Mineralogy of Selected Sedimentary Interbeds at or near the Idaho National Engineering Laboratory, Idaho

By Michael F. Reed and Roy C. Bartholomay

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To Obtain
acre-foot (acre-ft)	1,233	cubic meter
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

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.

Mineralogy of Selected Sedimentary Interbeds at or near the Idaho National Engineering Laboratory, Idaho

By Michael F. Reed and Roy C. Bartholomay

Abstract

The U.S. Geological Survey's (USGS) Project Office at the Idaho National Engineering Laboratory (INEL), in cooperation with the U.S. Department of Energy and Idaho State University, analyzed 66 samples from sedimentary interbed cores during a 38-month period beginning in October 1990 to determine bulk and clay mineralogy. These cores had been collected from 19 sites in the Big Lost River Basin, 2 sites in the Birch Creek Basin, and 1 site in the Mud Lake Basin, and were archived at the USGS lithologic core library at the INEL.

Mineralogy data indicate that core samples from the Big Lost River Basin have larger mean and median percentages of quartz, total feldspar, and total clay minerals, but smaller mean and median percentages of calcite than the core samples from the Birch Creek Basin. Core samples from the Mud Lake Basin have abundant quartz, total feldspar, calcite, and total clay minerals.

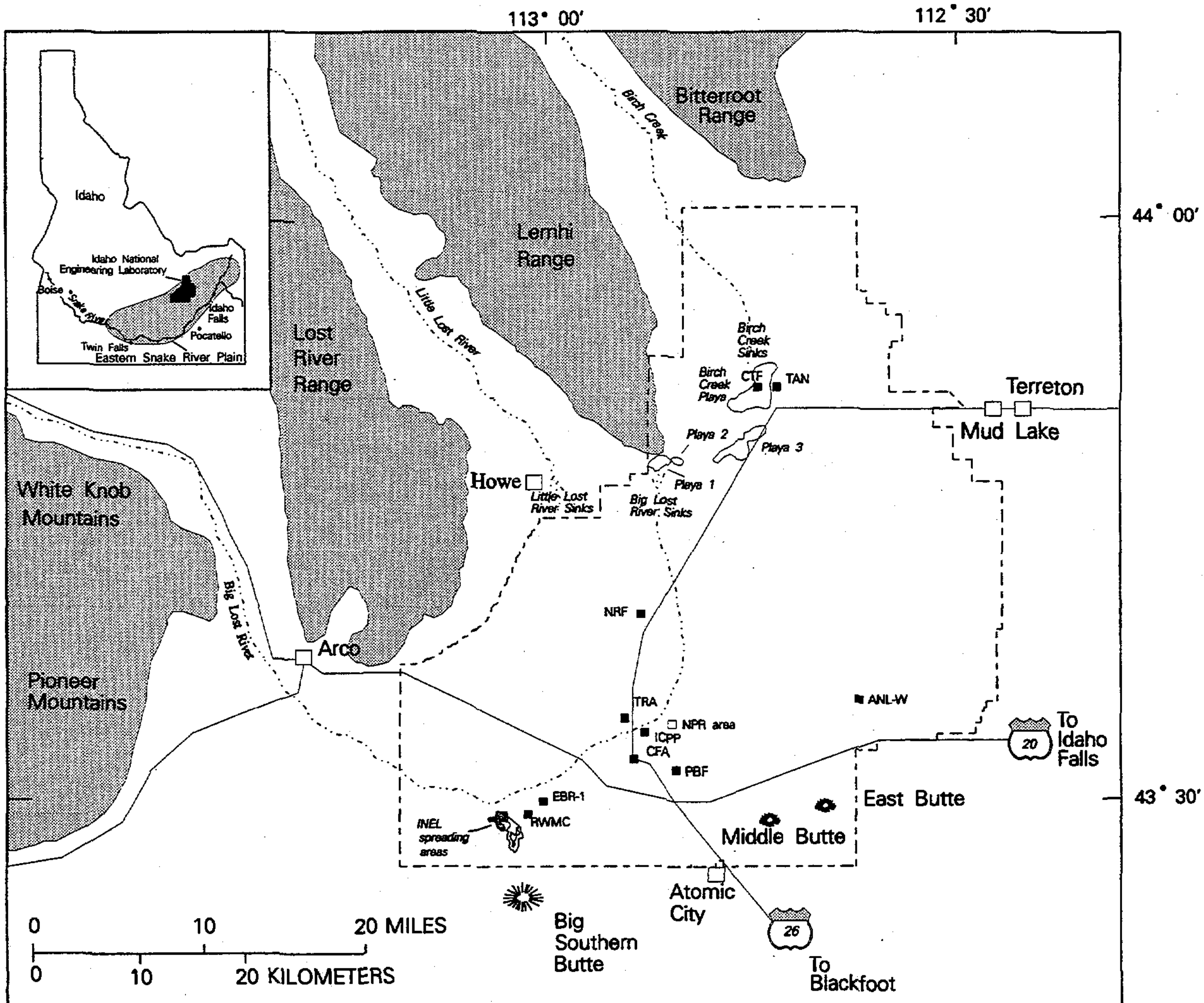
INTRODUCTION

The Idaho National Engineering Laboratory (INEL), which encompasses about 890 mi^2 of the eastern Snake River Plain in southeastern Idaho (fig. 1), is operated by the U.S. Department of Energy (DOE). INEL facilities 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. Many of the waste constituents enter the Snake River Plain aquifer indirectly following percolation through the unsaturated zone (Pittman and others, 1988, p. 2); however, the movement of some constituents—including some radionuclides—may be retarded by minerals in the unsaturated zone.

