Stratigraphic Data for Wells at and near the Idaho National Engineering Laboratory, Idaho

by S.R. Anderson, Daniel J. Ackerman, and
Michael J. Liszewski, U.S. Geological Survey,
and R.M. Freiburger, formerly with EG&G Idaho, Inc.

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To Obtain
inch (in)	2.540	centimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
gallon	3.785	liter

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 the United States and Canada, formerly called Sea Level Datum of 1929.

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Abstract

A stratigraphic data base containing 230 stratigraphic units in 333 wells was constructed for deposits that make up the unsaturated zone and the Snake River Plain aquifer at and near the Idaho National Engineering Laboratory in eastern Idaho. Stratigraphic units, which were identified and correlated using the data from numerous outcrops, 26 continuous cores, and 328 natural-gamma logs available in December 1993, include 121 basalt-flow groups, 102 sedimentary interbeds, 6 andesite-flow groups, and 1 rhyolite dome. By volume, basalt flows make up about 90 percent of the deposits underlying most of this 890 mi^2 area.

Several types of data were used to identify and correlate stratigraphic units. Basalt, sediment, andesite, and rhyolite were identified from outcrops and cores that were selectively evaluated for paleomagnetic inclination and polarity, K-Ar and $^{40}Ar/^{39}Ar$ ages, petrographic characteristics, and major-oxide and trace-element chemical composition. Stratigraphic units were correlated using these data and natural-gamma logs, which respond to potassium contents of less than 1 percent in basalt to more than 4 percent in rhyolite. The best correlations were obtained for basalt and sediment at Test Area North, the Naval Reactors Area, the Test Reactor Area, the Idaho Chemical Processing Plant, and the Radioactive Waste Management Complex, where most cores and two thirds of the logs were obtained. Correlations range from good at the Radioactive Waste Management Complex to uncertain in the eastern half of the study area.

Copies of the stratigraphic data are contained on a 3 1/2-inch diskette included with this report. The data are presented in two styles in American Standard Code for Information Interchange (ASCII) format. Two files, one for well-site information and one for stratigraphic information, are presented with comma delimited fields. These two files are suitable for creation of a stratigraphic data base by most software capable of importing raw data. A third file presents the well information and stratigraphic information as text in a table format, generally one page per well. The files occupy 0.03, 0.26, and 0.81 megabyte disk space respectively.

INTRODUCTION

The Idaho National Engineering Laboratory (INEL) is operated by the U.S. Department of Energy (DOE) and covers about 890 mi^2 of the eastern Snake River Plain in eastern Idaho (fig. 1). Facilities at the INEL are used in the development of peacetime atomic-energy applications, nuclear safety research, defense programs, and advanced energy concepts. Liquid radionuclide and chemical wastes generated at these facilities have been discharged to onsite infiltration ponds and disposal wells since 1952. Liquid-waste disposal has resulted in detectable concentrations of several waste constituents in water in the Snake River Plain aquifer underlying the INEL (Orr and Cecil, 1991).

Concern about the potential for migration of radioactive and chemical wastes in the unsaturated zone and aquifer has resulted in numerous studies of the subsurface at the INEL. In 1988, the U.S. Geological Survey (USGS) in cooperation with the DOE, began a study of the stratigraphy of volcanic and sedimentary units underlying the INEL to determine stratigraphic relations that might affect the movement of wastes. Three earlier reports, Anderson and Lewis (1989), Anderson (1991), and Anderson and Bowers (1995), describe stratigraphic relations and their

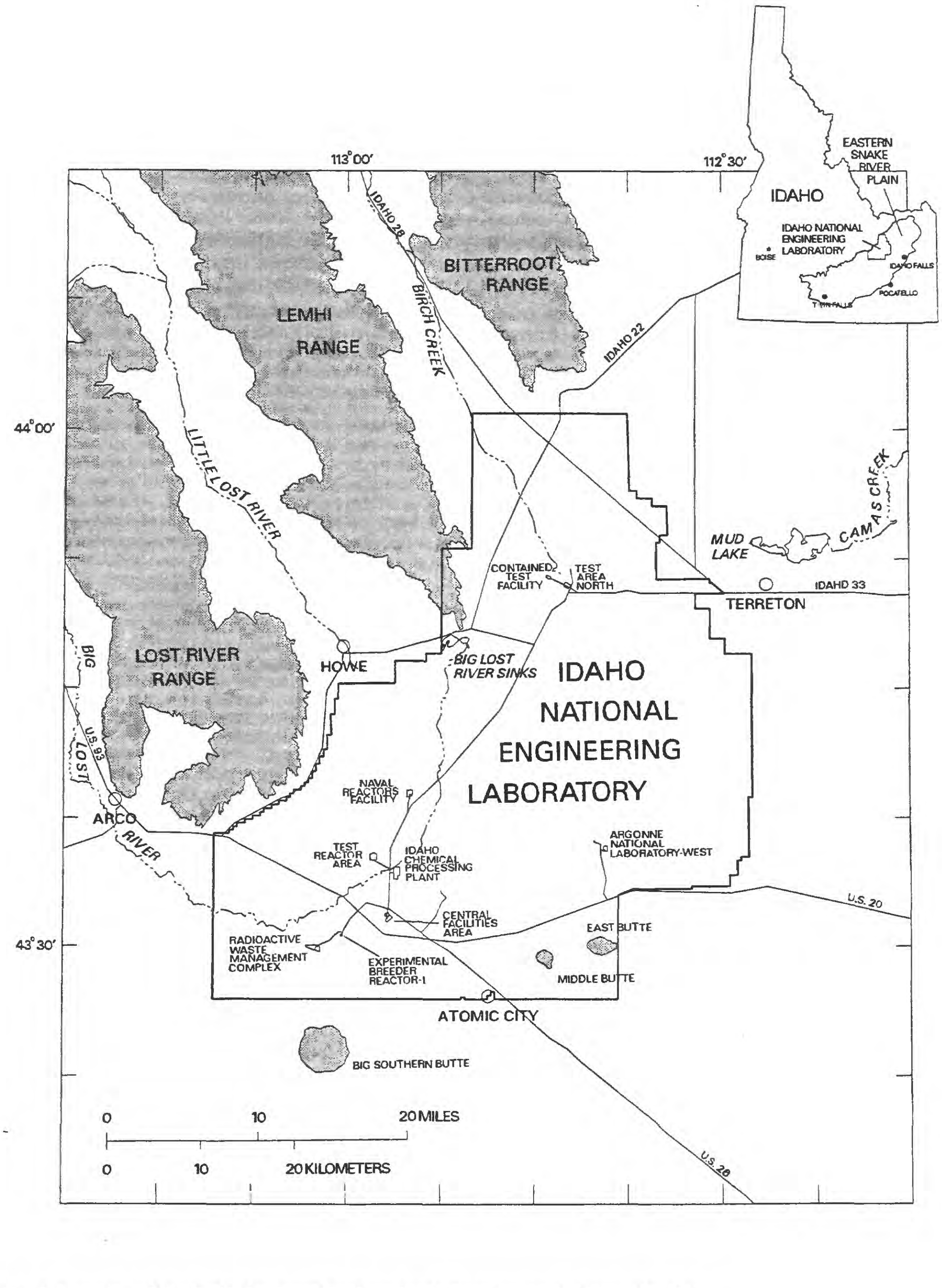

Figure 1. Location of the Idaho National Engineering Laboratory and selected facilities.

implications regarding the movement of wastes at the Radioactive Waste Management Complex (RWMC), the Idaho Chemical Processing Plant (ICPP), the Test Reactor Area (TRA) and Test Area North (TAN) (fig. 1). Other facilities where detailed stratigraphic studies were conducted include the Contained Test Facility (CTF), Naval Reactors Facility (NRF), Argonne National Laboratory-West (ANL-W), Central Facilities Area (CFA), and Experimental Breeder Reactor-1 (EBR-1) (fig 1). Although earlier reports contain important geologic discussions, detailed stratigraphic relations and the names used to identify stratigraphic units described therein are superceded by those in this report.

In this report, a stratigraphic unit is defined as the smallest layer of a rock sequence that can be subdivided and correlated using the data available in December 1993. Stratigraphic units described in this report include 121 basalt-flow groups, 102 sedimentary interbeds, 6 andesite-flow groups, and 1 rhyolite dome. Andesite, following the general usage of Kuntz and others (1994), refers to rocks such as those of Cedar Butte that consist mainly of trachyandesite and trachydacite (Le Bas and others, 1986; Hayden, 1992; Fishel, 1993).

Purpose and Scope

This report describes a data base containing 230 stratigraphic units in 333 wells that make up the unsaturated zone and the Snake River Plain aquifer at and near the INEL. The data base provides an intermediate-scale, computer-ready stratigraphic framework for users who need this type of geologic information. Because most wells are completed in the unsaturated zone or in the uppermost part of the aquifer, stratigraphic data for the lowermost part of the aquifer are limited. Areal coverage of the data base corresponds with that of the geologic map presented by Kuntz and others (1994), although most wells from which data were obtained are within the boundaries of the INEL. Data are concentrated near major facilities (figs. 1-5; table 1, located at end of this report), and are sparse elsewhere. The data base is constructed so that stratigraphic units can be sorted and rearranged by lithologic type for less detail or multiplied by a layering number for more detail. These features may be useful for applications such as determining the aggregate thickness of sediment and the total number of basalt-flow contacts in a model layer composed of numerous basalt-flow groups and sedimentary interbeds.

