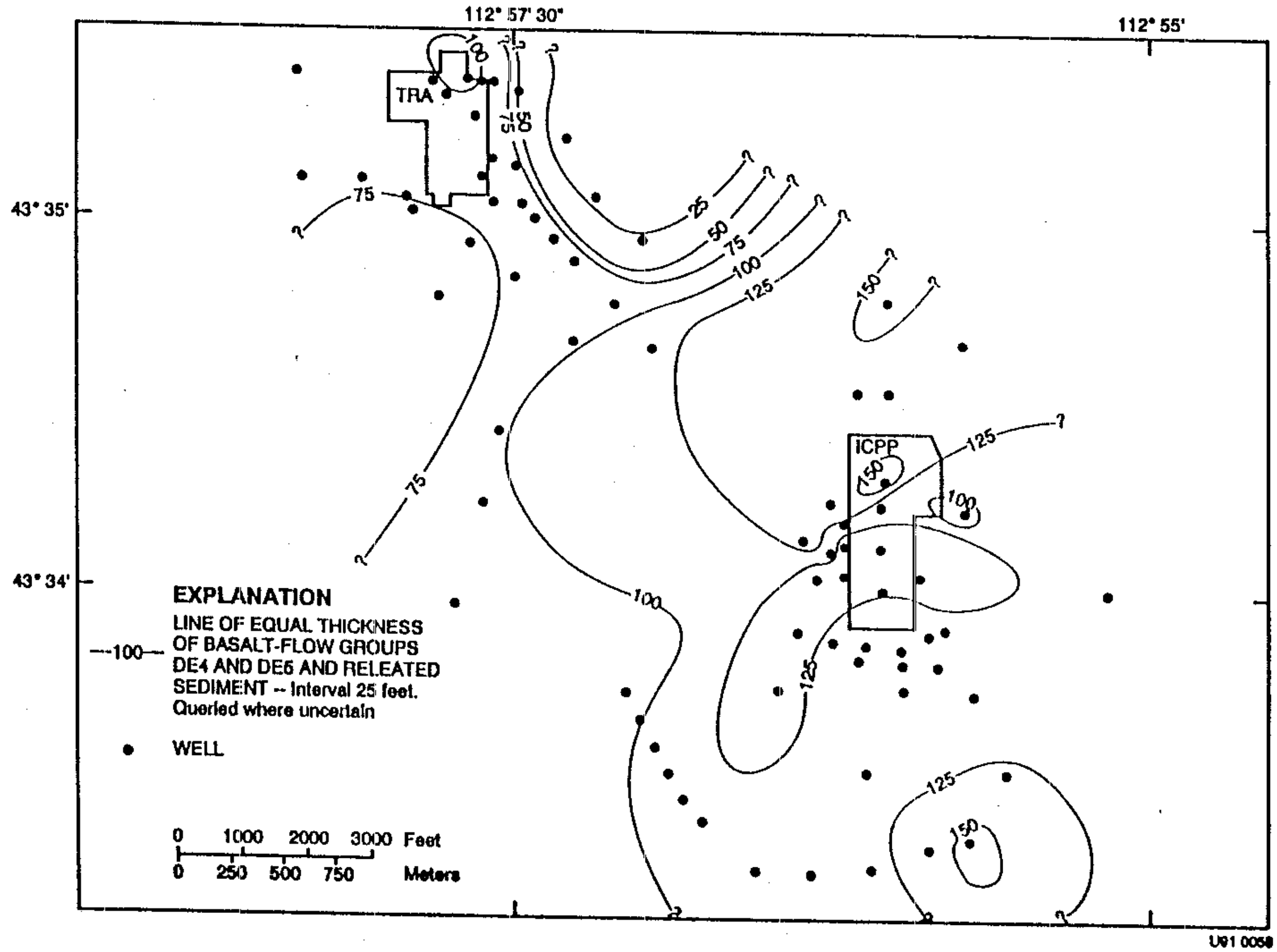



Figure 17.--Thickness of basalt-flow groups DE4 and DE5 and related sediment at the Idaho Chemical Processing Plant and Test Reactors Area.