In 1949, the U.S. Atomic Energy Commission—now the U.S. DOE—requested that the U.S. Geological Survey (USGS) investigate the geohydrologic conditions at the INEL and adjacent areas before the development of reactor operations. Ongoing research by the USGS at the INEL involves investigation of the migration of radioactive elements contained in low-level radioactive waste, hydrologic and geologic factors affecting waste movement, and geochemical factors that influence the chemical composition of the waste. Identification of the mineralogy of the Snake River Plain is needed to aid in the study of the hydrology and geochemistry of subsurface waste disposal.

Purpose and Scope

This report describes the methods used to collect, prepare, and analyze 66 sedimentary interbed core samples from 22 sites: 19 in the Big Lost River Basin, 2 in the Birch Creek Basin, and 1 in the Mud Lake Basin (fig. 2). The samples were collected from selected cores archived at the USGS lithologic core library at the INEL. Samples were analyzed for bulk and clay mineralogy by the USGS, in cooperation with the DOE and Idaho State University (ISU), during a 38-month period



EXPLANATION

---- BOUNDARY OF IDAHO NATIONAL ENGINEERING LABORATORY

■ SELECTED FACILITIES AT THE IDAHO NATIONAL ENGINEERING LABORATORY

□ NPR area LOCATION OF FEASIBILITY STUDY FOR A NEW PRODUCTION REACTOR

ANL-W	ARGONNE NATIONAL LABORATORY-WEST	NRF	NAVAL REACTORS FACILITY
CFA	CENTRAL FACILITIES AREA	PBF	POWER BURST FACILITY
CTF	CONTAINED TEST FACILITY (formerly called Loss of Fluid Test Facility--LOFT)	RWMC	RADIOACTIVE WASTE MANAGEMENT COMPLEX
EBR-1	EXPERIMENTAL BREEDER REACTOR NO. 1	TAN	TEST AREA NORTH
ICPP	IDAHO CHEMICAL PROCESSING PLANT	TRA	TEST REACTORS AREA

Figure 1.--Location of the Idaho National Engineering Laboratory.

beginning in October 1990. In addition, clay mineralogy analyses of 10 samples from 3 sites analyzed in 1970 are presented because the data have not been published previously.

Geohydrologic Setting

The eastern Snake River Plain is a northeast-trending structural basin about 200 mi long and 50 to 70 mi wide (fig. 1). The plain is underlain by a layered sequence of basaltic lava flows and cinder beds interbedded with eolian, fluvial, and lacustrine sedimentary deposits. Thickness of individual flows generally ranges from 10 to 50 ft and the average thickness may be from 20 to 25 ft (Mundorff and others, 1964, p. 143). The sedimentary deposits consist mainly of beds of sand, silt, and clay with lesser amounts of gravel. Locally, rhyolitic lava flows and tuffs are exposed at land surface or occur at depth. The basaltic lava flows and interbedded sedimentary deposits combine to form the Snake River Plain aquifer, which is the main source of water on the plain. The altitude of the water table for the Snake River Plain aquifer in July 1988 ranged from about 4,590 ft above sea level in the northern part of the INEL to about 4,420 ft in the southern part (Orr and Cecil, 1991, p. 25). Corresponding depths to water below land surface ranged from about 200 ft in the northern part of the INEL to more than 900 ft in the southeastern part (Orr and Cecil, 1991, p. 25). The INEL obtains its entire water supply from the Snake River Plain aquifer.

Much of the northern part of the INEL is a topographically closed depression that includes the Big Lost River Sinks; Little Lost River Sinks; Birch Creek Sinks; Big Lost River Playas 1, 2, and 3; and Birch Creek Playa. The Big Lost River, Little Lost River, and Birch Creek terminate in the Birch Creek Playa (Robertson and others, 1974, p. 8) (fig. 1). The INEL also contains several other small, isolated closed basins. Flow from the Little Lost River and Birch Creek is diverted for irrigation and power generation and does not reach the playas except during years with above-normal flow. Surface water at the INEL principally is derived from flow in the Big Lost River, most of which ultimately recharges the Snake River Plain aquifer. Data from May and November 1985 seepage runs on the Big Lost River near the Idaho Chemical Processing Plant (ICPP) (fig. 1) indicate that the river loses from 1.1 to 3.8 (acre-ft/day)/mi depending on the amount of flow in the channel (Mann and others, 1988, p. 17). Other surface drainages that provide recharge to the Snake River Plain aquifer at the INEL include Birch Creek, the Little Lost River, and streams terminating in Mud Lake (fig. 2).

Previous Investigations

The USGS has conducted geologic, hydrologic, and water-quality investigations at the INEL since it was selected as a reactor testing area in 1949. Many reports generated by these investigations contain data on the physical and chemical characteristics of the Snake River Plain aquifer materials. Information published in previous USGS reports, including the type of data and the number of analyses for each, are summarized in Bartholomay and others (1989).

Mineralogic data for surficial sediment or sedimentary interbeds are presented in several reports. Mineralogical data for silt and clay-sized material from several shallow core holes at the INEL were presented by Voegeli and Deutsch (1953) and Nace and others (1956). The data published by Nace and others (1956) were republished by Nace and others (1975). Mineralogical data for surficial sediment from the Big Lost River drainage basin were presented by Bartholomay and others (1989, table 8, p. 23). Mineralogic data for surficial sediment from the Little Lost River and Birch Creek drainage basins were presented by Bartholomay and Knobel (1989, tables 4-5, p. 17-18). Mineralogical data for sedimentary interbeds at the Radioactive Waste Management Complex (RWMC), Test Reactors Area (TRA), and ICPP were presented by Barraclough and others (1976, table A-V, p. 123-124); Rightmire (1984, table 5, p. 17); Rightmire and Lewis (1987, table 7, p. 35); and Bartholomay and others (1989, table 11, p. 30). Mineralogical data for a sedimentary interbed 400 ft below land surface at Test Area North (TAN) were presented in Bartholomay (1990, table 2, p. 9).