Approach

Several types of data were used to identify and correlate stratigraphic units underlying the INEL and adjacent areas. Volcanic and sedimentary units were identified from outcrops and cores selectively evaluated for paleomagnetic inclination and polarity, K-Ar and $^{40}Ar/^{39}Ar$ ages, petrographic characteristics, and major-oxide and trace-element chemical composition. Stratigraphic units were correlated using these data and natural-gamma logs, which respond to potassium contents of less than 1 percent in basalt to more than 4 percent in rhyolite. The distribution and characteristics of basalt, sediment, andesite, and rhyolite outcrops are described by Kuntz and others (1994). The cores and sources of data used to identify stratigraphic units underlying the area are summarized in table 2 (located at the end of this report). The method for correlating stratigraphic units using cores and natural-gamma logs is described by Anderson and Bartholomay (1996). Stratigraphic relations were determined using numerous outcrops and 26 continuous cores and 328 natural-gamma logs obtained from the wells shown in figures 2-5 and table 1. Natural-gamma logs for many of these wells are available in a report by Bartholomay (1990). These and all other logs are on file at the INEL project office of the USGS. Cores are available for inspection at the INEL Lithologic Core Storage Library.

Names, types, altitudes, depths, and thicknesses of stratigraphic units form the main body of data presented in this report. Depths of stratigraphic units, in feet below land surface, were determined visually from natural-gamma logs showing the upper and lower contacts of units after final correlations were made. Depth information, which is considered accurate to the nearest ±2 ft, was transferred to data sheets and then entered into the data base. Altitude and

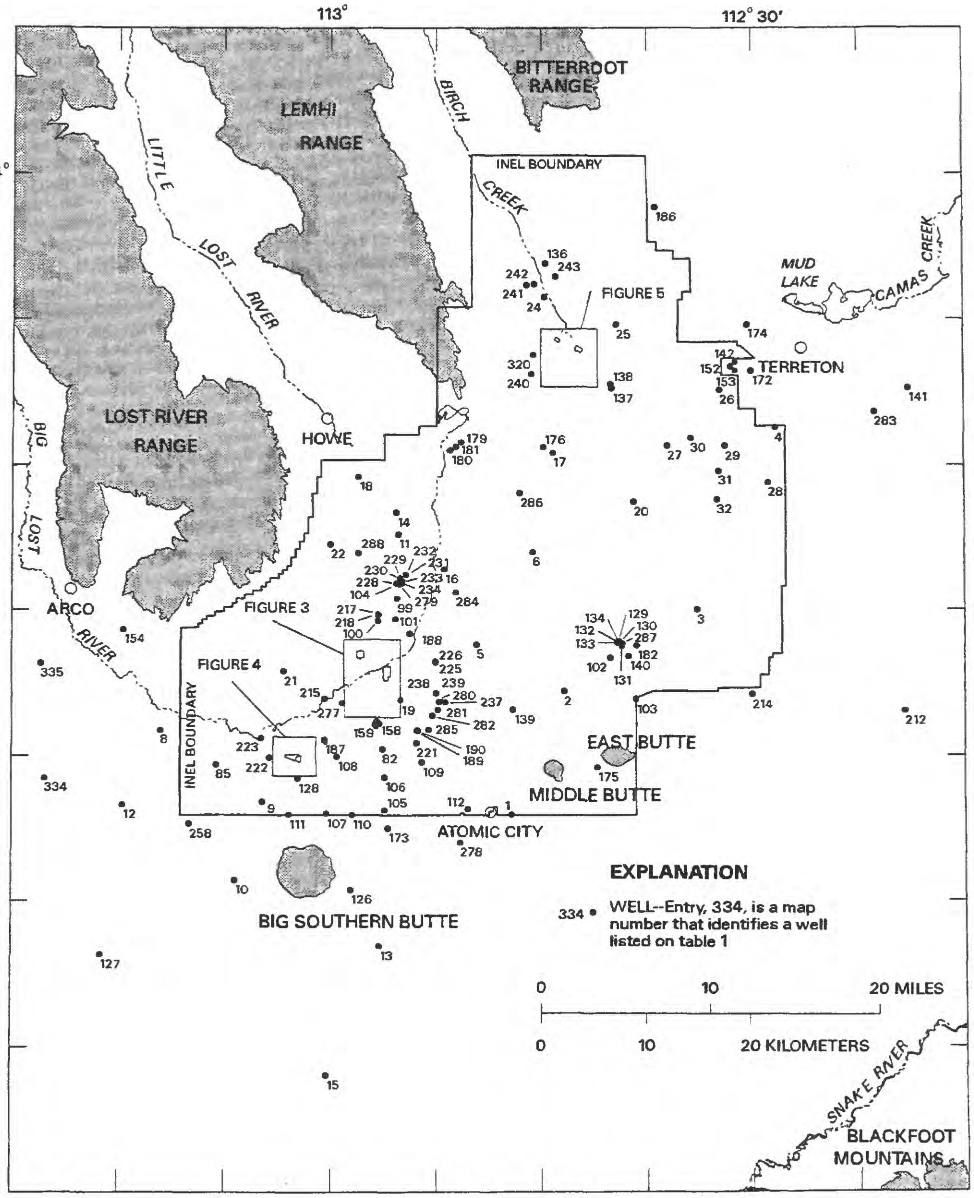

Figure 2. Locations of wells at and near the Idaho National Engineering Laboratory for which stratigraphic data are available.

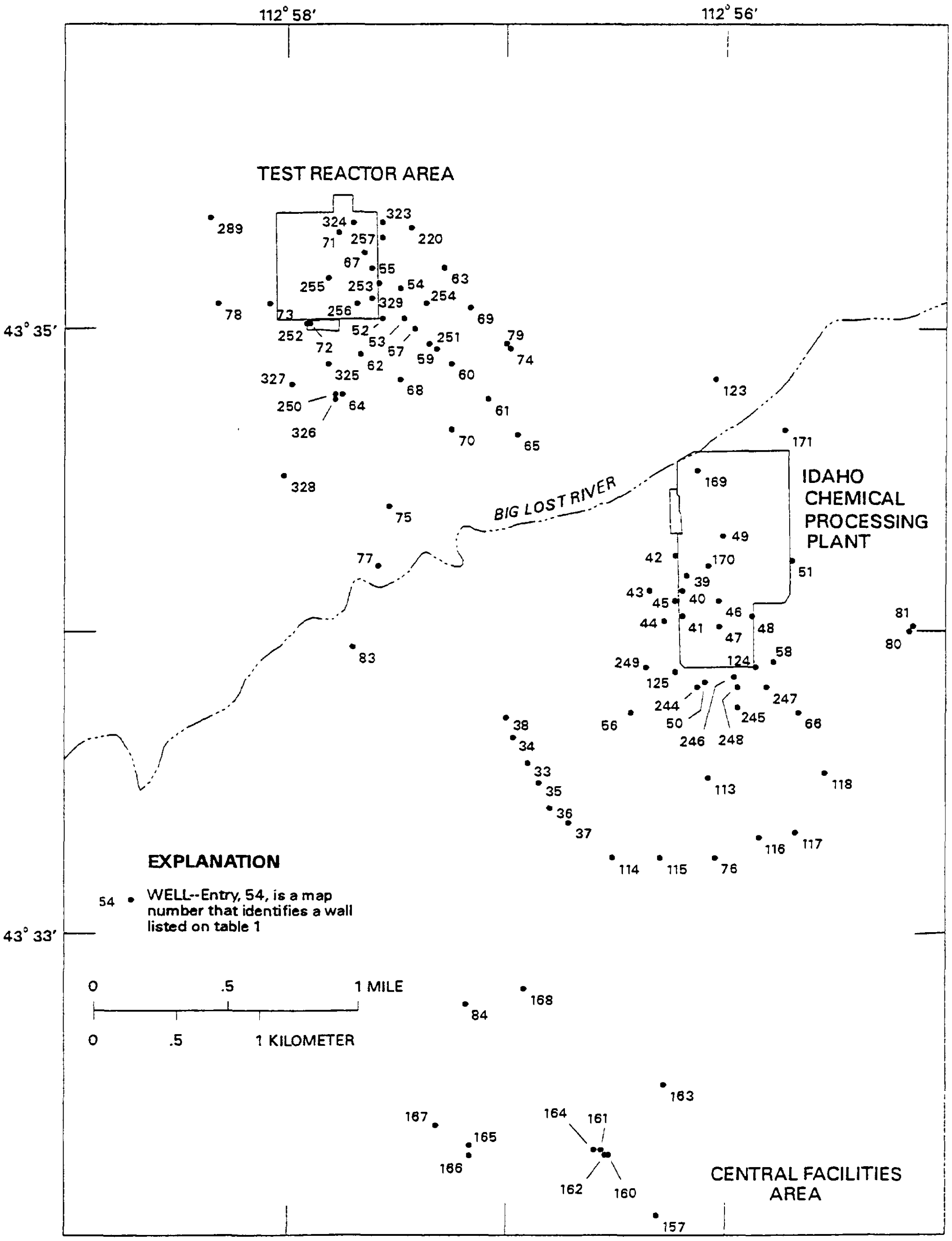

Figure 3. Locations of wells at and near the Idaho Chemical Processing Plant, Test Reactor Area, and Central Facilities Area for which stratigraphic data are available.