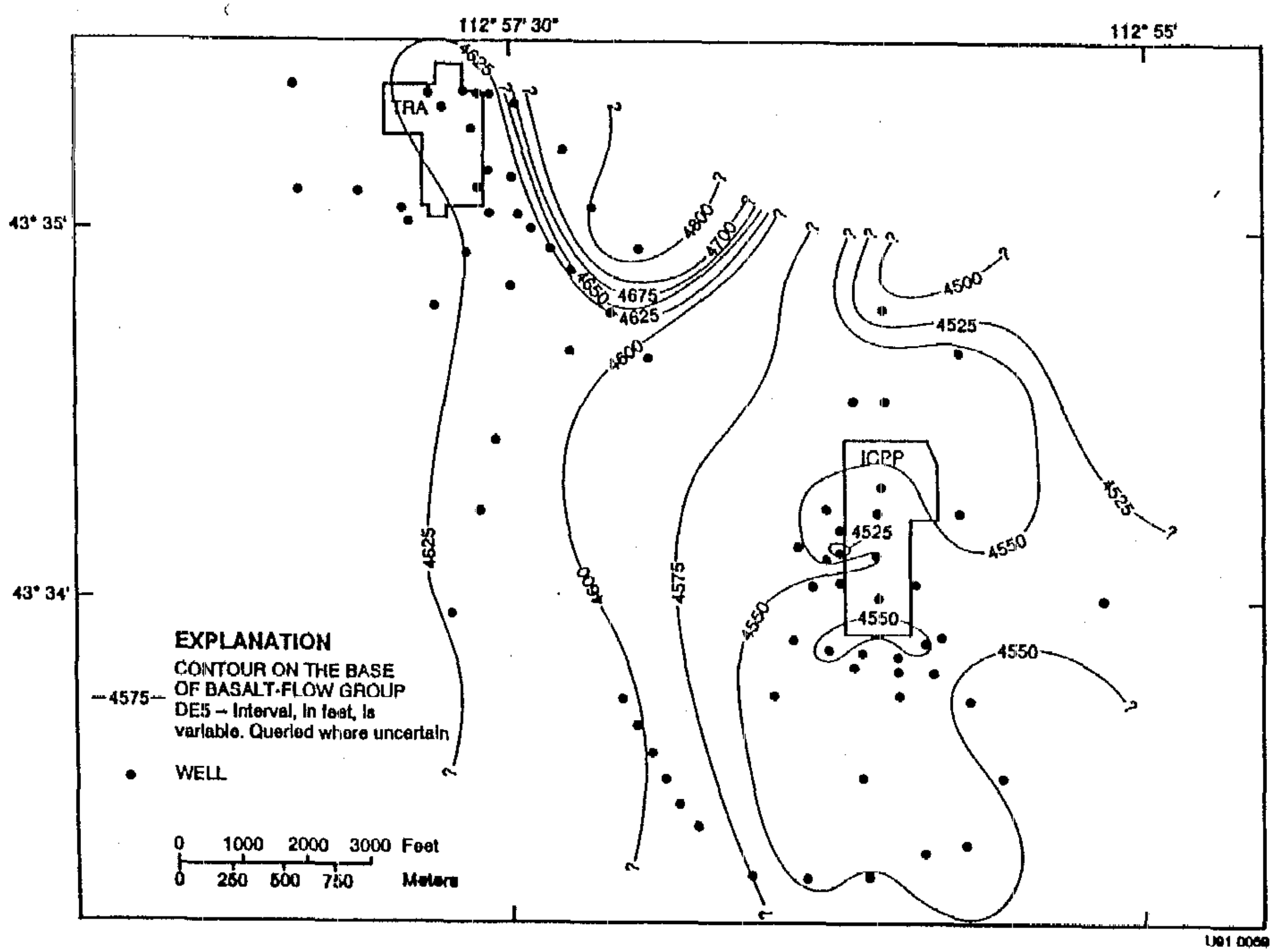



Figure 18.--Altitude of the base of basalt-flow group DE5 at the Idaho Chemical Processing Plant and Test Reactors Area.

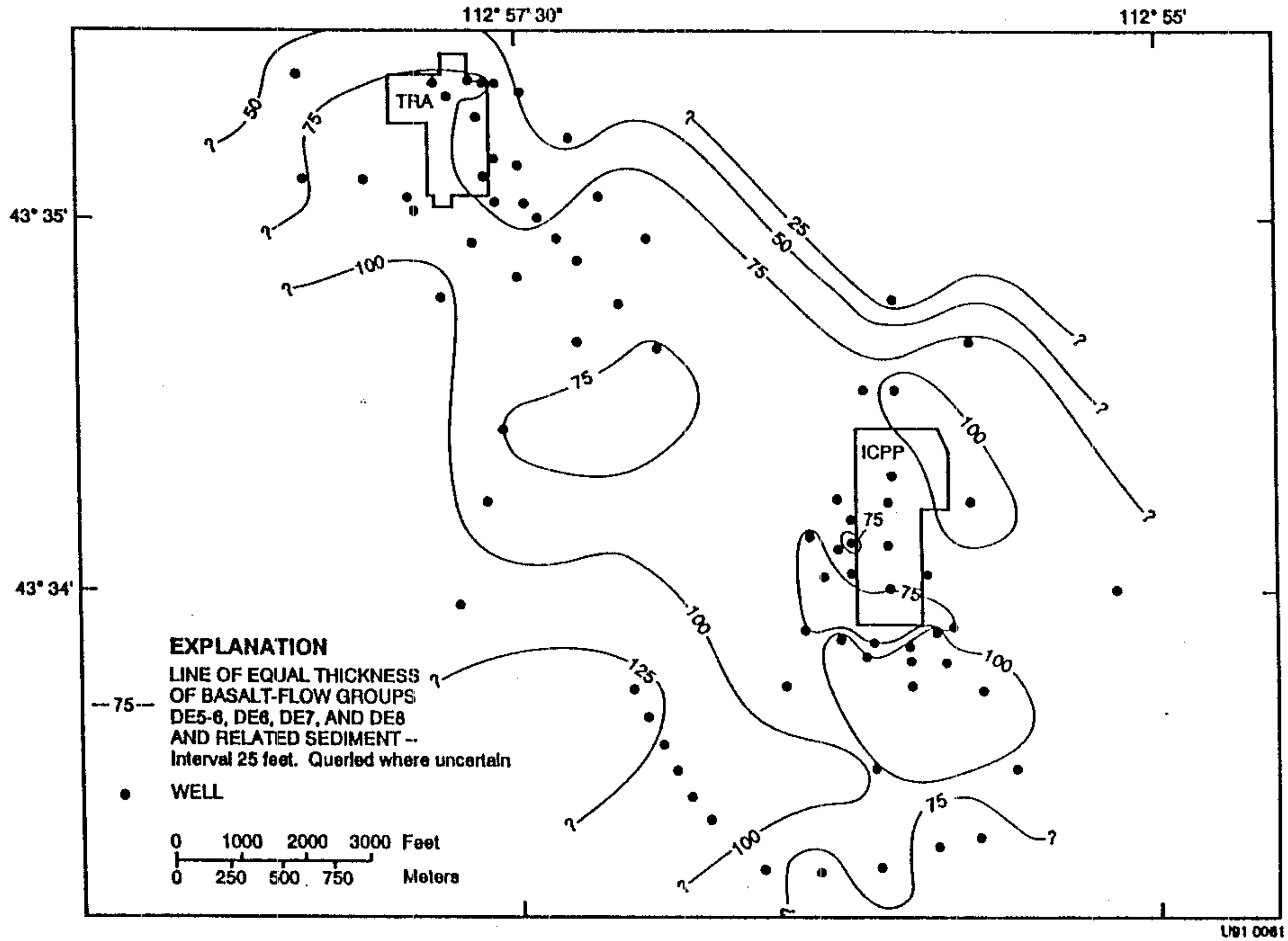



Figure 19.--Thickness of basalt-flow groups DE5-6, DE6, DE7, and DE8 and related sediment at the Idaho Chemical Processing Plant and Test Reactors Area.