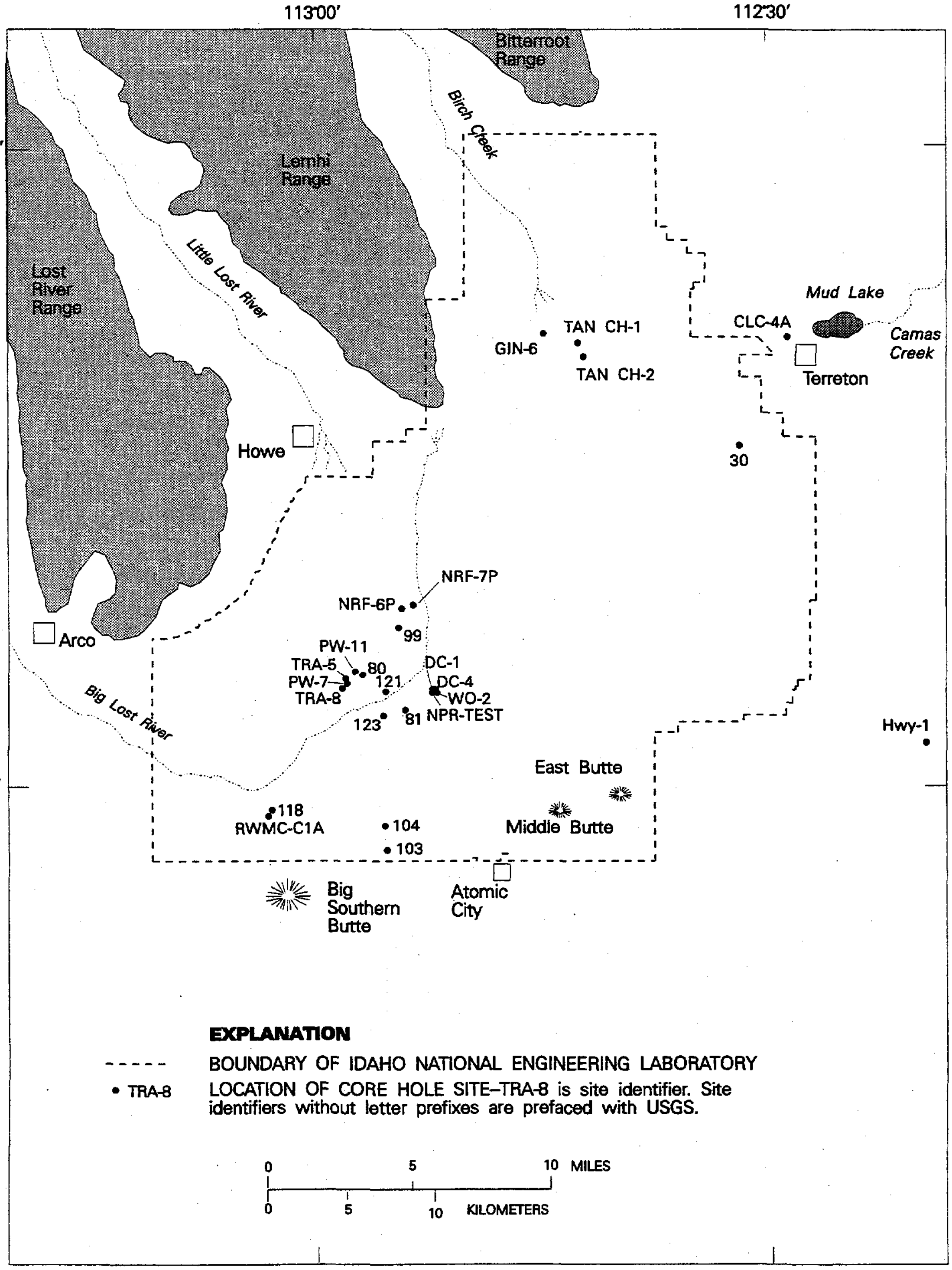


Figure 2.–Location of core hole sites at the Idaho National Engineering Laboratory.

Acknowledgments

The authors gratefully acknowledge the ISU Department of Geology—David W. Rodgers, Chairman—for providing X-ray diffraction equipment, laboratory space, and computer support. In addition, special thanks are given to Jeanne Fromm of the ISU Department of Geology for information on well USGS 123 and Judith Krieg of the ISU Department of Geology for her help with the clay-separation techniques. The authors are grateful for technical review of the manuscript by Judith Krieg of ISU and LeRoy L. Knobel of the USGS.

METHODS

Sample Collection

Samples collected from archived sedimentary interbed cores from 22 sites were analyzed during a 38-month period beginning in October 1990 (fig. 2). The basis for selection was the availability of core at the USGS lithologic core library at the INEL. Sediments from 19 sites in the Big Lost River Basin were sampled as follows: 14 samples from 4 sites (DC-1, DC-4, NPR-TEST, and WO-2) at the New Production Reactor (NPR) area; 10 samples from 5 sites (PW-7, PW-11, TRA-5, TRA-8, and USGS 80) near the TRA; 13 samples from 3 sites (USGS 81, USGS121, and USGS 123) near the ICPP; 8 samples from 2 sites (RWMC-C1A and USGS 118) near the RWMC; 5 samples from 3 sites (NRF-6P, NRF-7P, and USGS 99) near the Naval Reactors Facility (NRF); 1 sample from USGS 103; and 1 sample from USGS 104. In addition, nine sediment cores from two sites (TAN CH-1 and TAN CH-2) near TAN in the Birch Creek Basin, and five sediment cores from one site (CLC-4A) in the Mud Lake Basin also were sampled. Samples were collected by placing approximately 20 grams (g) of sediment from a drill core into a glass container. The samples were labeled and transported to the ISU laboratory for analyses.