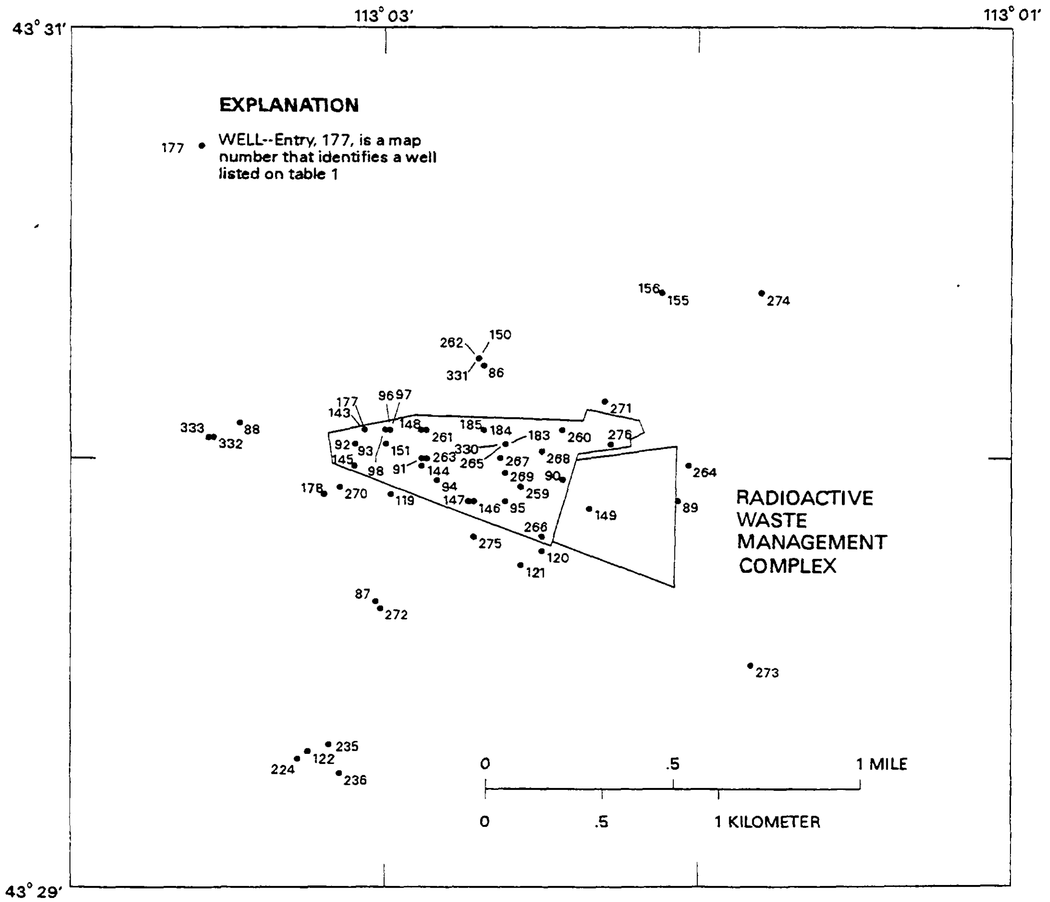

Figure 4. Locations of wells at and near the Radioactive Waste Management Complex for which stratigraphic data are available.

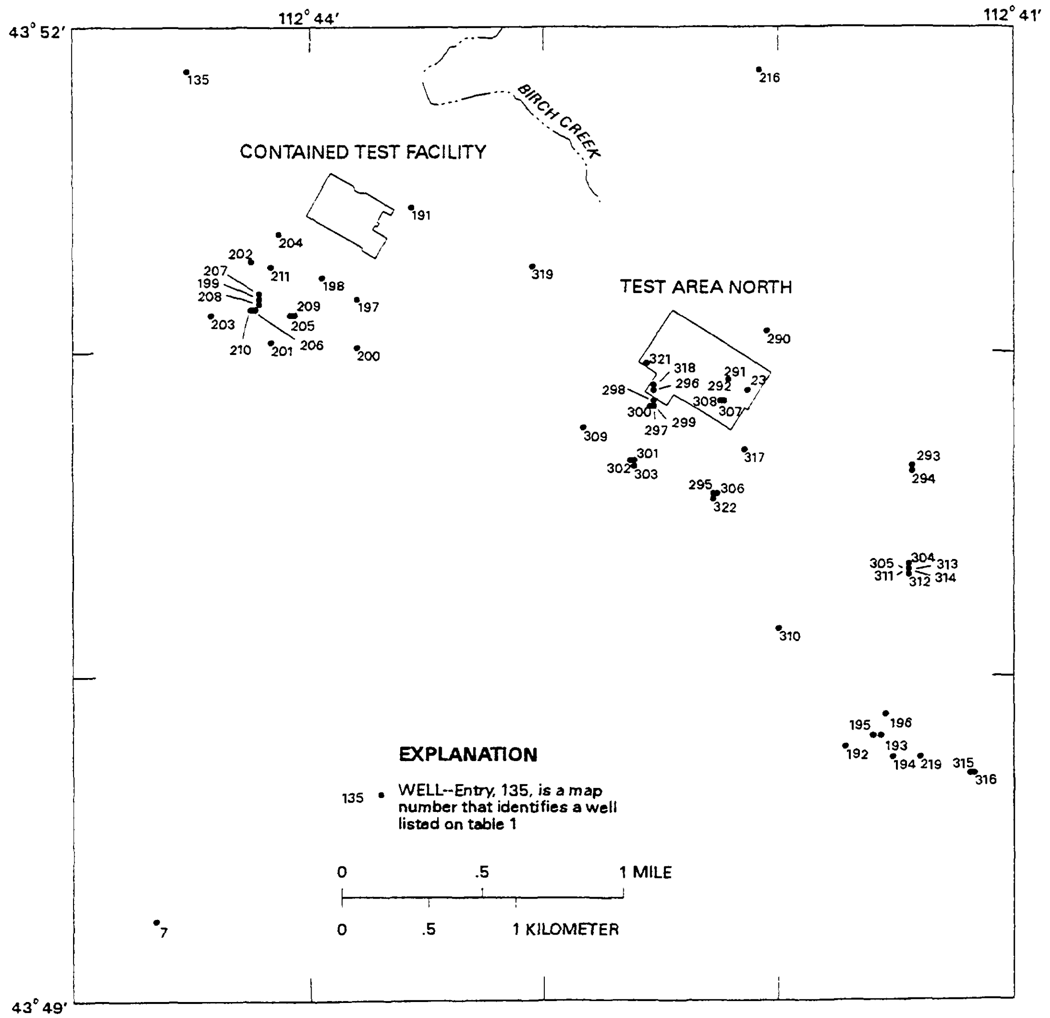

Figure 5. Locations of wells at and near the Contained Test Facility and Test Area North for which stratigraphic data are available.

thickness of stratigraphic units were calculated using land-surface altitude and depth information. All stages of this process were manually or automatically verified to ensure that stratigraphic data were correct. The original gamma logs and data sheets showing stratigraphic interpretations and well-site information are on file with a copy of this report at the INEL project office of the USGS. Printouts of final data tables and reports and files from which well-site information was compiled also are available. Well-site information for 256 of the 333 wells in this report were compiled from Bagby and others (1984) and Bartholomay (1990). Latitude, longitude, and altitude were determined from maps and standard surveying methods and are tied to the North American Datum of 1927 and the National Geodetic Vertical Datum of 1929.

Acknowledgments

Technical assistance in preparing the stratigraphic data base was provided by Richard P. Smith, Lockheed Idaho Technologies Co. Funding for data entry was provided by the Department of Environmental Restoration, EG&G Idaho, Inc. Technical assistance and data from numerous geologic investigations were obtained from Duane E. Champion, Marvin A. Lanphere, and Mel A. Kuntz, USGS, Geologic Division. Core-sampling supervision was provided by Linda C. Davis, USGS, Water-Resources Division. Numerous employees of the DOE and its INEL contractors, the State of Idaho, and the USGS provided wells, cores, logs, and technical assistance that greatly improved the quality of stratigraphic interpretations described in this report.

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 sequence of Tertiary and Quaternary volcanic rocks and sedimentary interbeds that is more than 10,000 ft thick (Doherty and others, 1979; Whitehead, 1992; Smith and others, 1994; Hackett and others, 1994). The volcanic rocks consist mainly of basaltic lava flows, ash, and cinders in the upper part and rhyolitic ash flows and tuffs in the lower part. In places, especially along the axis of the plain, Quaternary rhyolite domes stand as high as 2,000 ft above the surface of the plain. The basaltic rocks, which are interbedded with andesite and sediment, underlie the plain to depths ranging from 2,265 to 3,770 ft in the southwestern part of the INEL. Sediment consists of fluvial, lacustrine, and eolian deposits of clay, silt, sand, and gravel. Source vents for the basalt, andesite, and rhyolite are concentrated in a volcanic zone along the axis of the plain and in volcanic rift zones that trend perpendicular to the axis of the plain (Kuntz and others, 1992; Kuntz and others, 1994).

The INEL is underlain by hundreds of basalt flows, basalt-flow groups, and sedimentary interbeds; by volume, basalt makes up about 90 percent of the volume of deposits in the unsaturated zone and the aquifer in most areas. 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). A basalt-flow group consists of one or more distinct basalt flows deposited during a single eruptive event (Kuntz and others, 1980). All basalt flows of each group erupted from the same vent or vents and have similar ages, paleomagnetic properties, potassium contents, and natural-gamma emissions (Anderson and Bartholomay, 1996). The basalt flows, which locally are altered (Fromm and others, 1994), consist mainly of medium- to dark-gray vesicular to dense olivine basalt. Individual flows are as much as 100 ft thick and in places are interbedded with cinders and thin layers of sediment. Sedimentary interbeds, which are most abundant between flow groups, accumulated on the ancestral land surface for hundreds to hundreds of thousands of years during periods of volcanic quiescence. 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.