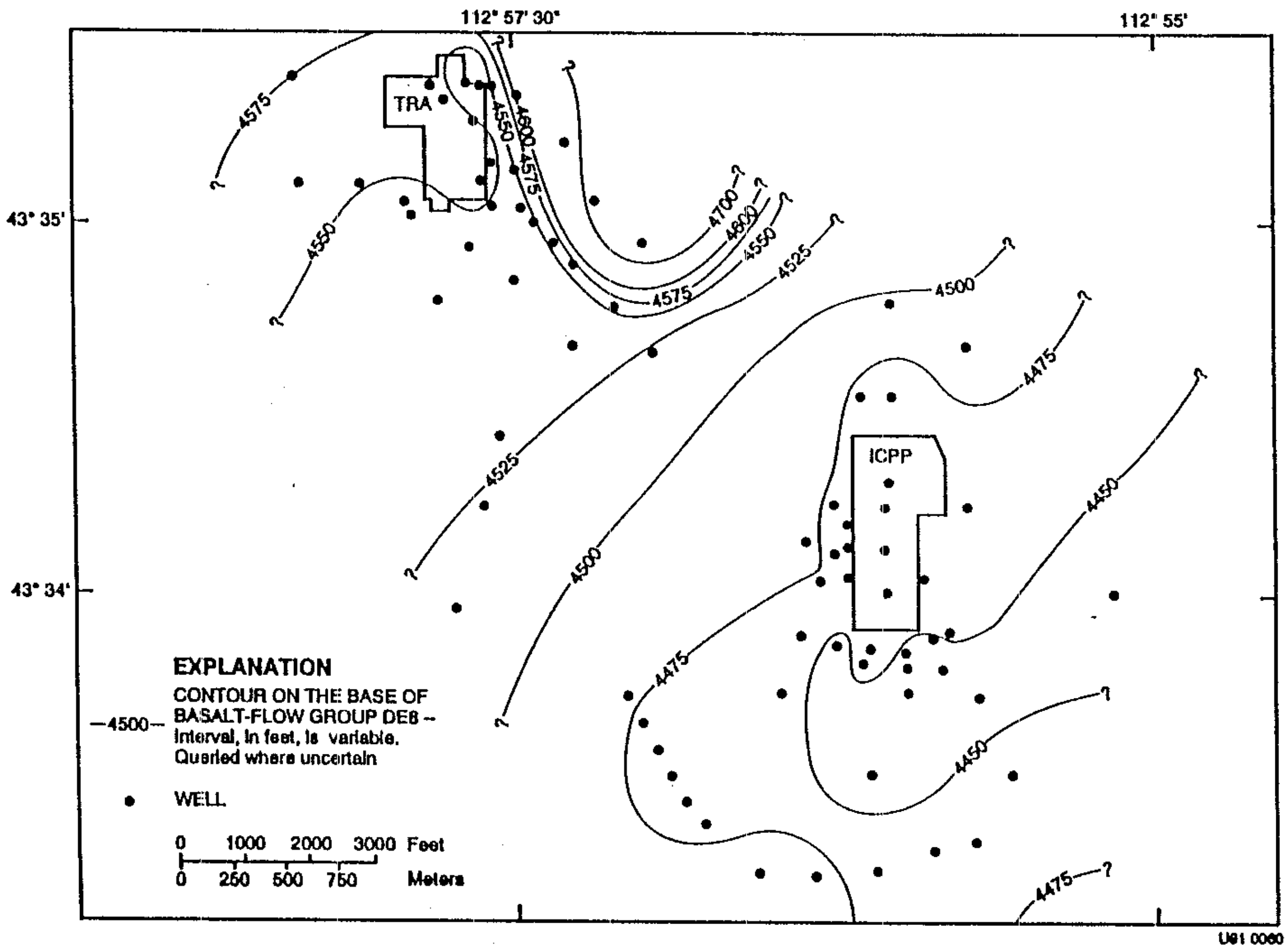



Figure 20.--Altitude of the base of basalt-flow group DE8 at the Idaho Chemical Processing Plant and Test Reactors Area.

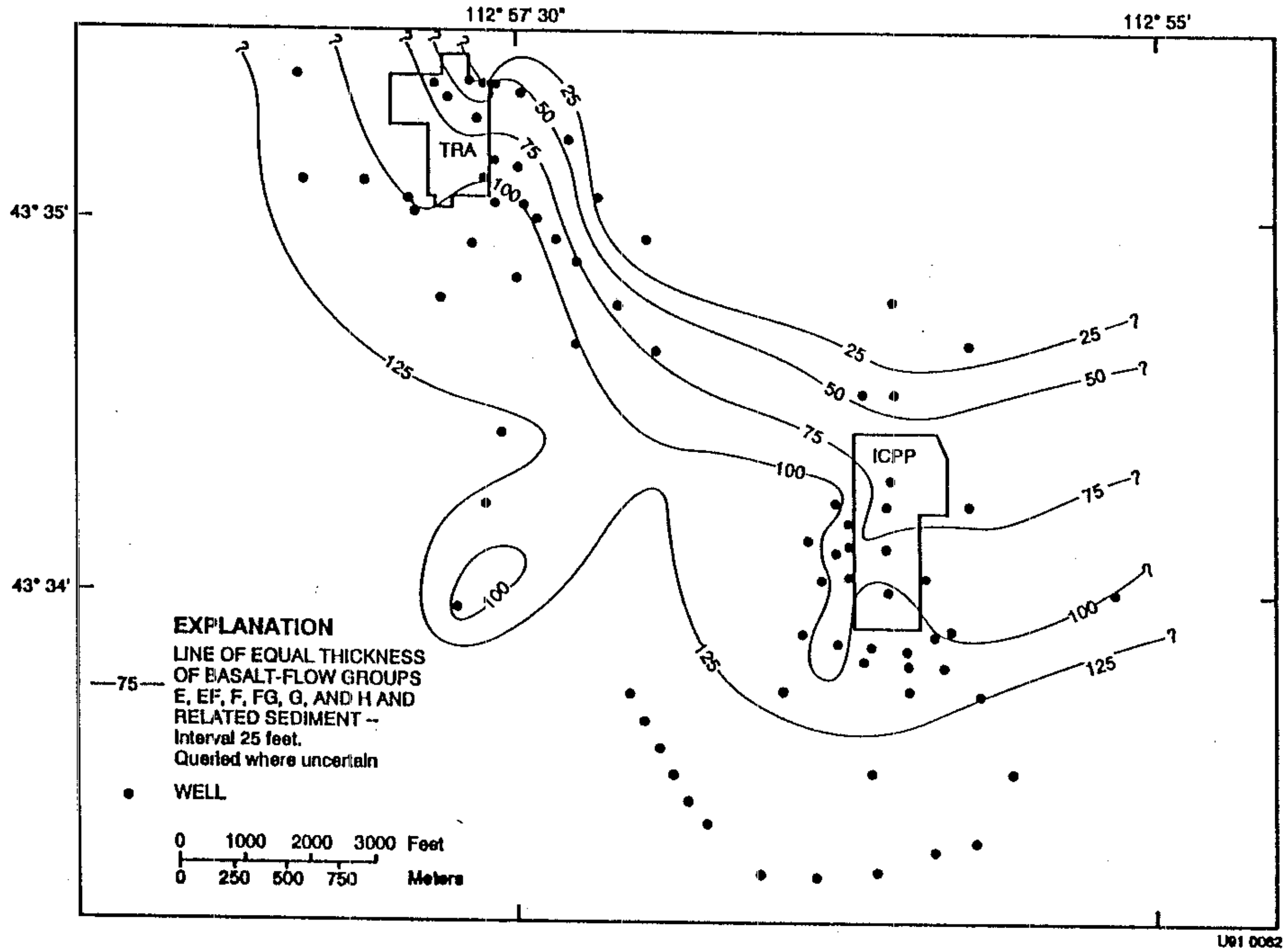



Figure 21.--Thickness of basalt-flow groups E, EF, F, FG, G, and H and related sediment at the Idaho Chemical Processing Plant and Test Reactors Area.