In addition, clay mineralogy of 10 samples that were analyzed in 1970 is presented because these data have not been published previously. The 10 samples were from sites GIN-6, Hwy-1, and USGS 30 and consisted of sediment and vesicle infill.

Sample Preparation and Analysis

X-ray diffraction analysis was used to determine bulk mineralogy of all particles less than 0.5 millimeters (mm) in diameter and clay mineralogy of particles less than 2 micrometers (μm) in diameter. Clay mineralogy was determined only for samples that had clay minerals present in the bulk analysis. To determine bulk mineralogy, the sample first was passed through a 0.5-mm sieve, then approximately 3 g was ground for 8 minutes in a ball-and-mill device to reduce grain size and to homogenize the sample. The sample then was ground using a mortar and pestle until all of the sample passed through a 0.062-mm sieve. The powdered sample was packed into an aluminum holder and scanned with a diffractometer using copper Kα (wavelength of the characteristic line) radiation at a rotation rate of 1 degree 2 theta per minute. The generator was operated at 35 kilovolts and 15 milliamps. Diffractograms were prepared at a scale factor of 1, a multiplier of 0.5, a time constant of 2, and a chart speed of 2 degrees 2 theta per inch.

Semiquantitative analysis was used to determine the relative abundances of minerals in the samples. To obtain the relative mineral percentages, a modification of the method described by Diebold and others (1963) and Schultz (1964) was used. The raw percentage of each mineral was determined by dividing the intensity of each mineral peak height by the intensity of its pure standard. The raw percentages were normalized to 100 percent. The intensities of the pure standards were calculated from standard minerals provided by the ISU Department of Geology. Schultz (1964, p. C1) reported uncertainties of ±10 percent for minerals that make up at least 15 percent of the sample. Diebold and others (1963, table 5, p. 130) calculated weight percentages within ±8 percent of the true concentrations using a 95-percent confidence interval.

For samples that had a total clay mineral peak present in the bulk mineralogy analysis, a qualitative identification of individual clay minerals was made. A modification of methods described by

Drever (1973), Jackson (1985), and Kunze (1965) was used to prepare clay slides for analysis. First, the organic matter was removed from approximately 5 g of the original sample by using a solution containing 30 percent hydrogen peroxide. Next, sodium hexametaphosphate was added to aid in the dispersing of the clay particles. The less-than-45-µm fraction then was isolated by using a 325- mesh sieve. The less-than-2-µm clay particle fraction was isolated by using the principle of Stoke's Law, which predicts that the finest silt-size particles will settle below the top 5 centimeters of suspension after 3.5 hours. After 3.5 hours, the suspended clay particles were collected by pipette and concentrated on a 0.45 µm filter. The filtrate was then transferred to a glass slide and allowed to dry. Once the sample was dry, it was scanned by X-ray diffraction to determine the clay minerals present.

The slides were scanned with a diffractometer using copper Kα radiation at a rotation rate of 1 degree 2 theta per minute. The generator was operated at 35 kilovolts and 15 milliamps. Diffractograms were prepared at a scale factor of 1 or 0.5, a multiplier of 0.5, and a time constant of 2. The samples were exposed to ethylene glycol for at least 24 hours and rescanned to differentiate between smectite and chlorite clays. Smectite expands from 14 to 17 angstrom units when ethylene glycol replaces water in the crystal lattice.

The results reported by the X-ray diffraction laboratory at ISU for the 49 samples analyzed for clay mineralogy give qualitative estimates of the abundance of clay minerals in the samples. The estimates were based on the relative heights of the clay mineral peaks on the X-ray diffractograms. Six categories were designated in order of decreasing abundance: dominant, major, minor, trace, possibly present, and not detected

Mineralogy of Selected Sedimentary Interbeds

The bulk mineralogy of 66 samples from 22 sites is listed in table 1 as percent mineral abundance. Statistical parameters for the bulk mineralogy data are listed by hydrologic basin in table 2, and by selected facility in table 3. Clay mineralogy for 49 of the 66 samples is listed in table 4. X-ray slides were not prepared for 17 of the samples because they did not contain clay minerals. Clay mineralogy for 10 samples from 3 sites analyzed in 1970 is listed in table 5.

Statistical parameters for semiquantitative bulk mineral analyses for sedimentary interbeds (table 2) show that quartz, total feldspar, and total clay minerals are abundant in core samples from the Big Lost River Basin. Fifty-two core samples from the Big Lost River Basin have respective mean and median percentages of 36 and 36 for quartz; 29 and 29 for total feldspar; and 15 and 14 for total clay minerals. Samples collected in the vicinity of selected facilities, which are all in the Big Lost River Basin, have similar abundances of quartz, total feldspar, and total clay minerals (table 3).

Core samples from the Birch Creek Basin have less abundant quartz, total feldspar, and total clay minerals than core samples from the Big Lost River Basin. Respective mean and median percentages for the Birch Creek Basin are 21 and 20 for quartz, 8 and 8 for total feldspar, and 6 and 4 for total clay minerals.