The basalt and sediment underlying the INEL are saturated at depth and together form the Snake River Plain aquifer. Depth to water at the INEL ranges from about 200 ft below land surface in the northern part to about 900 ft in the southern part (Ott and others, 1992); the general direction of ground-water flow is northeast to southwest. The effective base of the aquifer at the INEL generally coincides with the top of a thick and widespread layer of clay, silt, sand, and altered basalt that is older than about 1.6 million years (Anderson and Bowers, 1995). The top of this layer ranges in depth from 815 to 1,710 ft below land surface in the western half of the INEL (table 3, located at the end of this report). The effective saturated thickness of the aquifer ranges from about 600 ft near TAN to about 1,200 ft near the ICPP and RWMC (fig. 1). Saturated thickness in the eastern half of the INEL may be greater than 1,200 ft. 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, the basalt and sediment in the uppermost part of the aquifer yield thousands of gallons per minute of water to wells, with negligible drawdown (Ackerman, 1991). Hydraulic data for the basalt, sediment, ash, and tuff underlying the aquifer are sparse, but data from well INEL-1 (fig. 2; tables 1 and 3) indicate that these deposits are relatively impermeable compared to the aquifer (Mann, 1986). Localized zones of perched ground water, which are attributed mainly to infiltration of water from unlined percolation ponds and recharge from the Big Lost River, are present in basalt and sediment overlying the regional aquifer (Cecil and others, 1991).

STRATIGRAPHIC FRAMEWORK

About 100 basalt flows, 1 andesite flow, 4 rhyolite domes, and surficial sediment cover the INEL and adjacent areas (Kuntz and others, 1994). Deposits identified in 333 wells completed in the unsaturated zone and the Snake River Plain aquifer include 121 basalt-flow groups, 102 sedimentary interbeds, 6 andesite-flow groups, and 1 rhyolite dome. Outcrops and subsurface deposits are subdivided into about 300 stratigraphic units, each of which is assigned an informal alphanumeric name, from Au(1) to S5(1), that corresponds to its age relative to other units. The youngest of the 232 units identified in wells is designated Al(1) and the oldest is designated S5(1) (table 4, located at the end of this report). Additional names, such as Au(1) through Au(5), and Al(7), AB(25), and LM4(3), are reserved for about 70 surficial units that were not identified in wells and are not listed in table 4. Stratigraphic units consist of basalt-flow groups, surficial sediment/sedimentary interbeds, andesite-flow groups, and rhyolite domes. Basalt and andesite erupted from numerous vents, many of which are now buried by younger deposits (Anderson and Lewis, 1989; Anderson, 1991; Kuntz and others, 1994; Anderson and Bowers, 1995).

Stratigraphic units and names were modified from and supercede those described earlier at the RWMC (Anderson and Lewis, 1989), the ICPP and TRA (Anderson, 1991), and TAN (Anderson and Bowers, 1995). A numerical suffix was added to all names to describe the relative age of units having the same letter name (table 4). For example, the names of basalt-flow groups B, C, and F at the RWMC and LM(E), LM(W), and P at TAN were changed to B(1), C(1), F(1), LM6(2), LM6(3), and P(1), respectively. The name of the youngest flow group, A, at the RWMC was changed to Al(9) to show its age relative to the youngest unit at the INEL, Au(1). Many units, such as basalt-flow groups DE3-4(E) and DE3-4(W) at the ICPP and TRA, were subdivided and renamed on the basis of new data; these flow groups are now referred to as DE3-4(1), DE3-4(2), DE3-4(3), and DE3-4(4), respectively. The names of sedimentary interbeds, such as C-D at the RWMC and P-Q at TAN, also were changed to correspond with the names used for volcanic units of the same or similar age; these interbeds are now referred to as CD(1) and PQ(1). Differences between this stratigraphic framework and earlier frameworks are least at TAN and greatest at the ICPP and TRA.

Ages of selected basalt, andesite, and rhyolite outcrops and cores were measured using various methods (Kuntz and others, 1994; Lanphere and others, 1994; Forman and others, 1994; Lanphere and others, 1993; Forman and others, 1993;

Champion and others, 1988; and tables 2 and 5, located at the end of this report). Ages of selected basalt-flow groups also were estimated using linear accumulation rates in selected wells to evaluate measured ages of flow groups with respect to their stratigraphic position in the subsurface (table 5). Ages of surficial volcanic units range from about 5.2 thousand to 1.40 million years (Kuntz and others, 1994). Measured ages of basalt-flow groups Al(9) through S5(1) in the unsaturated zone and Snake River Plain aquifer range from about 100 thousand to 2.56 million years (table 5). Estimated ages of flow groups Al(9) through S5(1) range from about 100 thousand to 1.60 million years (table 5). Agreement between measured and estimated ages is good for flow groups Al(9) through R1(1) and poor for flow groups S1(1) through S5(1) (table 5). Flow groups S1(1) through S5(1), which were identified only in the subsurface at and near TAN, either yielded unreliable measured ages (Anderson and Bowers, 1995) or are incorrectly assigned to the lowermost part of the aquifer. This conclusion is based on a unique flow group, TU(1), situated just below the effective base of the aquifer near the ICPP, that yielded a convincing $^{40}Ar/^{39}Ar$ and paleomagnetic age of about 1.86 million years (M.A. Lanphere, USGS, written commun., 1995). Determining the ages of basalt flows at the INEL is difficult because the flows are extremely young and are altered in and below the lowermost part of the aquifer. The most reliable measured ages generally are obtained from outcrops, the unsaturated zone, and the uppermost part of the aquifer (table 5).

Ages of stratigraphic units were constrained by paleomagnetic inclination and polarity data obtained from 25 cores (table 2). Stratigraphic units younger than about 780 thousand years generally have normal paleomagnetic polarity and are assigned to the Brunhes Normal-Polarity Chron (table 5). Flow group F(1), a unique stratigraphic marker in the lowermost part of the unsaturated zone and uppermost part of the aquifer, has reversed polarity, an age of about 565 thousand years, and is assigned to the Big Lost Reversed-Polarity Subchron (Champion and others, 1988). Units older than about 780 thousand years generally have reversed paleomagnetic polarity and are assigned to the Matuyama Reversed-Polarity Chron. Flow group TU(1), a unique stratigraphic marker just below the effective base of the aquifer, has normal polarity, an age of about 1.86 million years, and is assigned to the Olduvai Normal-Polarity Subchron (M.A. Lanphere, USGS, written commun., 1995). Paleomagnetic inclination of flow groups generally ranges from 40 to 80 degrees and is similar for all flows of each group. In well USGS 80 for example, inclination ranges from 53.9±1.9 degrees for flow group I(1) to 76.0±2.4 degrees for flow group DE5-6(3) (Lanphere and others, 1993). In well TCH #1, inclination ranges from -50.2±3.9 degrees for flow group R1(1) to -71.5±0.6 degrees for flow groups O(1), P(1), and Q(1) (Lanphere and others, 1994).

Of the youngest 73 basalt-flow groups identified in outcrops, units Au(2) through Au(5), Al(2) through Al(13), and AB(2) through AB(58), only 22 were identified in wells. This is due partly to the distribution of flow groups and partly to the distribution of wells from which cores and natural-gamma logs were obtained. Although some young flow groups were locally derived, most erupted from vents east, south, and west of the INEL (Kuntz and others, 1994) and did not have sufficient volume to cover the area now occupied by TAN, NRF, ICPP, TRA, CFA, and RWMC where most cores and two thirds of the natural-gamma logs were obtained. Identification and correlation of young flow groups in outlying areas were aided by knowing the distribution of outcrops. However, because cores and wells are sparse in these areas, identification and correlation of older flow groups are uncertain and may be biased by data collected from facilities located near the Big Lost River (fig. 1). Positive identifications and good correlations have been demonstrated for some older flow groups using cores obtained from wells up to 10 miles apart (Kuntz and others, 1980; Champion and others, 1988; Lanphere and others, 1993; Lanphere and others, 1994). However, additional cores will be needed to verify similar interpretations made from natural-gamma logs for older flow groups in outlying areas. If the number and distribution of older flow groups is similar to that of young flow groups, there may be as many as 300 additional flow groups, not yet identified, in the unsaturated zone and aquifer in outlying areas. Using the data obtained as of December 1993, correlations range from good at the RWMC to uncertain in the eastern half of the study area.

Although the number and distribution of flow groups in some areas are uncertain, the age and integrity of the stratigraphic framework are strengthened by the presence of many widespread sedimentary interbeds. The most widespread interbeds, B-BC(2), CD(1), DE2-3(1), DE5-6(6), DE9(1), and HI(1) (table 4), have ages of about 225, 270, 360, 460, 500, and 630 thousand years, respectively. These and other interbeds and the surficial sediment, Au(1), Al(1), AB(1), and B(1), were deposited over large areas during periods of general volcanic quiescence that include the past 200 thousand years.

The distribution of basalt and sediment was controlled, in part, by subsidence and uplift as described by Anderson (1991) and Anderson and Bowers (1995). Uplift near TAN about 800 thousand years ago following the eruption of flow group LM1(1) controlled the distribution of younger basalt and sediment south and east of TAN. Similar uplifts occurred near the ICPP, TRA, and RWMC from about 580 to 350 thousand years ago and affected the distribution of basalt-flow groups DE1(1) through H(1) and related sediment; uplift prevented a thick and wide-spread sequence of basalt and sediment, DE1(1) through DE8(1) (table 4), from accumulating at the RWMC. Areas of localized uplift, which are attributed to deep silicic intrusions, faulting, differential subsidence, or other processes, coincided with regional subsidence (Smith and others, 1994) and accumulation of deposits during the last 1.6 million years. These structural processes greatly affected and complicated the stratigraphic framework of the INEL and adjacent areas.