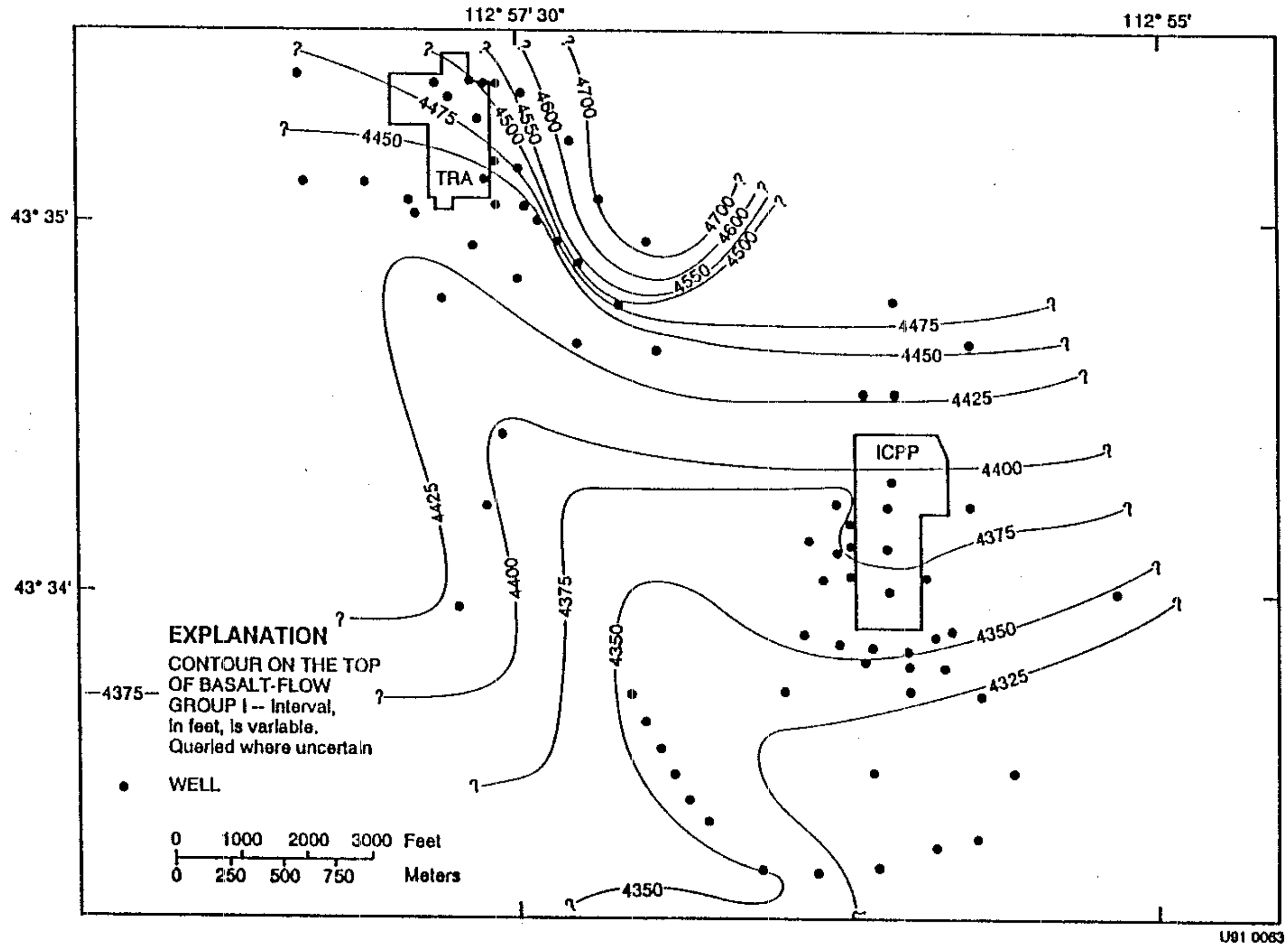



Figure 22.--Altitude of the top of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area.

Table 1.--Altitude of the top, thickness, percent sediment, and altitude of the base of composite stratigraphic units from land surface to the base of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area

[Altitude and thickness rounded to the nearest foot and accurate to ±2 feet. --Indicates no data; < indicates less than; > indicates greater than; % indicates percent]

| | Surficial Sediment | | | Basalt-flow groups B and BC and related sediment | | | Basalt-flow groups C, CD, D, and DE1 and related sediment | | |
|---|---|---|---|---|---|---|---|---|---|
| Well | Altitude of land surface | Thickness | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base |
| 34 | 4930 | 32 | 4898 | 4898 | 79 / 11 | 4819 | 4819 | 48 / 25 | 4771 |
| 35 | 4930 | 33 | 4897 | 4897 | 88 / 7 | 4809 | 4809 | 29 / 0 | 4766 |
| 36 | 4930 | 30 | 4900 | 4900 | 90 / 12 | 4810 | 4810 | 35 / 14 | 4775 |
| 37 | 4930 | 36 | 4894 | 4894 | 81 / 16 | 4813 | 4813 | 37 / 16 | 4774 |
| 38 | 4930 | 23 | 4907 | 4907 | 102 / 10 | 4805 | 4805 | 35 / 23 | 4770 |
| 39 | 4937 | 30 | 4907 | 4907 | 90 / 12 | 4817 | 4817 | 35 / 23 | 4782 |
| 40 | 4916 | 55 | 4861 | 4861 | 53 / 0 | 4808 | 4808 | 35 / 37 | 4773 |
| 41 | 4917 | 44 | 4873 | 4873 | 54 / 0 | 4819 | 4819 | 41 / 46 | 4778 |
| 42 | 4918 | 33 | 4885 | 4885 | 71 / 0 | 4814 | 4814 | 42 / 45 | 4772 |
| 43 | 4915 | 52 | 4864 | 4864 | 61 / 0 | 4833 | 4833 | 32 / 19 | 4771 |
| 44 | 4919 | 34 | 4885 | 4885 | 62 / 0 | 4823 | 4823 | 49 / 49 | 4774 |
| 45 | 4920 | 53 | 4867 | 4867 | 50 / 0 | 4817 | 4817 | 45 / 16 | 4772 |
| 46 | 4917 | 39 | 4878 | 4878 | 60 / 0 | 4818 | 4818 | 43 / 28 | 4775 |
| 47 | 4916 | 39 | 4877 | 4877 | 68 / 0 | 4809 | 4809 | 31 / 13 | 4778 |
| 48 | 4917 | 32 | 4885 | 4885 | 69 / 0 | 4816 | 4816 | 46 / 35 | 4770 |
| 49 | 4913 | 27 | 4886 | 4886 | 71 / 0 | 4815 | 4815 | 44 / 54 | 4771 |
| 50 | 4913 | 45 | 4868 | 4868 | 54 / 0 | 4814 | 4814 | 36 / 14 | 4778 |
| 51 | 4918 | 30 | 4888 | 4888 | 73 / 0 | 4815 | 4815 | 47 / 40 | 4768 |
| 52 | 4910 | 43 | 4867 | 4867 | 56 / 0 | 4811 | 4811 | 41 / 58 | 4770 |
| 53 | 4924 | 44 | 4880 | 4880 | 44 / 0 | 4836 | 4836 | >2 / 0 | <4834 |
| 54 | 4922 | 60 | 4862 | 4862 | >31 / 0 | <4831 | -- | -- / -- | -- |
| 55 | 4921 | 43 | 4878 | 4878 | >16 / 0 | <4862 | -- | -- / -- | -- |
| 56 | 4922 | 54 | 4868 | 4868 | >28 / 0 | <4840 | -- | -- / -- | -- |
| 57 | 4923 | 53 | 4870 | 4870 | 55 / 0 | 4815 | 4815 | 29 / 10 | 4786 |
| 58 | 4919 | 47 | 4872 | 4872 | 43 / 0 | 4829 | 4829 | 50 / 0 | 4779 |
| 59 | 4914 | 22 | 4892 | 4892 | 83 / 8 | 4809 | 4809 | 36 / 100 | 4773 |
| 60 | 4921 | 62 | 4859 | 4859 | 31 / 0 | 4828 | 4828 | >12 / 0 | <4816 |
| 61 | 4923 | 61 | 4862 | 4862 | 33 / 0 | 4829 | 4829 | >23 / 0 | <4806 |
| 62 | 4924 | 53 | 4871 | 4871 | 39 / 0 | 4832 | 4832 | 60 / 0 | 4772 |
| 63 | 4926 | 57 | 4869 | 4869 | 30 / 0 | 4839 | 4839 | >10 / 0 | <4829 |
| 64 | 4916 | 35 | 4881 | 4881 | 51 / 0 | 4830 | 4830 | 45 / 0 | 4785 |
| 65 | 4926 | 52 | 4874 | 4874 | 30 / 0 | 4844 | 4844 | 70 / 0 | 4774 |
| 66 | 4922 | 49 | 4873 | 4873 | 49 / 0 | 4824 | 4824 | 39 / 0 | 4785 |
| 67 | 4916 | 23 | 4893 | 4893 | 82 / 0 | 4811 | 4811 | 37 / 76 | 4774 |
| 68 | 4921 | 45 | 4876 | 4876 | 49 / 0 | 4827 | 4827 | >34 / 0 | <4793 |
| 69 | 4924 | 50 | 4874 | 4874 | 51 / 0 | 4823 | 4823 | >14 / 0 | <4809 |
| 70 | 4918 | 44 | 4874 | -- | 0 / 0 | -- | -- | 0 / 0 | -- |
| 71 | 4925 | 55 | 4870 | 4870 | 30 / 0 | 4840 | 4840 | 52 / 14 | 4788 |
| 72 | 4921 | 36 | 4885 | 4885 | 50 / 10 | 4835 | 4835 | 54 / 0 | 4781 |
| 73 | 4928 | 57 | 4871 | 4871 | 32 / 0 | 4839 | 4839 | >38 / 0 | <4801 |