Overall, calcite is not abundant in core samples from the Big Lost River Basin but is abundant in samples from the Birch Creek Basin (table 2). For example, the respective mean and median percentages of calcite for the Big Lost River Basin are 12 and 5.5; conversely, the respective mean and median percentages of calcite for the Birch Creek Basin are 62 and 72.

Core samples from site CLC-4A in the Mud Lake Basin (fig. 2) have respective mean and median percentages of 31 and 33 for quartz; 19 and 17 for total feldspar; 22 and 15 for calcite; and 21 and 22 for total clay minerals (table 2).

Clay mineral analyses of the 49 samples containing clay minerals show that smectite and illite are the most abundant clay minerals (table 4). Clay mineral analyses of the eight sediment samples and two vesicle infill samples analyzed in 1970 show that smectite is the most abundant clay mineral (table 5).

SUMMARY

The USGS project office at the INEL, in cooperation with the DOE and ISU, analyzed 66 samples from archived sedimentary interbed cores from 22 sites during a 38-month period beginning October 1990 to determine bulk and clay mineralogy. The cores had been collected from 19 sites in the Big Lost River Basin, 2 sites in the Birch Creek Basin, and 1 site in the Mud Lake Basin.

Semiquantitative X-ray diffraction analysis was used to determine bulk mineralogy. Individual clay minerals were identified in 49 samples.

Mineralogy data indicate that the core samples from the Big Lost River Basin have larger mean and median percentages of quartz, total feldspar, and total clay minerals, but smaller mean and median percentages of calcite than core samples from the Birch Creek Basin. Core samples from the Mud Lake Basin have abundant quartz, total feldspar, calcite, and total clay minerals. Smectite and illite are the most abundant clay minerals present.

Clay mineral analyses of eight sediment samples and two vesicle infill samples analyzed in 1970 show that smectite is most abundant mineral.

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Table 1.—Bulk mineralogy of samples by X-ray diffraction analysis from selected sedimentary interbeds at the Idaho National Engineering Laboratory

[See figure 2 for location of core-hole sites. Samples analyzed at the X-ray diffraction laboratory at Idaho State University]

Site identifier	Date sampled	Interval sampled (feet below land surface)	Bulk analyses (in percent mineral abundance)								
			Quartz	Plagioclase feldspar	Potassium feldspar	Calcite	Pyroxene	Olivine	Dolomite	Hematite	Total clay minerals
[Big Lost River Basin]											
DC-1	2/24/93	238	44	26	5	15	0	0	0	0	10
DC-4	2/24/93	112.9-113.3	15	9	13	52	0	0	0	0	11
DC-4	2/24/93	241.7	33	23	5	15	0	0	0	0	25
NPR-TEST	11/13/90	100-112	29	18	12	31	0	0	0	0	10
NPR-TEST	11/13/90	247-265	32	16	10	3	8	0	0	0	31
NPR-TEST	11/13/90	410	38	15	10	0	10	0	0	0	26
NPR-TEST	11/13/90	413-425	32	16	6	0	9	0	0	0	36
WO-2	2/24/93	560-564	62	19	19	0	0	0	0	0	0
WO-2	2/24/93	600	21	15	15	6	0	0	0	0	42
WO-2	2/24/93	719	39	13	18	3	0	0	1	0	26
WO-2	2/24/93	815	30	25	6	8	6	6	0	0	20
WO-2	2/24/93	871	34	9	5	36	0	0	0	0	16
WO-2	2/24/93	932.3	32	27	18	2	11	0	1	0	8
WO-2	2/24/93	1001.5	31	20	13	1	8	0	0	0	28
PW-7	6/9/93	219.3	45	17	0	0	0	0	0	0	38
PW-7	6/9/93	230	44	19	14	3	6	0	0	0	13
PW-11	6/9/93	139.4	26	12	10	6	46	0	0	0	0
TRA-5	6/9/93	69	31	6	0	13	6	0	0	0	43
TRA-5	6/9/93	150	2	2	0	96	0	0	0	0	0

Table 1.—Bulk mineralogy of samples by X-ray diffraction analysis from selected sedimentary interbeds at the Idaho National Engineering Laboratory—Continued

Site identifier	Date sampled	Interval sampled (feet below land surface)	Bulk analyses (in percent mineral abundance)								
			Quartz	Plagioclase feldspar	Potassium feldspar	Calcite	Pyroxene	Olivine	Dolomite	Hematite	Total clay minerals
TRA-5	6/9/93	172-173	29	4	15	40	11	0	0	0	0
TRA-8	6/9/93	116.5	25	13	13	11	0	0	0	0	38
TRA-8	6/9/93	204.5	23	5	0	33	13	0	0	0	26
USGS 80	2/24/93	165	49	19	18	0	7	0	0	0	6
USGS 80	2/24/93	175	35	14	13	0	9	0	0	0	28
USGS 81	2/24/93	27	29	16	19	10	7	0	1	0	17
USGS 81	2/24/93	107	43	23	23	10	0	0	0	0	0
USGS 121	6/9/93	33-34.5	40	28	6	0	18	0	0	0	8
USGS 121	6/9/93	401	39	23	8	0	11	0	0	0	19
USGS 121	6/9/93	410.8	31	21	6	16	9	0	2	0	15
USGS 123	6/9/93	10-12	56	15	0	10	10	0	0	0	8
USGS 123	6/9/93	112.4	42	10	8	10	10	0	0	0	20
USGS 123	6/9/93	117	39	19	0	15	8	0	0	0	19
USGS 123	6/9/93	420	40	27	9	0	9	0	0	0	15
USGS 123	5/14/93	502	22	12	8	32	8	0	0	0	17
USGS 123	5/14/93	563.6	54	19	18	0	9	0	0	0	0
USGS 123	5/14/93	690	20	46	18	0	6	0	0	0	10
USGS 123	6/9/93	741.7	39	31	10	0	0	0	0	20	0
RWMC-C1A	11/30/93	229.7	42	28	17	0	13	0	0	0	0
RWMC-C1A	11/30/93	291.5	37	34	20	0	9	0	0	0	0
RWMC-C1A	11/30/93	332.5	40	16	11	9	7	0	0	0	18