DESCRIPTION OF DATA TABLES

Stratigraphic data for 333 wells (table 1) in the unsaturated zone and the Snake River Plain aquifer are presented in two styles in tables 6, 7, and 8 on a 3 1/2-inch micro floppy disk. The data are presented as text in a table format (table 6, diskette) and as comma delimited raw data files (tables 7 and 8, diskette).

Each page of table 6 includes well-site and stratigraphic data for a well at or near the INEL. Most wells occupy a single page; two wells, Highway # 1 Piezo A and NPR WO-2 (table1), cover two pages. Using well USGS 23 as an example, figure 6 shows how the data are presented and explains each table entry. Entries for well USGS 23 indicate that 18 stratigraphic units, consisting of surficial sediment, 13 basalt-flow groups, and 4 sedimentary interbeds, were identified in this well. Entries for Depth of hole and Depth of log indicate that the last 4 feet of flow group F(1), which is not fully penetrated by the well, are estimated in well USGS 23. Entries for Site identifier and Depth of well indicate that well USGS 23 was inventoried by the USGS as of December 1993 and is used for hydrologic monitoring. Well USGS 23 is located west of the NRF in Butte County on USGS 7.5 minute topographic map Circular Butte 3 NW. Well USGS 23, which is completed in the uppermost part of the aquifer, is typical of most wells at and near the INEL. Depth to water in the well, data that are not included in tables 6, 7, and 8, was about 397 ft and saturated thickness of deposits was about 70 ft in December 1990 (Ott and others, 1992). An entry for Secondary name indicates that geophysical logs for well USGS 23 were published by Bartholomay (1990).

The comma delimited raw data files (tables 7 and 8) are provided for users who may wish to construct their own data base. Table 7 provides information for each data field for each well in the following order:

1. Primary name
2. Secondary name
3. Well location
4. Site identifier
5. Latitude
6. Longitude
7. Altitude of well
8. Depth of well
9. Depth of hole
10. Depth of log
11. County
12. Map.

Primary name: local well identifier used by the USGS in December 1993; see table 1. **Secondary name:** local well identifier used by Bartholomay (1990); entry indicates that geophysical logs have been published. **Well location:** township, range, and section of well; see figure 8. **Site identifier**: unique numerical identifier of well inventoried by the USGS as of December 1993. **Latitude:** in degrees, minutes, and seconds. **Longitude**: in degrees, minutes, and seconds. **Altitude of well:** altitude of land surface at well, in feet above sea level. **Depth of well:** total depth of well used for hydrologic monitoring, in feet below land surface. **Depth of hole:** in feet below land surface. **Depth of log:** total depth of natural-gamma log, if available, in feet below land surface. **County:** county in which the well is located. **Map:** USGS 7.5 minute topographic map on which the well is located. **Stratigraphic unit:** the smallest layer of a rock sequence that can be subdivided and correlated using available data. **Name:** an informal alphanumeric name assigned to a stratigraphic unit; see table 4. **Type:** generalized lithologic description of a stratigraphic unit. Entries include the following types : Bas = basalt; Sed = sediment; And = andesite; and Rhy = rhyolite; see table 4. **Altitude:** altitude of a geologic contact, in feet above sea level. **Top:** altitude of the uppermost contact. **Base:** altitude of the lowermost contact. **Depth:** depth to a geologic contact, in feet below land surface. **Top:** depth to the uppermost contact. **Base:** depth to the lowermost contact. **Thickness:** thickness of a stratigraphic unit, in feet. **Layers**: estimated number of layers that make up a stratigraphic unit. **Symbols:** <, indicates less than. >, indicates greater than. Entries for altitude, depth, and thickness are rounded to the nearest foot and are accurate to ±2 feet.

Example of an entry from table6.txt for well USGS 23.

Table 6. Well site and stratigraphic information used for constructing a stratigraphic data base of deposits underlying the Idaho National Engineering Laboratory and adjacent areas--Continued

Primary name: USGS 23	Altitude of well: 4884 ft
Secondary name: USGS-23	Depth of well: 463 ft
Well location: 04N 29E 09dcd1	Depth of hole: 467 ft
Site Identifier: 434055112595901	Depth of log: 463 ft
Latitude: 434055	County: Butte
Longitude: 1125959	Map: Circular Butte 3 NW

Stratigraphic Unit		Altitude		Depth		Thickness	Layers
Name	Type	Top	Base	Top	Base		
A1(1)	Sed	4884	4879	0	5	5	1
AB(8)	Bas	4879	4862	5	22	17	1
BC(1)	Bas	4862	4818	22	66	44	2
DE1(3)	Bas	4818	4805	66	79	13	1
DE2(1)	Bas	4805	4784	79	100	21	2
DE2-3(1)	Sed	4784	4773	100	111	11	1
DE2-3(2)	Sed	4773	4760	111	124	13	1
DE3(1)	Bas	4760	4735	124	149	25	2
DE4(1)	Bas	4735	4681	149	203	54	3
DE5(1)	Bas	4681	4621	203	263	60	3
DE5-6(6)	Bas	4621	4550	263	334	71	3
DE7(1)	Bas	4550	4535	334	349	15	1
DE8(1)	Bas	4535	4495	349	389	40	2
E(1)	Bas	4495	4466	389	418	29	2
E(2)	Sed	4466	4461	418	423	5	1
EF(1)	Bas	4461	4445	423	439	16	1
EF(2)	Sed	4445	4437	439	447	8	1
F(1)	Bas	4437	<4417	447	>467	>20	1

Figure 6. Example from table 6 showing well-site and stratigraphic data for USGS 23.

Table 8 provides entries for each stratigraphic unit for each data field for each well in the following order:

1. Primary name
2. Stratigraphic unit Name
3. Stratigraphic unit Type
4. Altitude of the Top
5. Qualifier for Altitude of the Base
6. Altitude of the Base
7. Depth to the Top
8. Qualifier for Depth to the Base
9. Depth to the Base
10. Qualifier for Thickness
11. Thickness
12. Layers.

Fields which are empty have no data between delimiters. Using well USGS 23 as an example, figure 7 (below) shows how the data in tables 7 and 8 are presented.

The data files (tables 6-8) are on a high-density, double-sided micro floppy disk with a capacity of 1.44 megabytes. The files were stored by a computer compatible with the MS-DOS operating system in American Standard Code for Information Interchange (ASCII) format. The table numbers, file names, and approximate file lengths are:

Table 6, table6.txt, 0.81 megabytes;

Table 7, table7.dat, 0.03 megabytes; and

Table 8, table8.dat, 0.26 megabytes.

Each well in the stratigraphic data base is identified by a Primary name in tables 6, 7, and 8 and can be located by a Well location or by a Latitude and Longitude listed in tables 6 and 7. The Idaho well-numbering system for a Well location listed in tables 6 and 7 is described in figure 8.

Example of an entry from file table7.dat for well USGS 23.

```
USGS 23,USGS-23,04N 29E 09dcd1,434055112595901,434055,1125959,4884,463,467,463,Butte,Circular Butte 3 NW
```

Example of an entry from file table8.dat for well USGS 23.

```
USGS 23,Al(1),Sediment,4884,,4879,0,,5,,5,1
USGS 23,AB(8),Basalt,4879,,4862,5,,22,,17,1
USGS 23,BC(1),Basalt,4862,,4818,22,,66,,44,2
USGS 23,DE1(3),Basalt,4818,,4805,66,,79,,13,1
USGS 23,DE2(1),Basalt,4805,,4784,79,,100,,21,2
USGS 23,DE2-3(1),Sediment,4784,,4773,100,,111,,11,1
USGS 23,DE2-3(2),Sediment,4773,,4760,111,,124,,13,1
USGS 23,DE3(1),Basalt,4760,,4735,124,,149,,25,2
USGS 23,DE4(1),Basalt,4735,,4681,149,,203,,54,3
USGS 23,DE5(1),Basalt,4681,,4621,203,,263,,60,3
USGS 23,DE5-6(6),Basalt,4621,,4550,263,,334,,71,3
USGS 23,DE7(1),Basalt,4550,,4535,334,,349,,15,1
USGS 23,DE8(1),Basalt,4535,,4495,349,,389,,40,2
USGS 23,E(1),Basalt,4495,,4466,389,,418,,29,2
USGS 23,E(2),Sediment,4466,,4461,418,,423,,5,1
USGS 23,EF(1),Basalt,4461,,4445,423,,439,,16,1
USGS 23,EF(2),Sediment,4445,,4437,439,,447,,8,1
USGS 23,F(1),Basalt,4437,<,4417,447,>,467,>,20,1
```

Figure 7. Example of data records from tables 7 and 8 showing well-site and stratigraphic information for well USGS 23.

The U.S. Geological Survey in Idaho numbers well locations within the official rectangular subdivision of the public lands, with reference to the Boise base line and Meridian. For example, the first segment (3N) of well number 03N-29E-24dad2 designates the township north or south, the second (29E), the range east or west, and the third (24), the section in which the well is located. Letters (dad) following the section number indicate the well's location within the section and are assigned in counterclockwise order beginning with the northeast quarter. The first letter (d) denotes the 1/4 section (160-tract), the second (a) denotes the 1/4-1/4 section (40-acre tract), and the third (d) denotes the 1/4-1/4-1/4 section (10-acre tract). The last number (2) is a serial number assigned when the well was inventoried.