Table 1.--Altitude of the top, thickness, percent sediment, and altitude of the base of composite stratigraphic units from land surface to the base of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area--Continued

[Altitude and thickness rounded to the nearest foot and accurate to ±2 feet. --Indicates no data; < indicates less than; > indicates greater than; % indicates percent]

| | Basalt flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment | | | Basalt-flow groups DE4 and DE5 and related sediment | | | Basalt-flow groups DE5-6 DE6, DE7, and DE8 and related sediment | | |
|---|---|---|---|---|---|---|---|---|---|
| Well | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base |
| 34 | 4771 | 66 / 0 | 4705 | 4705 | 115 / 0 | 4590 | 4590 | 124 / 17 | 4466 |
| 35 | 4766 | 68 / 32 | 4698 | 4698 | 98 / 7 | 4600 | 4600 | 135 / 10 | 4465 |
| 36 | 4775 | 75 / 0 | 4700 | 4700 | 118 / 3 | 4582 | 4582 | 112 / 46 | 4470 |
| 37 | 4774 | 82 / 23 | 4692 | 4692 | 107 / 11 | 4585 | 4585 | 115 / 32 | 4470 |
| 38 | 4770 | 82 / 8 | 4688 | 4688 | 107 / 6 | 4581 | 4581 | 111 / 31 | 4470 |
| 39 | 4782 | 72 / 21 | 4710 | 4710 | 93 / 4 | 4617 | 4617 | 136 / 8 | 4481 |
| 40 | 4773 | 105 / 12 | 4668 | 4668 | 122 / 0 | 4546 | 4546 | 77 / 32 | 4469 |
| 41 | 4778 | 111 / 17 | 4667 | 4667 | 142 / 8 | 4525 | 4525 | 63 / 36 | 4462 |
| 42 | 4772 | 91 / 21 | 4681 | 4681 | 139 / 2 | 4542 | 4542 | 76 / 18 | 4466 |
| 43 | 4771 | 90 / 51 | 4681 | 4681 | 133 / 0 | 4548 | 4548 | 78 / 24 | 4470 |
| 44 | 4774 | 93 / 13 | 4681 | 4681 | 129 / 5 | 4552 | 4552 | 74 / 26 | 4478 |
| 45 | 4772 | 93 / 17 | 4679 | 4679 | 132 / 7 | 4547 | 4547 | 73 / 14 | 4474 |
| 46 | 4775 | 104 / 23 | 4671 | 4671 | 122 / 0 | 4549 | 4549 | 82 / 27 | 4467 |
| 47 | 4778 | 97 / 13 | 4681 | 4681 | 130 / 5 | 4551 | 4551 | 89 / 28 | 4462 |
| 48 | 4770 | 103 / 15 | 4667 | 4667 | 125 / 2 | 4542 | 4542 | 75 / 15 | 4467 |
| 49 | 4771 | 100 / 15 | 4671 | 4671 | 133 / 3 | 4538 | 4538 | 85 / 24 | 4453 |
| 50 | 4778 | 77 / 22 | 4701 | 4701 | 153 / 5 | 4548 | 4548 | >40 / 22 | <4508 |
| 51 | 4768 | 118 / 18 | 4650 | 4650 | 112 / 4 | 4538 | 4538 | 78 / 13 | 4460 |
| 52 | 4770 | 108 / 23 | 4662 | 4662 | 98 / 0 | 4564 | 4564 | 111 / 25 | 4453 |
| 53 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 54 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 55 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 56 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 57 | 4786 | 103 / 5 | 4683 | 4683 | 146 / 9 | 4537 | 4537 | 79 / 28 | 4458 |
| 58 | 4779 | 72 / 61 | 4707 | 4707 | 93 / 4 | 4614 | 4614 | 73 / 7 | 4541 |
| 59 | 4773 | 130 / 20 | 4643 | 4643 | 115 / 10 | 4528 | 4528 | 74 / 8 | 4454 |
| 60 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 61 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 62 | 4772 | >13 / 100 | <4759 | -- | -- / -- | -- | -- | -- / -- | -- |
| 63 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 64 | 4785 | 45 / 78 | 4740 | 4740 | >29 / 0 | <4711 | -- | -- / -- | -- |
| 65 | 4774 | 83 / 46 | 4691 | 4691 | 60 / 8 | 4631 | 4631 | 103 / 16 | 4528 |
| 66 | 4785 | 69 / 56 | 4715 | 4716 | 123 / 0 | 4593 | 4593 | 74 / 20 | 4519 |
| 67 | 4774 | 98 / 13 | 4676 | 4676 | 116 / 5 | 4560 | 4560 | 119 / 3 | 4441 |
| 68 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 69 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 70 | -- | 0 / 0 | -- | 4874 | 10 / 0 | 4864 | 4864 | >46 / 0 | <4818 |
| 71 | 4788 | >47 / 53 | <4741 | -- | -- / -- | -- | -- | -- / -- | -- |
| 72 | 4781 | >60 / 42 | <4721 | -- | -- / -- | -- | -- | -- / -- | -- |
| 73 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |

Table 1.--Altitude of the top, thickness, percent sediment, and altitude of the base of composite stratigraphic units from land surface to the base of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area--Continued

[Altitude and thickness rounded to the nearest foot and accurate to ±2 feet. --Indicates no data; < indicates less than; > indicates greater than; % indicates percent]

| | Basalt-flow groups E, EF, F, FG, G, and H and related sediment | | | Basalt-flow group I and related sediment | | |
|---|---|---|---|---|---|---|
| Well | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base |
| 34 | 4466 | 131 / 12 | 4335 | 4335 | >105 / 0 | <4230 |
| 35 | 4465 | >113 / 0 | <4352 | -- | -- / -- | -- |
| 36 | 4470 | >107 / 0 | <4363 | -- | -- / -- | -- |
| 37 | 4470 | >112 / 0 | <4358 | -- | -- / -- | -- |
| 38 | 4470 | 140 / 4 | 4330 | 4330 | 85 / 0 | 4245 |
| 39 | 4481 | >116 / 0 | <4365 | -- | -- / -- | -- |
| 40 | 4469 | 83 / 6 | 4386 | 4386 | 122 / 0 | 4264 |
| 41 | 4462 | 80 / 5 | 4382 | 4382 | 115 / 0 | 4267 |
| 42 | 4466 | 98 / 0 | 4368 | 4368 | 120 / 0 | 4248 |
| 43 | 4470 | 105 / 0 | 4365 | 4365 | 125 / 0 | 4240 |
| 44 | 4478 | 109 / 0 | 4369 | 4369 | >100 / 0 | <4269 |
| 45 | 4474 | 104 / 8 | 4370 | 4370 | >101 / 0 | <4269 |
| 46 | 4467 | 97 / 6 | 4370 | 4370 | >104 / 0 | <4266 |
| 47 | 4462 | 82 / 6 | 4380 | 4380 | >115 / 0 | <4265 |
| 48 | 4467 | 105 / 5 | 4362 | 4362 | 127 / 0 | 4235 |
| 49 | 4453 | 82 / 2 | 4371 | 4371 | >114 / 0 | <4257 |
| 50 | -- | -- / -- | -- | -- | -- / -- | -- |
| 51 | 4460 | 106 / 4 | 4354 | 4354 | >95 / 0 | <4259 |
| 52 | 4453 | 74 / 5 | 4379 | 4379 | 119 / 0 | 4260 |
| 53 | -- | -- / -- | -- | -- | -- / -- | -- |
| 54 | -- | -- / -- | -- | -- | -- / -- | -- |
| 55 | -- | -- / -- | -- | -- | -- / -- | -- |
| 56 | -- | -- / -- | -- | -- | -- / -- | -- |
| 57 | 4458 | 110 / 4 | 4348 | 4348 | 95 / 0 | 4253 |
| 58 | 4541 | >97 / 0 | <4444 | -- | -- / -- | -- |
| 59 | 4454 | 99 / 3 | 4355 | 4355 | >98 / 0 | <4257 |
| 60 | -- | -- / -- | -- | -- | -- / -- | -- |
| 61 | -- | -- / -- | -- | -- | -- / -- | -- |
| 62 | -- | -- / -- | -- | -- | -- / -- | -- |
| 63 | -- | -- / -- | -- | -- | -- / -- | -- |
| 64 | -- | -- / -- | -- | -- | -- / -- | -- |
| 65 | 4528 | >100 / 10 | <4428 | -- | -- / -- | -- |
| 66 | 4519 | >72 / 0 | <4447 | -- | -- / -- | -- |
| 67 | 4441 | 125 / 22 | 4316 | 4316 | >94 / 0 | <4222 |
| 68 | -- | -- / -- | -- | -- | -- / -- | -- |
| 69 | -- | -- / -- | -- | -- | -- / -- | -- |
| 70 | -- | -- / -- | -- | -- | -- / -- | -- |
| 71 | -- | -- / -- | -- | -- | -- / -- | -- |
| 72 | -- | -- / -- | -- | -- | -- / -- | -- |
| 73 | -- | -- / -- | -- | -- | -- / -- | -- |

Table 1.--Altitude of the top, thickness, percent sediment, and altitude of the base of composite stratigraphic units from land surface to the base of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area--Continued

[Altitude and thickness rounded to the nearest foot and accurate to ±2 feet. --Indicates no data; < indicates less than; > indicates greater than; % indicates percent]