Table 1.—Bulk mineralogy of samples by X-ray diffraction analysis from selected sedimentary interbeds at the Idaho National Engineering Laboratory—Continued

Site identifier	Date sampled	Interval sampled (feet below land surface)	Bulk analyses (in percent mineral abundance)								
			Quartz	Plagioclase feldspar	Potassium feldspar	Calcite	Pyroxene	Olivine	Dolomite	Hematite	Total clay minerals
RWMC-C1A	11/30/93	745.7	39	20	15	0	12	0	0	0	14
RWMC-C1A	11/30/93	971	35	12	0	24	0	0	0	0	29
RWMC-C1A	11/30/93	1,072.3	39	16	11	0	11	0	0	0	23
USGS 118	2/24/93	9.4	44	25	13	0	4	0	0	0	14
USGS 118	6/9/93	237.9	39	11	16	16	6	0	0	0	13
NRF-6P	6/9/93	94.8	31	13	11	30	11	0	3	0	0
NRF-6P	6/9/93	354	36	27	20	0	16	0	0	0	0
NRF-7P	6/9/93	93	36	25	22	0	8	0	0	0	9
NRF-7P	6/9/93	156	15	9	0	75	0	0	0	0	0
USGS 99	2/24/93	25-30	43	19	18	6	4	0	0	0	10
USGS 103	2/24/93	15	36	17	13	4	12	0	0	0	17
USGS 104	2/24/93	142	64	28	0	5	3	0	0	0	0
[Birch Creek Basin]											
TAN CH-1	6/9/93	401	20	0	0	80	0	0	0	0	0
TAN CH-1	6/9/93	411	11	4	4	82	0	0	0	0	0
TAN CH-1	6/9/93	444.5	8	2	0	81	0	0	0	0	8
TAN CH-1	6/9/93	446.5	9	8	0	72	0	0	2	0	9
TAN CH-2	6/9/93	245.5	22	3	3	58	0	0	0	0	14
TAN CH-2	6/9/93	449	44	9	0	46	0	0	0	0	0
TAN CH-2	6/9/93	471.5	2	0	0	98	0	0	0	0	0
TAN CH-2	6/9/93	735	23	19	0	27	13	0	13	0	4

Table 1.—Bulk mineralogy of samples by X-ray diffraction analysis from selected sedimentary interbeds at the Idaho National Engineering Laboratory—Continued

Site identifier	Date sampled	Interval sampled (feet below land surface)	Bulk analyses (in percent mineral abundance)								
			Quartz	Plagioclase feldspar	Potassium feldspar	Calcite	Pyroxene	Olivine	Dolomite	Hematite	Total clay minerals
TAN CH-2	6/9/93	977.7	47	13	11	10	0	0	0	0	19
[Mud Lake Basin]											
CLC-4A	10/24/90	0-1.3	35	14	7	15	7	0	0	0	22
CLC-4A	10/24/90	1.3-2.5	21	8	5	35	0	0	4	0	26
CLC-4A	10/24/90	4.5-5.2	24	10	5	31	0	0	6	0	24
CLC-4A	10/24/90	6.3-7.0	42	12	5	14	9	0	5	0	13
CLC-4A	10/24/90	15-16	33	19	12	13	0	0	2	0	21

Table 2.—Statistical parameters for bulk mineralogy of sedimentary interbeds by hydrologic basin

[Values are percent mineral abundance and are derived from table 1. Total feldspar is the sum of plagioclase feldspar and potassium feldspar in table 1]

Mineral	Statistical parameter				
	Minimum	Maximum	Median	Mean	Sample size
	[Big Lost River Basin]				
Quartz	2	64	36	36	52
Plagioclase feldspar	2	46	17.5	18	52
Potassium feldspar	0	23	11	11	52
Total feldspar	2	64	29	29	52
Calcite	0	96	5.5	12	52
Pyroxene	0	46	7.5	7	52
Olivine	0	6	0	0	52
Dolomite	0	3	0	0	52
Hematite	0	20	0	0	52
Total clay minerals	0	43	14	15	52
	[Birch Creek Basin]				
Quartz	2	47	20	21	9
Plagioclase feldspar	0	19	4	6	9
Potassium feldspar	0	11	0	2	9
Total feldspar	0	24	8	8	9
Calcite	10	98	72	62	9
Pyroxene	0	13	0	1	9
Dolomite	0	13	0	2	9
Total clay minerals	0	19	4	6	9
	[Mud Lake Basin]				
Quartz	21	42	33	31	5
Plagioclase feldspar	8	19	12	13	5
Potassium feldspar	5	12	5	7	5
Total feldspar	13	31	17	19	5
Calcite	13	35	15	22	5
Pyroxene	0	9	0	3	5
Dolomite	0	6	4	3	5
Total clay minerals	13	26	22	21	5

Table 3.—Statistical parameters for bulk mineralogy of sedimentary interbeds in the vicinity of selected facilities at the Idaho National Engineering Laboratory