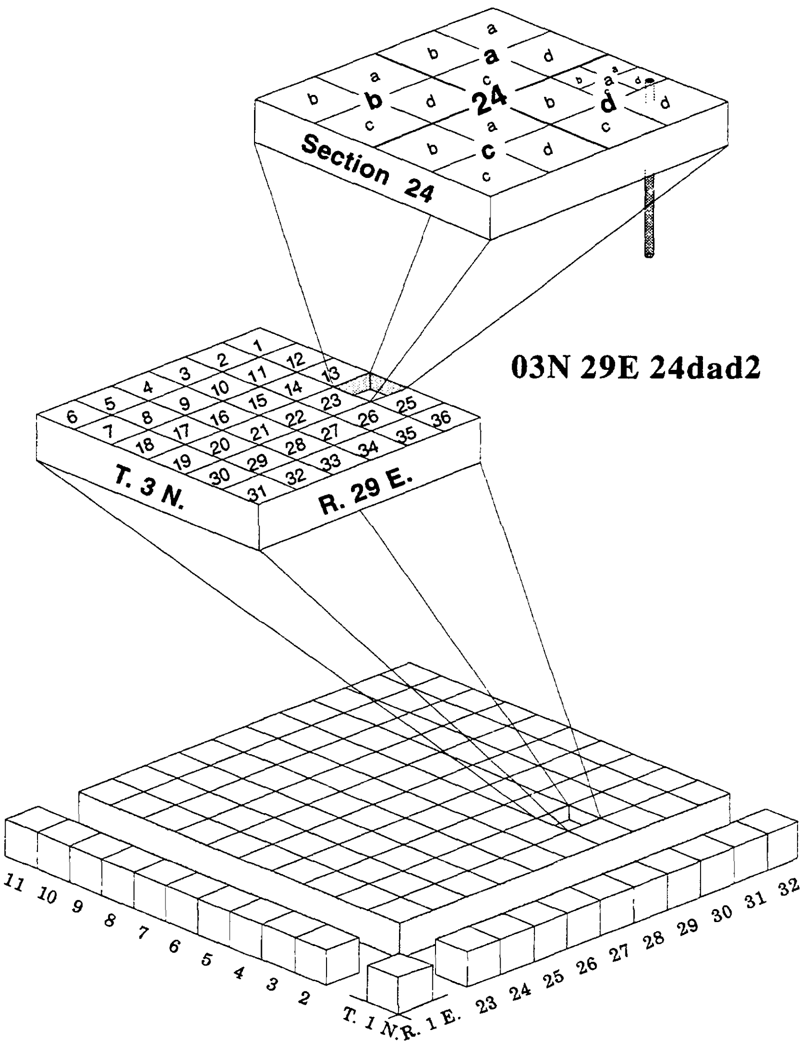

Figure 8. Idaho well-numbering system.

SUMMARY

A stratigraphic data base containing 230 stratigraphic units in 333 wells was constructed for deposits that make up the unsaturated zone and the Snake River Plain aquifer at and near the Idaho National Engineering Laboratory. Stratigraphic units, which were identified and correlated using the data from numerous outcrops, 26 continuous cores, and 328 natural-gamma logs available in December 1993, include 121 basalt-flow groups, 102 sedimentary interbeds, 6 andesite-flow groups, and 1 rhyolite dome. By volume, basalt flows make up about 90 percent of the deposits underlying most of this 890 mi^2 area.

Copies of the stratigraphic data are contained on a 3 1/2-inch diskette included with this report. The data are presented in two styles in American Standard Code for Information Interchange (ASCII) format. Two files, one for well-site information and one for stratigraphic information, are presented with comma delimited fields. These two files are suitable for creation of a stratigraphic data base by most software capable of importing raw data. A third file presents the well information and stratigraphic information as text in a table format generally one page per well. The files occupy 0.03, 0.26, and 0.81 megabyte disk space respectively

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Table 1. Wells at and near the Idaho National Engineering Laboratory for which stratigraphic data are available

[Well: Entry, USGS 1, is a well for which stratigraphic data are available; identifier is primary name from table 6 (diskette). Figure number indicates the figure number of the map on which a well is located. Map number: Entries, 1 through 335, indicate the map number for each well on figures 2, 3, 4, or 5 and the page number for each well in table 6; numbers, 213 and 227, are additional page numbers for wells Highway #1 Piezo A and NPR WO-2 in table 6 and are not used to identify wells on maps]

Well identifier	Figure number	Map number
USGS 1	2	1
USGS 2	2	2
USGS 3A	2	3
USGS 4	2	4
USGS 5	2	5
USGS 6	2	6
USGS 7	5	7
USGS 8	2	8
USGS 9	2	9
USGS 11	2	10
USGS 12	2	11
USGS 13	2	12
USGS 14	2	13
USGS 15	2	14
USGS 16	2	15
USGS 17	2	16
USGS 18	2	17
USGS 19	2	18
USGS 20	2	19
USGS 21	2	20
USGS 22	2	21
USGS 23	2	22
USGS 24	5	23
USGS 25	2	24
USGS 26	2	25
USGS 27	2	26
USGS 28	2	27
USGS 29	2	28
USGS 30A	2	29
USGS 31	2	30
USGS 32	2	31
USGS 33	2	32
USGS 34	3	33
USGS 35	3	34
USGS 36	3	35
USGS 37	3	36
USGS 38	3	37
USGS 39	3	38
USGS 40	3	39
USGS 41	3	40
USGS 42	3	41
USGS 43	3	42
USGS 44	3	43
USGS 45	3	44
USGS 46	3	45
USGS 47	3	46
USGS 48	3	47
USGS 49	3	48
USGS 50	3	49
USGS 51	3	50
USGS 52	3	51
USGS 53	3	52
USGS 54	3	53
USGS 55	3	54
USGS 56	3	55
USGS 57	3	56
USGS 58	3	57
USGS 59	3	58
USGS 60	3	59
USGS 61	3	60
USGS 62	3	61
USGS 63	3	62
USGS 64	3	63
USGS 65	3	64
USGS 66	3	65
USGS 67	3	66
USGS 68	3	67
USGS 69	3	68
USGS 70	3	69
USGS 71	3	70
USGS 72	3	71
USGS 73	3	72
USGS 74	3	73
USGS 75	3	74
USGS 76	3	75
USGS 77	3	76
USGS 78	3	77
USGS 79	3	78
USGS 80	3	79
USGS 81	3	80
USGS 82	3	81
USGS 83	2	82

Table 1. Wells at or near the Idaho National Engineering Laboratory for which stratigraphic data are available—Continued

Well identifier	Figure number	Map number	Well identifier	Figure number	Map number
USGS 84	3	83	ANL-IWP-M1	2	129
USGS 85	3	84	ANL-IWP-M2	2	130
USGS 86	2	85	ANL-IWP-M3	2	131
USGS 87	4	86	ANL-IWP-M4	2	132
USGS 88	4	87	ANL-IWP-M5	2	133
USGS 89	4	88	ANL-IWP-M6	2	134
USGS 90	4	89	ANP #6	5	135
USGS 91	4	90	ANP #7	2	136
USGS 92	4	91	ANP #9	2	137
USGS 93	4	92	ANP #10	2	138
USGS 93A	4	93	AREA II	2	139
USGS 94	4	94	Arbor Test 1	2	140
USGS 95	4	95	R. Archer	2	141
USGS 96	4	96	Ashcraft	2	142
USGS 96A	4	97	BG-76-1	4	143
USGS 96B	4	98	BG-76-2	4	144
USGS 97	2	99	BG-76-3	4	145
USGS 98	2	100	BG-76-4	4	146
USGS 99	2	101	BG-76-4A	4	147
USGS 100	2	102	BG-76-5	4	148
USGS 101	2	103	BG-76-6	4	149
USGS 102	2	104	BG-77-1	4	150
USGS 103	2	105	BG-77-2	4	151
USGS 104	2	106	Barney North	2	152
USGS 105	2	107	Barney South	2	153
USGS 106	2	108	Butte City #2	2	154
USGS 107	2	109	C-1	4	155
USGS 108	2	110	C-1A	4	156
USGS 109	2	111	CFA 1	3	157
USGS 110	2	112	CFA 2	2	158
USGS 111	3	113	CFA 4	2	159
USGS 112	3	114	CFA LF 2-8	3	160
USGS 113	3	115	CFA LF 2-9	3	161
USGS 114	3	116	CFA LF 2-10	3	162
USGS 115	3	117	CFA LF 2-11	3	163
USGS 116	3	118	CFA LF 2-12	3	164
USGS 117	4	119	CFA LF 3-8	3	165
USGS 118	4	120	CFA LF 3-9	3	166
USGS 119	4	121	CFA LF 3-10	3	167
USGS 120	4	122	CFA LF 3-11	3	168
USGS 121	3	123	CPP 2	3	169
USGS 122	3	124	CPP Disp.	3	170
USGS 123	3	125	CPP 4	3	171
USGS 124	2	126	Callaway	2	172
1-27-14	2	127	Cerro Grande	2	173
A11A31	2	128	Cope	2	174

Table 1. Wells at or near the Idaho National Engineering Laboratory for which stratigraphic data are available—Continued