| | Surficial Sediment | | | Basalt-flow groups B and BC and related sediment | | | Basalt-flow groups C, CD, D, and DE1 and related sediment | | |
|---|---|---|---|---|---|---|---|---|---|
| Well | Altitude of land surface | Thickness | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base |
| 74 | 4929 | 32 | 4897 | -- | 0 / 0 | -- | 4897 | 111 / 3 | 4786 |
| 75 | 4918 | 43 | 4875 | -- | 0 / 0 | -- | -- | 0 / 0 | -- |
| 76 | 4931 | 73 | 4858 | 4858 | 29 / 0 | 4829 | 4829 | 63 / 0 | 4766 |
| 77 | 4923 | 13 | 4910 | 4910 | 99 / 11 | 4811 | 4811 | 33 / 48 | 4778 |
| 78 | 4933 | 67 | 4866 | 4866 | 29 / 0 | 4837 | 4837 | 70 / 0 | 4767 |
| 79 | 4932 | 15 | 4917 | -- | 0 / 0 | -- | 4917 | 121 / 0 | 4796 |
| 80 | 4917 | 41 | 4876 | -- | 0 / 0 | -- | -- | 0 / 0 | -- |
| 81 | 4909 | 2 | 4907 | 4907 | 91 / 7 | 4816 | 4816 | >11 / 100 | <4805 |
| 82 | 4908 | 3 | 4905 | 4905 | 90 / 8 | 4815 | 4815 | 50 / 30 | 4765 |
| 84 | 4939 | 57 | 4882 | 4882 | 42 / 7 | 4840 | 4840 | 74 / 8 | 4766 |
| 111 | 4920 | 8 | 4912 | 4912 | 100 / 10 | 4812 | 4812 | 28 / 32 | 4784 |
| 112 | 4927 | 24 | 4903 | 4903 | 109 / 6 | 4794 | 4794 | 17 / 24 | 4777 |
| 113 | 4925 | 20 | 4905 | 4905 | 109 / 8 | 4796 | 4796 | 21 / 38 | 4775 |
| 114 | 4920 | 16 | 4904 | 4904 | 84 / 5 | 4820 | 4820 | 40 / 38 | 4780 |
| 115 | 4919 | 20 | 4899 | 4899 | 91 / 0 | 4808 | 4808 | 24 / 25 | 4784 |
| 116 | 4916 | 28 | 4888 | 4888 | 80 / 0 | 4808 | 4808 | 28 / 54 | 4780 |
| 121 | 4910 | 30 | 4880 | 4880 | 54 / 15 | 4826 | 4826 | 53 / 15 | 4773 |
| 122 | 4914 | 24 | 4890 | 4890 | 78 / 0 | 4812 | 4812 | 31 / 0 | 4781 |
| 123 | 4918 | 32 | 4886 | 4886 | 73 / 0 | 4813 | 4813 | 23 / 26 | 4790 |
| CPP-1 | 4913 | 36 | 4877 | 4877 | 43 / 0 | 4834 | 4834 | 41 / 12 | 4793 |
| CPP-2 | 4915 | 36 | 4879 | 4879 | 47 / 0 | 4832 | 4832 | 50 / 0 | 4782 |
| CPP-4 | 4907 | 34 | 4873 | 4873 | 45 / 0 | 4828 | 4828 | 46 / 0 | 4782 |
| CPP DISP | 4914 | 46 | 4868 | 4868 | 55 / 0 | 4813 | 4813 | 37 / 14 | 4776 |
| MTR TEST | 4917 | 35 | 4882 | 4882 | 57 / 0 | 4825 | 4825 | 33 / 15 | 4792 |
| PW-1 | 4917 | 30 | 4887 | 4887 | 73 / 0 | 4814 | 4814 | >17 / 35 | <4797 |
| PW-2 | 4917 | 18 | 4899 | 4899 | 86 / 0 | 4813 | 4813 | >27 / 56 | <4786 |
| PW-3 | 4916 | 27 | 4889 | 4889 | 75 / 0 | 4814 | 4814 | >23 / 65 | <4791 |
| PW-4 | 4915 | 31 | 4884 | 4884 | 70 / 7 | 4814 | 4814 | 39 / 82 | 4775 |
| PW-5 | 4924 | 29 | 4895 | 4895 | 72 / 0 | 4823 | 4823 | >30 / 67 | <4793 |
| PW-6 | 4920 | 37 | 4883 | 4883 | 70 / 0 | 4813 | 4813 | >28 / 21 | <4785 |
| PW-7 | 4925 | 50 | 4875 | 4875 | 30 / 0 | 4845 | 4845 | 70 / 0 | 4775 |
| PW-8 | 4918 | 64 | 4854 | 4854 | 26 / 0 | 4828 | 4828 | 55 / 0 | 4773 |
| PW-9 | 4927 | 49 | 4878 | 4878 | 31 / 0 | 4847 | 4847 | 65 / 0 | 4782 |
| TRA-1 | 4919 | 54 | 4865 | 4865 | 36 / 0 | 4829 | 4829 | 30 / 0 | 4799 |
| TRA-2 | 4921 | 41 | 4880 | 4880 | 46 / 0 | 4834 | 4834 | 40 / 0 | 4794 |
| TRA-3 | 4919 | 40 | 4879 | 4879 | 49 / 0 | 4830 | 4830 | 33 / 12 | 4797 |
| TRA-4 | 4920 | 39 | 4881 | 4881 | 45 / 11 | 4836 | 4836 | 44 / 0 | 4792 |
| TRA DISP | 4925 | 37 | 4888 | 4888 | 61 / 0 | 4827 | 4827 | 39 / 0 | 4788 |
| SITE 19 | 4923 | 48 | 4875 | 4875 | 46 / 0 | 4829 | 4829 | 34 / 12 | 4795 |

Table 1.--Altitude of the top, thickness, percent sediment, and altitude of the base of composite stratigraphic units from land surface to the base of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area--Continued

[Altitude and thickness rounded to the nearest foot and accurate to ±2 feet. --Indicates no data; < indicates less than; > indicates greater than; % indicates percent]