[Values are percent mineral abundance and are derived from table 1. New Production Reactor includes results from site identifiers DC-1, DC-4, NPR-TEST, and WO-2 (table 1). Test Reactors Area includes results from site identifiers PW-7, PW-11, TRA-5, TRA-8, and USGS 80 (table 1). Idaho Chemical Processing Plant includes results for site identifiers USGS 81, USGS 121, and USGS 123 (table 1). Radioactive Waste Management Complex includes results for site identifiers RWMC-C1A and USGS 118 (table 1). Naval Reactors Facility includes results for site identifiers NRF-6P, NRF-7P, and USGS 99 (table 1)]

Mineral	Statistical parameter				
	Minimum	Maximum	Median	Mean	Sample size
	[New Production Reactor]				
Quartz	15	62	32	34	14
Plagioclase feldspar	9	27	17	18	14
Potassium feldspar	5	19	11	11	14
Total feldspar	14	45	30	29	14
Calcite	0	52	4.5	12	14
Pyroxene	0	11	0	4	14
Olivine	0	6	0	0	14
Dolomite	0	1	0	0	14
Total clay minerals	0	42	22.5	21	14
	[Test Reactors Area]				
Quartz	2	49	30	31	10
Plagioclase feldspar	2	19	12.5	11	10
Potassium feldspar	0	18	11.5	8	10
Total feldspar	2	37	20.5	19	10
Calcite	0	96	8.5	20	10
Pyroxene	0	46	6.5	10	10
Total clay minerals	0	43	19.5	19	10

Table 3.—Statistical parameters for bulk mineralogy of sedimentary interbeds in the vicinity of selected facilities at the Idaho National Engineering Laboratory—Continued

Mineral	Statistical parameter				
	Minimum	Maximum	Median	Mean	Sample size
	[Idaho Chemical Processing Plant]				
Quartz	20	56	39	38	13
Plagioclase feldspar	10	46	21	22	13
Potassium feldspar	0	23	8	10	13
Total feldspar	15	64	34	33	13
Calcite	0	32	10	8	13
Pyroxene	0	18	9	8	13
Dolomite	0	2	0	0	13
Hematite	0	20	0	2	13
Total clay minerals	0	20	15	11	13
	[Radioactive Waste Management Complex]				
Quartz	35	44	39	39	8
Plagioclase feldspar	11	34	18	20	8
Potassium feldspar	0	20	14	13	8
Total feldspar	12	54	31	33	8
Calcite	0	24	0	6	8
Pyroxene	0	13	8	8	8
Total clay minerals	0	29	14	14	8
	[Naval Reactors Facility]				
Quartz	15	43	36	32	5
Plagioclase feldspar	9	27	19	19	5
Potassium feldspar	0	22	18	14	5
Total feldspar	9	47	37	33	5
Calcite	0	75	6	22	5
Pyroxene	0	16	8	8	5
Dolomite	0	3	0	1	5
Total clay minerals	0	10	0	4	5

Table 4.—Mineralogy of particle fraction less than 2 micrometers by X-ray diffraction analysis of samples from selected sedimentary interbeds at the Idaho National Engineering Laboratory

[See figure 2 for location of core-hole sites. Samples analyzed at the X-ray diffraction laboratory at Idaho State University. Clay analyses: tr, mineral is present in a trace amount; maj, mineral is major in abundance; min, mineral is minor in abundance; poss, mineral is possibly present; nd, not detected; dom, mineral is dominant in abundance]

			Clay analyses (by abundance category)								
								Other minerals			
Site identifier	Date sampled	Interval sampled (feet below land surface)	Mixed layer	Smectite	Kaolinite	Illite	Chlorite	Quartz	Calcite	Feldspar	Dolomite
DC-1	2/24/93	238	tr	maj	min	maj	poss	min	nd	tr	nd
DC-4	2/24/93	112.9-113.3	nd	nd	tr	min	nd	min	dom	poss	nd
DC-4	2/24/93	241.7	nd	dom	min	dom	nd	min	nd	tr	nd
NPR-TEST	11/13/90	100-112	nd	nd	nd	maj	nd	maj	maj	min	nd
NPR-TEST	11/13/90	247-265	maj	dom	min	maj	min	min	nd	nd	nd
NPR-TEST	11/13/90	410	maj	dom	maj	dom	poss	min	nd	tr	nd
NPR-TEST	11/13/90	413-425	maj	dom	maj	dom	nd	min	nd	tr	nd
WO-2	2/24/93	600	nd	dom	min	maj	poss	min	nd	nd	nd
WO-2	2/24/93	719	tr	dom	min	maj	tr	min	nd	tr	nd
WO-2	2/24/93	815	tr	maj	min	maj	min	min	nd	tr	nd
WO-2	2/24/93	871	tr	nd	tr	dom	nd	min	tr	tr	nd
WO-2	2/24/93	932.3	nd	nd	nd	tr	nd	maj	nd	dom	nd
WO-2	2/24/93	1,001.5	min	poss	nd	dom	nd	min	nd	poss	nd
PW-7	6/9/93	219.3	tr	dom	min	maj	poss	min	tr	nd	nd
PW-7	6/9/93	230	tr	dom	min	maj	poss	min	nd	poss	nd
TRA-5	6/9/93	69	tr	min	min	dom	min	maj	nd	tr	nd
TRA-8	6/9/93	116.5	poss	dom	min	maj	nd	maj	nd	tr	nd

Table 4.—Mineralogy of particle fraction less than 2 micrometers by X-ray diffraction analysis of samples from selected sedimentary interbeds at the Idaho National Engineering Laboratory—Continued