Well identifier	Figure number	Map number
Corehole 1	2	175
Corehole 2A	2	176
D-10	4	177
D-15	4	178
DH1B	2	179
DH2A	2	180
DH3	2	181
DH-50	2	182
DO-2	4	183
DO-6	4	184
DO-6A	4	185
Dahle	2	186
EBR I	2	187
EFS Well	2	188
EOCR	2	189
EOCR (Disp)	2	190
FET-Disp-1	5	191
GIN #1	5	192
GIN #2	5	193
GIN #3	5	194
GIN #4	5	195
GIN #5	5	196
GIN #6	5	197
GIN #7	5	198
GIN #8	5	199
GIN #9	5	200
GIN #10	5	201
GIN #11	5	202
GIN #12	5	203
GIN #13	5	204
GIN #14	5	205
GIN #15	5	206
GIN #16	5	207
GIN #17	5	208
GIN #18	5	209
GIN #19	5	210
GIN #20	5	211
Highway #1 Piezo A	2	212
Highway #2	2	214
Highway #3	2	215
IET Disp.	5	216
INEL #1	2	217
Water Supply for INEL #1	2	218
LPTF Disposal	5	219
MTR Test	3	220
Main Gate Well	2	221
NA 89-1	2	222
NA 89-2	2	223
NA 89-3	4	224
NPR Test	2	225
NPR WO-2	2	226
NRF #4	2	228
NRF #6	2	229
NRF #6P	2	230
NRF #7	2	231
NRF #7P	2	232
NRF 89-04	2	233
NRF 89-05	2	234
OW-1	4	235
OW-2	4	236
PBF#2	2	237
PBF (CW)	2	238
PBF (WW)	2	239
PSTF Test	2	240
P & W #1	2	241
P & W #2	2	242
P & W #3	2	243
PW-1	3	244
PW-2	3	245
PW-3	3	246
PW-4	3	247
PW-5	3	248
PW-6	3	249
PW-7	3	250
PW-8	3	251
PW-9	3	252
PW-10	3	253
PW-11	3	254
PW-12	3	255
PW-13	3	256
PW-14	3	257
Quaking Aspen Butte Well	2	258
RWMC-78-1	4	259
RWMC-78-2	4	260
RWMC-78-3	4	261
RWMC-78-4	4	262
RWMC-78-5	4	263
RWMC-79-1	4	264
RWMC-79-2	4	265
RWMC-79-3	4	266
RWMC-88-1D	4	267
RWMC-88-02D	4	268

Table 1. Wells at or near the Idaho National Engineering Laboratory for which stratigraphic data are available—Continued

Well identifier	Figure number	Map number
RWMC-89-01D	4	269
RWMC M1SA	4	270
RWMC M3S	4	271
RWMC M4D	4	272
RWMC M6S	4	273
RWMC M7S	4	274
RWMC M10S	4	275
RWMC Prod.	4	276
Rifle Range Well	2	277
Leo Roger's #1	2	278
S5G Test (NRF #5)	2	279
Sdd-1	2	280
Sdd-2	2	281
Sdd-3	2	282
Siddoway	2	283
Site 6	2	284
Site 9	2	285
Site 14	2	286
Site 16	2	287
Site 17	2	288
Site 19	3	289
TAN #3	5	290
TAN #4	5	291
TAN #5	5	292
TAN #6	5	293
TAN #7	5	294
TAN #8	5	295
TAN #9	5	296
TAN #10	5	297
TAN #10A	5	298
TAN #11	5	299
TAN #12	5	300
TAN #13	5	301
TAN #17	5	306

Well identifier	Figure number	Map number
TAN #13A	5	302
TAN #14	5	303
TAN #15	5	304
TAN #16	5	305
TAN #18	5	307
TAN #19	5	308
TAN #20	5	309
TAN #21	5	310
TAN #22	5	311
TAN #22A	5	312
TAN #23	5	313
TAN #23A	5	314
TAN #24	5	315
TAN #24A	5	316
TAN Drainage Disp.#1	5	317
TAN Drainage Disp.#2	5	318
TAN Drainage Disp.#3	5	319
TAN Exploratory Well	2	320
TCH #1	5	321
TCH #2 Piezo A	5	322
TRA #3	3	323
TRA #4	3	324
TRA 05/PZ1	3	325
TRA 06A	3	326
TRA 07	3	327
TRA 08	3	328
TRA Disp.	3	329
TW-1	4	330
VZT-1	4	331
WWW#1	4	332
WWW#2	4	333
Water table	2	334
Weaver and Lowe	2	335

Table 2. Selected cores and sources of data used to evaluate stratigraphic units underlying the Idaho National Engineering Laboratory and adjacent areas

[Well is one from which continuous core was obtained. Depth is total depth of well and approximate total depth of core, in feet below land surface. Data include paleomagnetic inclination and polarity, K-Ar (potassium-argon) and $^{40}Ar/^{39}Ar$ (argon-argon) ages, petrographic descriptions, and major-oxide and trace element chemistry. Symbol: -- indicates no data. Numbers in columns 3-6 indicate the following data references: 1 = Kuntz and others (1980); 2 = Champion and others (1988); 3 = Lanphere and others (1993); 4 = Lanphere and others (1994); 5 = Knobel and others (1995); 6 = Reed and others (1996); 7 = Duane E. Champion, USGS, written commun., 1989-95; 8 = Marvin A. Lanphere, USGS, written commun., 1989-95; 9 = Mel A. Kuntz, USGS, written commun., 1989-95; and 10 = Roy C. Bartholomay, written commun., 1989-95. Additional data for deposits in and underlying the Snake River Plain aquifer are indicated by the following references: 11 = Shervais and others, 1994; 12 = Lawrence and Hackett, 1994; and 13 = Hackett and others, 1994]

Well and core identifer	Depth (feet)	Source of paleomagnetic data	Source of geochronologic data	Source of petrographic data	Source of chemical data
BG-76-1	228	1	1	1	--
BG-77-1	600	1	1, 2	1	10
C-1A	1,805	7	8	--	--
Corehole 1	2,002	7	--	--	--
Corehole 2A	3,000	7	8	--	--
DH-50	250	7	---	--	--
GIN #5	430	4	--	--	--
GIN #6	200	4	--	--	--
NPR Test	609	2	2	--	5, 10
NPR WO-2	5,000	7, 13	8, 13	12	11
NRF #6P	500	7	--	--	--
NRF #7P	500	7	8	--	--
NRF 89-04	248	3	3	--	--
NRF 89-05	242	3	3	3	--
PW-13	148	7	--	--	--
TCH #1	600	4	4	4	5
TCH #2 Piezo A	1,114	4	4	4	5
TRA 05/PZ1	297	7	8	--	5
USGS 80	204	3	3	3	--
USGS 81	108	7	--	--	--
USGS 93A	233	--	--	1	--
USGS 94	302	1	1	1	--
USGS 118	570	7	--	--	10
USGS 121	746	7	8	9	6
USGS 123	744	3	3	3	6
WWW #1	265	7	--	--	--

Table 3. Wells that penetrate the effective base of the Snake River Plain aquifer at and near the Idaho National Engineering Laboratory

[Depth is total depth of well, in feet below land surface. Base is the depth to the effective base of the Snake River Plain aquifer, in feet below land surface. Lithology indicates the relative abundance of basalt (B) and sediment (S) below the base of the aquifer to a depth of 500 feet; greatest abundance is listed first. Core indicates the availability of continuous core; see table 2]

Well identifier	Depth (feet)	Base (feet)	Lithology	Core
C-1A	1,805	1,710	B, S	Yes
Corehole 2A	3,000	846	S, B	Yes
INEL #1	10,365	965	S, B	No
NPR WO-2	5,000	1,660	B, S	Yes
S5G Test	1,276	884	B, S	No
TCH #2	1,114	883	B, S	Yes
TRA #4	970	909	B, S	No
TRA Disp	1,275	907	B, S	No
USGS 7	1,200	895	B, S	No
USGS 15	1,497	815	S, B	No

Table 4. Stratigraphic units underlying the Idaho National Engineering Laboratory and adjacent areas

[Name is informal name of stratigraphic unit modified from Anderson and Lewis (1989), Anderson (1991), and Anderson and Bowers (1995); names ranked from youngest, Al(1), to oldest, S5(1). Type indicates the following generalized lithologic types: Bas = basalt; Sed = sediment; And = Andesite; and Rhy = rhyolite; basalt, andesite, and rhyolite are flow groups that consist of one or more flows from a single eruptive event. Wells indicate the number of wells in which each unit is present; does not include thin sediment layers between individual basalt flows of some basalt-flow groups. See table 6 for distribution of units in wells. Additional names, such as Au(1) through Au (5) and A1(7), AB(25), and LM4(3), are reserved for about 70 surficial units that were not identifed in wells]