| | Basalt-flow groups DE2, DE3, DE3-4(W), and DE3-4(E) and related sediment | | | Basalt-flow groups DE4 and DE5 and related sediment | | | Basalt-flow groups DE5-6 DE6, DE7, and DE8 and related sediment | | |
|---|---|---|---|---|---|---|---|---|---|
| Well | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base |
| 74 | 4786 | >49 / 82 | <4737 | -- | -- / -- | -- | -- | -- / -- | -- |
| 75 | -- | 0 / 0 | -- | 4875 | 29 / 0 | 4846 | 4846 | 90 / 12 | 4756 |
| 76 | 4766 | 63 / 56 | 4703 | 4703 | 99 / 10 | 4604 | 4604 | 75 / 7 | 4529 |
| 77 | 4778 | 122 / 5 | 4656 | 4656 | 105 / 6 | 4551 | 4551 | 96 / 18 | 4455 |
| 78 | 4767 | >38 / 13 | <4729 | -- | -- / -- | -- | -- | -- / -- | -- |
| 79 | 4796 | 76 / 51 | 4720 | 4720 | 90 / 6 | 4630 | 4630 | 74 / 4 | 4556 |
| 80 | -- | 0 / 0 | -- | 4876 | 30 / 0 | 4846 | 4846 | 89 / 12 | 4757 |
| 81 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| 82 | 4765 | 117 / 20 | 4648 | 4648 | 117 / 0 | 4531 | 4531 | 84 / 31 | 4447 |
| 84 | 4766 | 52 / 8 | 4714 | 4714 | 90 / 6 | 4624 | 4624 | 111 / 13 | 4513 |
| 111 | 4784 | 130 / 8 | 4654 | 4654 | 116 / 3 | 4538 | 4538 | 99 / 29 | 4439 |
| 112 | 4777 | 98 / 16 | 4679 | 4679 | 103 / 13 | 4576 | 4576 | 91 / 37 | 4485 |
| 113 | 4775 | 112 / 20 | 4663 | 4663 | 117 / 10 | 4546 | 4546 | 61 / 30 | 4485 |
| 114 | 4780 | 112 / 9 | 4668 | 4668 | 137 / 9 | 4531 | 4531 | 64 / 12 | 4467 |
| 115 | 4784 | 100 / 9 | 4684 | 4684 | 158 / 8 | 4526 | 4526 | 61 / 8 | 4465 |
| 116 | 4780 | 99 / 0 | 4681 | 4681 | 128 / 8 | 4553 | 4553 | 91 / 12 | 4462 |
| 121 | 4773 | 105 / 6 | 4668 | 4668 | 154 / 0 | 4514 | 4514 | 22 / 54 | 4492 |
| 122 | 4781 | 126 / 16 | 4655 | 4655 | 91 / 20 | 4564 | 4564 | 115 / 10 | 4449 |
| 123 | 4790 | 109 / 6 | 4681 | 4681 | 119 / 8 | 4562 | 4562 | 117 / 3 | 4445 |
| CPP-1 | 4793 | 94 / 47 | 4699 | 4699 | 129 / 0 | 4570 | 4570 | 104 / 22 | 4466 |
| CPP-2 | 4782 | 69 / 64 | 4713 | 4713 | 146 / 9 | 4567 | 4567 | 97 / 12 | 4470 |
| CPP-4 | 4782 | 81 / 10 | 4701 | 4701 | 132 / 0 | 4569 | 4569 | 82 / 23 | 4487 |
| CPP DISP | 4776 | 117 / 17 | 4659 | 4659 | 116 / 7 | 4543 | 4543 | 89 / 14 | 4454 |
| MTR TEST | 4792 | 76 / 8 | 4716 | 4716 | 38 / 0 | 4678 | 4678 | 49 / 16 | 4629 |
| PW-1 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-2 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-3 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-4 | 4775 | >10 / 0 | <4765 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-5 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-6 | -- | -- / -- | -- | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-7 | 4775 | 85 / 55 | 4690 | 4690 | >2 / 0 | <4688 | -- | -- / -- | -- |
| PW-8 | 4773 | >33 / 54 | <4740 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-9 | 4782 | >56 / 89 | <4726 | -- | -- / -- | -- | -- | -- / -- | -- |
| TRA-1 | 4799 | 80 / 71 | 4719 | 4719 | 98 / 0 | 4621 | 4621 | 82 / 18 | 4539 |
| TRA-2 | 4794 | 76 / 40 | 4718 | 4718 | 100 / 0 | 4618 | 4618 | 73 / 6 | 4545 |
| TRA-3 | 4797 | 89 / 90 | 4708 | 4708 | 91 / 0 | 4617 | 4617 | 57 / 14 | 4560 |
| TRA-4 | 4792 | 75 / 35 | 4717 | 4717 | 105 / 8 | 4612 | 4612 | 76 / 8 | 4536 |
| TRA DISP | 4788 | 81 / 82 | 4707 | 4707 | 86 / 6 | 4621 | 4621 | 66 / 12 | 4555 |
| SITE 19 | 4795 | 78 / 23 | 4717 | 4717 | 82 / 0 | 4635 | 4635 | 60 / 0 | 4575 |

Table 1.--Altitude of the top, thickness, percent sediment, and altitude of the base of composite stratigraphic units from land surface to the base of basalt-flow group I at the Idaho Chemical Processing Plant and Test Reactors Area--Continued

[Altitude and thickness rounded to the nearest foot and accurate to ±2 feet. --Indicates no data; < indicates less than; > indicates greater than; % indicates percent]

| | Basalt-flow groups E, EF, F, FG, G, and H and related sediment | | | Basalt-flow group I and related sediment | | |
|---|---|---|---|---|---|---|
| Well | Altitude of top | Thickness/ % sediment | Altitude of base | Altitude of top | Thickness/ % sediment | Altitude of base |
| 74 | -- | -- / -- | -- | -- | -- / -- | -- |
| 75 | 4756 | 16 / 100 | 4740 | 4740 | >34 / 0 | <4706 |
| 76 | 4529 | 130 / 2 | 4399 | 4399 | 172 / 0 | 4227 |
| 77 | 4455 | >142 / 16 | <4313 | -- | -- / -- | -- |
| 78 | -- | -- / -- | -- | -- | -- / -- | -- |
| 79 | 4556 | 115 / 4 | 4441 | 4441 | 191 / 0 | 4250 |
| 80 | 4757 | 20 / 100 | 4737 | 4737 | >24 / 0 | <4713 |
| 81 | -- | -- / -- | -- | -- | -- / -- | -- |
| 82 | 4447 | 102 / 5 | 4345 | 4345 | >137 / 0 | <4208 |
| 84 | 4513 | >79 / 0 | <4434 | -- | -- / -- | -- |
| 111 | 4439 | >114 / 0 | <4325 | -- | -- / -- | -- |
| 112 | 4485 | >121 / 2 | <4364 | -- | -- / -- | -- |
| 113 | 4485 | >124 / 0 | <4361 | -- | -- / -- | -- |
| 114 | 4467 | >109 / 8 | <4358 | -- | -- / -- | -- |
| 115 | 4465 | >127 / 3 | <4338 | -- | -- / -- | -- |
| 116 | 4462 | >126 / 0 | <4336 | -- | -- / -- | -- |
| 121 | 4492 | 8 / 100 | 4484 | 4484 | 219 / 1 | 4265 |
| 122 | 4449 | >17 / 35 | <4432 | -- | -- / -- | -- |
| 123 | 4445 | 90 / 3 | 4355 | 4355 | 121 / 0 | 4234 |
| CPP-1 | 4466 | 40 / 18 | 4426 | 4426 | >98 / 3 | <4328 |
| CPP-2 | 4470 | 45 / 7 | 4425 | 4425 | >115 / 6 | <4310 |
| CPP-4 | 4487 | 18 / 100 | 4469 | 4469 | 220 / 2 | 4249 |
| CPP DISP | 4454 | 68 / 19 | 4386 | 4386 | >70 / 9 | <4316 |
| MTR TEST | 4629 | 53 / 11 | 4576 | 4576 | >239 / 0 | <4337 |
| PW-1 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-2 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-3 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-4 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-5 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-6 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-7 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-8 | -- | -- / -- | -- | -- | -- / -- | -- |
| PW-9 | -- | -- / -- | -- | -- | -- / -- | -- |
| TRA-1 | 4539 | 25 / 0 | 4514 | 4514 | >195 / 18 | <4319 |
| TRA-2 | 4545 | 47 / 11 | 4498 | 4498 | 264 / 3 | 4234 |
| TRA-3 | 4560 | 52 / 21 | 4508 | 4508 | >191 / 0 | <4317 |
| TRA-4 | 4536 | 36 / 11 | 4500 | 4500 | 277 / 0 | 4223 |
| TRA DISP | 4555 | 100 / 4 | 4455 | 4455 | 250 / 0 | 4205 |
| SITE 19 | 4575 | 118 / 5 | 4457 | 4457 | 203 / 2 | 4254 |