			Clay analyses (by abundance category)								
								Other minerals			
Site identifier	Date sampled	Interval sampled (feet below land surface)	Mixed layer	Smectite	Kaolinite	Illite	Chlorite	Quartz	Calcite	Feldspar	Dolomite
TRA-8	6/9/93	204.5	tr	dom	min	maj	nd	min	nd	nd	nd
USGS 80	2/24/93	165	tr	nd	nd	min	nd	maj	nd	maj	nd
USGS 80	2/24/93	175	tr	dom	tr	maj	nd	min	nd	nd	nd
USGS 81	2/24/93	27	tr	nd	nd	dom	nd	maj	nd	tr	nd
USGS 121	6/9/93	33-34.5	poss	maj	min	dom	tr	min	nd	tr	nd
USGS 121	6/9/93	401	nd	maj	tr	maj	poss	min	nd	tr	nd
USGS 121	6/9/93	410.8	nd	dom	min	min	nd	maj	tr	tr	nd
USGS 123	6/9/93	10-12	poss	dom	min	maj	tr	min	nd	tr	nd
USGS 123	6/9/93	112.4	tr	nd	nd	maj	nd	maj	nd	maj	nd
USGS 123	6/9/93	117	nd	nd	nd	maj	nd	dom	nd	nd	nd
USGS 123	5/14/93	420	min	min	nd	dom	min	maj	nd	poss	nd
USGS 123	5/14/93	502	tr	dom	min	min	tr	maj	min	poss	nd
USGS 123	5/14/93	690	poss	nd	nd	poss	nd	maj	nd	dom	nd
RWMC-C1A	11/30/93	332.5	nd	dom	tr	tr	nd	tr	nd	poss	nd
RWMC-C1A	11/30/93	745.7	poss	nd	nd	dom	nd	nd	nd	nd	nd
RWMC-C1A	11/30/93	971	poss	dom	min	maj	poss	maj	poss	tr	nd
RWMC-C1A	11/30/93	1,072.7	poss	nd	nd	min	poss	maj	nd	dom	nd
USGS 118	2/24/93	9.4	tr	min	min	maj	poss	maj	nd	tr	nd
USGS 118	2/24/93	237.9	tr	dom	tr	min	nd	min	nd	poss	nd
NRF-7P	6/9/93	93	tr	nd	nd	dom	nd	nd	nd	nd	nd

Table 4.—Mineralogy of particle fraction less than 2 micrometers by X-ray diffraction analysis of samples from selected sedimentary interbeds at the Idaho National Engineering Laboratory—Continued

			Clay analyses (by abundance category)								
								Other minerals			
Site identifier	Date sampled	Interval sampled (feet below land surface)	Mixed layer	Smectite	Kaolinite	Illite	Chlorite	Quartz	Calcite	Feldspar	Dolomite
USGS 99	2/24/93	25-30	min	min	tr	dom	nd	maj	nd	tr	nd
USGS 103	2/24/93	15	tr	min	tr	maj	poss	maj	nd	tr	nd
TAN CH-1	6/9/93	444.5	nd	dom	nd	nd	min	nd	min	nd	nd
TAN CH-1	6/9/93	446.5	poss	maj	nd	tr	nd	tr	dom	nd	nd
TAN CH-2	6/9/93	245.5	nd	dom	nd	nd	poss	min	nd	min	nd
TAN CH-2	6/9/93	735	poss	dom	nd	tr	poss	min	nd	tr	nd
TAN CH-2	6/9/93	977.7	tr	dom	min	maj	poss	min	nd	tr	nd
CLC-4A	10/24/90	0-1.3	min	min	maj	dom	nd	tr	tr	nd	nd
CLC-4A	10/24/90	1.3-2.5	maj	dom	maj	dom	poss	maj	maj	nd	tr
CLC-4A	10/24/90	4.5-5.2	maj	maj	maj	dom	nd	min	min	tr	poss
CLC-4A	10/24/90	6.3-7.0	maj	dom	maj	dom	poss	maj	maj	tr	poss
CLC-4A	10/24/90	15.0-16.0	maj	maj	maj	dom	poss	maj	min	tr	poss

Table 5.—Clay mineralogy of sediment and vesicle infill by X-ray diffraction analysis of core samples from GIN-6, Hwy-1, and USGS 30

[See figure 2 for location of core-hole sites. Samples analyzed April 7, 1970. Type of sample: S, sediment sample, I, vesicle filling in basalt. Clay analyses: min, mineral is minor in abundance; dom, mineral is dominant; nd, mineral was not detected; tr, mineral is present in a trace amount; maj, mineral is major in abundance; poss, mineral is possibly present]

			Clay analyses (by abundance category)							
								Other minerals		
Site identifier	Type of sample	Interval sampled (feet below land surface)	Mixed layer	Smectite	Kaolinite	Illite	Chlorite	Quartz	Feldspar	Calcite
Hwy-1	S	1,283	min	dom	min	min	nd	min	tr	nd
Hwy-1	S	1,288	min	dom	maj	min	nd	min	tr	nd
GIN-6	I	146	min	min	min	tr	nd	maj	tr	dom
GIN-6	I	146	tr	min	min	tr	nd	maj	tr	dom
USGS 30	S	453	poss	maj	min	nd	nd	min	tr	nd
USGS 30	S	454	poss	dom	maj	nd	nd	tr	tr	nd
USGS 30	S	455	min	dom	min	nd	nd	poss	tr	nd
USGS 30	S	494	tr	dom	maj	maj	nd	min	min	nd
USGS 30	S	495	min	dom	min	min	poss	min	tr	nd
USGS 30	S	521	min	dom	maj	min	nd	min	tr	nd