Name	Type	Wells
Al(1)	Sed	288
Al(3)	Bas	2
Al(5)	Bas	2
Al(6)	Bas	1
Al(9)	Bas	34
Al(9)	Sed	12
AB(1)	Sed	211
AB(8)	Bas	3
AB(9)	Bas	12
AB(10)	Bas	9
AB(11)	Bas	8
AB(11)	Sed	11
AB(12)	Bas	1
AB(13)	Bas	2
AB(16)	Bas	1
AB(17)	Sed	1
AB(18)	Bas	1
AB(18)	Sed	1
AB(22)	Bas	1
AB(23)	Bas	1
AB(26)	Bas	1
AB(28)	Bas	1
AB(30)	Bas	1
AB(31)	Bas	2
AB(47)	Bas	1
AB(49)	Bas	1
AB(51)	Bas	2
AB(53)	Bas	1
B(1)	Bas	143
B(1)	Sed	85
B-BC(1)	Bas	6
B-BC(1)	Sed	5
B-BC(2)	Bas	10
B-BC(2)	Sed	161
B-BC(3)	Bas	32
B-BC(3)	Sed	2
B-BC(4)	Bas	2
B-BC(4)	Sed	5
BC(1)	Bas	101
BC(1)	Sed	27
BC(2)	Bas	79
BC(2)	Sed	10
BC(3)	Bas	11
BC(3)	Sed	42
BC(4)	Bas	2
C(1)	Bas	131
C(1)	Sed	13
CD(1)	Bas	31
CD(1)	Sed	76
CD(2)	Bas	4
D(1)	Bas	95
D(1)	Sed	9
D(2)	Bas	2
D(2)	Sed	3
D(3)	Bas	6
D(4)	Bas	11
DE1(1)	Bas	5
DE1(1)	Sed	2
DE1(2)	Bas	10
DE1(3)	Bas	57
DE1(3)	Sed	10
DE1(4)	Bas	4
DE1(4)	Sed	2
DE1-2(1)	Bas	28
DE1-2(1)	Sed	37
DE1-2(2)	Bas	2
DE1-2(2)	Sed	11
DE1-2(3)	Bas	1
DE1-2(3)	Sed	1
DE2(1)	Bas	103
DE2(1)	Sed	42
DE2-3(1)	Bas	24
DE2-3(1)	Sed	67
DE2-3(2)	Bas	10
DE2-3(2)	Sed	10
DE2-3(3)	Bas	1
DE3(1)	Bas	118
DE3(1)	Sed	16
DE3(2)	Bas	10
DE3(2)	Sed	23
DE3-4(1)	Bas	42
DE3-4(1)	Sed	4
DE3-4(2)	Bas	3
DE3-4(2)	Sed	8
DE3-4(3)	Bas	103
DE3-4(3)	Sed	22
DE3-4(4)	Bas	29

Table 4. Stratigraphic units underlying the Idaho National Engineering Laboratory and adjacent areas—Continued

Name	Type	Wells	Name	Type	Wells	Name	Type	Wells
DE3-4(4)	Sed	39	DE7(2)	And	1	J(1)	Sed	3
DE3-4(5)	Bas	13	DE7-8(1)	Sed	27	JK(1)	Sed	3
DE3-4(5)	Sed	4	DE8(1)	Bas	123	K(1)	Bas	18
DE3-4(6)	Sed	1	DE8(1)	Sed	4	K(1)	Sed	6
DE4(1)	Bas	115	DE8(2)	And	1	KL(1)	Bas	15
DE4(1)	Sed	9	DE9(1)	Sed	51	KL(1)	Sed	4
DE4(2)	And	2	E(1)	Bas	135	KL(2)	Sed	1
DE4-5(1)	Bas	4	E(1)	Sed	7	L(1)	Bas	16
DE4-5(1)	Sed	16	E(2)	Sed	24	L(1)	Sed	1
DE4-5(2)	Bas	19	EF(1)	Bas	96	L(2)	Sed	2
DE4-5(2)	Sed	1	EF(1)	Sed	7	LM1(1)	Bas	3
DE4-5(3)	Bas	46	EF(2)	Sed	5	LM1(1)	Sed	7
DE4-5(3)	Sed	36	F(1)	Bas	98	LM1(2)	Bas	3
DE4-5(4)	Bas	10	F(1)	Sed	9	LM1(2)	Sed	7
DE4-5(4)	Sed	2	F(2)	Sed	6	LM1(3)	Bas	1
DE4-5(5)	Bas	1	FG(1)	Bas	84	LM1(4)	Bas	1
DE4-5(5)	Sed	2	FG(1)	Sed	26	LM1(4)	Sed	2
DE5(1)	Bas	122	FG(2)	Sed	8	LM2(1)	Bas	6
DE5(1)	Sed	9	G(1)	Bas	98	LM2(1)	Sed	2
DE5-6(1)	And	8	G(1)	Sed	9	LM2(2)	Sed	2
DE5-6(1)	Sed	1	G(2)	Sed	3	LM3(1)	Bas	10
DE5-6(2)	Bas	8	GH(1)	Bas	7	LM3(2)	Bas	1
DE5-6(3)	Bas	3	GH(1)	Sed	14	LM3(2)	Sed	3
DE5-6(3)	Sed	9	H(1)	Bas	51	LM4(1)	Bas	7
DE5-6(4)	Bas	7	H(1)	Sed	14	LM4(1)	Sed	1
DE5-6(5)	Sed	2	HI(1)	Bas	11	LM4(2)	Sed	4
DE5-6(6)	Bas	33	HI(1)	Sed	55	LM4(3)	Bas	2
DE5-6(6)	Sed	71	HI(2)	Sed	1	LM4(3)	Sed	2
DE6(1)	Bas	81	I(1)	Bas	66	LM5(1)	Bas	7
DE6(1)	Sed	25	I(1)	Sed	3	LM5(2)	Sed	1
DE6(2)	And	1	I(2)	Bas	58	LM6(1)	Bas	3
DE6-7(1)	Bas	7	I(2)	Sed	2	LM6(2)	Bas	9
DE6-7(1)	Sed	33	IJ(1)	Bas	2	LM6(3)	Bas	11
DE7(1)	Bas	120	IJ(1)	Sed	12	LM6(3)	Sed	2
DE7(1)	Sed	6	J(1)	Bas	34	LM7(1)	Bas	1

Table 4. Stratigraphic units underlying the Idaho National Engineering Laboratory and adjacent areas—Continued

Name	Type	Wells	Name	Type	Wells	Name	Type	Wells
LM7(2)	Sed	4	NO(1)	Bas	1	QR(3)	And	1
LM8(1)	Bas	2	NO(1)	Sed	8	R1(1)	Bas	9
LM8(2)	Sed	1	O(1)	Bas	40	R1(2)	Sed	10
M(1)	Bas	60	O(1)	Sed	2	R2(1)	Bas	11
M(2)	Sed	15	OP(1)	Sed	10	R2(2)	Sed	1
M(2)	Bas	1	P(1)	Bas	55	S1(1)	Bas	5
MN(1)	Bas	64	P(2)	Bas	3	S1(2)	Sed	1
MN(2)	Sed	7	P(3)	Bas	1	S2(1)	Bas	5
N(1)	Bas	64	PQ(1)	Sed	19	S2(2)	Sed	4
N(2)	Sed	1	Q(1)	Bas	41	S3(1)	Bas	3
N(3)	Bas	1	Q(2)	Bas	1	S4(1)	Bas	1
N(4)	Bas	2	QR(1)	Sed	14	S5(1)	Bas	2
N(5)	Sed	1	QR(2)	Rhy	1			

Table 5. Measured and estimated ages of selected basalt-flow groups underlying the Idaho National Engineering Laboratory and adjacent areas

[Each basalt-flow group, Al(9) through TU(1), includes one or more basalt flows deposited during a single eruptive event. Measured age is analytical age determined mainly by the K-Ar method; ages for Al(9), 101±7 Ka, and TU(1), 1.865±0.024 Ma, determined by thermoluminescence and $^{40}Ar/^{39}Ar$ methods, respectively. Estimated age is age that was determined using all measured ages and linear accumulation rates in selected wells; ages are listed in thousands (Ka) or millions (Ma) of years before present. Paleomagnetic polarity indicates normal (N) or reversed (R) polarity. Sample location indicates well or outcrop from which samples were obtained. Sample depth indicates depth or depth interval for age samples obtained from wells, in feet below land surface; letter, S, indicates surface or near surface samples. Hydrologic unit indicates that sample was obtained from: 1 = the unsaturated zone, 2U = the uppermost 300 feet of the Snake River Plain aquifer, 2L = the lowermost part of the aquifer; or 3 = below the effective base of the aquifer. Large differences between measured and estimated ages, such as for flow groups S1(1), S2(1), and S5(1) at TAN, indicate areas that need additional study. See table 2 for data references]

Basalt-flow group	Measured age	Estimated age	Paleomagnetic polarity	Sample location	Sample depth	Hydrologic unit
Al(9)	95±50Ka	100Ka	N	BG-77-1	30	1
	101±7Ka		N	RWMC	S	1
B(1)	<200Ka	200Ka	N	BG-77-1	81	1
BC(1)	247±46Ka	240Ka	N	NPR Test	81	1
DE1(2)	303±30Ka	300Ka	N	NRF 89-05	79	1
DE2(1)	350±40Ka	350Ka	N	NPR Test	157	1
DE5(1)	441±77Ka	440Ka	N	NPR Test	352	1
DE8(1)	491±80Ka	490Ka	N	NPR Test	444	1
E(1)	515±85Ka	515Ka	N	BG-77-1	300 to 329	1
F(1)	565±14Ka	565Ka	R	BG-77-1	426 to 544	1
FG(1)	580±93Ka	580Ka	N	NPR Test	508	2U
H(1)	619±22Ka	620Ka	N	USGS 123	540	2U
I(1)	641±54Ka	640Ka	N	NPR Test	606	2U
LM1(2)	807±55Ka	805Ka	R	Richard Butte	S	1
LM6(3)	939±154Ka	915Ka	R	Lava Ridge	S	1
N(1)	1.044±0.035Ma	1.06Ma	R	TCH#1	87	1
P(1)	1.248±0.069Ma	1.25Ma	R	TCH#1	175	1
R1(1)	1.412±0.047Ma	1.40Ma	R	TCH#2 Piezo A	467	2U
S1(1)	1.936±0.083Ma	1.45Ma	R	TCH#1	523	2L
S2(1)	2.115±0.046Ma	1.47Ma	R	TCH#2 Piezo A	637	2L
S5(1)	2.556±0.035Ma	1.54Ma	R	TCH#2 Piezo A	785	2L
TU(1)	1.865±0.024Ma	>1.60Ma	N	NPR WO-2	1708	3