Core Sample Descriptions and Summary Logs of Six Wells Within the Hanford Reservation

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Richland, Washington 99352**

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CORE SAMPLE DESCRIPTIONS
AND SUMMARY LOGS OF SIX WELLS
WITHIN THE HANFORD RESERVATION

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January 1977

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ABSTRACT

This report presents the description and summary logs of core samples from six wells and test holes drilled within the Hanford Reservation.

CONTENTS

	<u>Page</u>
Introduction.....	1
Background.....	1
Purpose and Scope.....	1
Sample Inventory.....	1
Study Methods.....	4
Descriptions.....	4
Volcanic Rocks.....	4
Sedimentary Rocks.....	4
Texture and composition.....	5
Size range and shape.....	5
Quartz frosting.....	5
Color.....	7
Maturity.....	7
Induration.....	7
Trace fragments.....	8
Fracture mineralization.....	8
Sedimentary fabric and structure.....	9
Final Descriptive Log.....	9
Summary Log.....	10
References Cited.....	12
Summary Logs.....	13

LIST OF ILLUSTRATIONS

Tables

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Recovery and survival rates of cored sediments and basalts.....	3
2	Descriptive log of well no. DH-6.....	15
3	Descriptive log of well no. DH-7.....	22
4	Descriptive log of well no. DH-8.....	27
5	Descriptive log of well no. DH-9.....	30
6	Descriptive log of well no. DH-9A.....	32
7	Descriptive log of well no. DH-9B.....	34

Figures

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Classification of clastic sedimentary rocks.	6
2	Symbols used on summary logs.....	11

Plate

<u>No.</u>	<u>Title</u>	<u>Page</u>
1	Location of wells for which sample suites are described.....	in pocket

INTRODUCTION

Background

From February through May, 1976, Atlantic Richfield Hanford Company core drilled selected sites on the Hanford Reservation. Five wells originally drilled with cable tools, DH-6, DH-7, DH-9, DH-9A, and DH-9B, were reentered and deepened to basalt. Core samples of the glaciofluvialite, the Ringold Formation, and the first underlying basalt flow were recovered. One new core hole was drilled, DH-8, which sampled three basalt flows and several interbeds.

These six holes provide a loose network of observation holes traversing the reservation in an east-west direction between the Columbia River and State Highway 240 (see plate). This program represents the first attempt to recover cores from the glaciofluvialite material and Ringold Formation beneath the Hanford Reservation.

Purpose and Scope

This report is a product of the continuing project aimed at quantifying the hydraulic parameters of the synthetic flow system of the Hanford Reservation (Summers and Deju, 1974, 1975). It deals with those features of the rocks that we observed in the cores. These features are of particular concern because they improve our understanding of fundamental lithologic and hydraulic properties of the sedimentary rocks, as they occur in the subsurface.

This is our basic-data report. It contains three parts:

- (1) an introductory text describing our method of inspection and format for written description;
- (2) summary logs that illustrate in condensed form the rocks penetrated by the wells drilled; and
- (3) the detailed written descriptions of core samples.

This report deals with core samples from six wells representing 1348 feet of section within a total drilled depth of 1493 feet. The detailed descriptions provide geologists with data for a variety of interpretative programs; whereas, the summary logs provide a quick visual reference to the lithologic units.

Sample Inventory

The intent of a sample inventory was to find how much core at what depths remained intact for each well suite described. This serves two purposes. First, the recovery of a particular rock type is roughly proportional to the degree of its induration. Second, the inventory provides a ready reference for those scientists pursuing further tests that require intact cores.

The cores are stored in heavy duty cardboard boxes that can contain as much as ten feet of intact core samples. All boxes are numbered sequentially; and each box gives the well number, the high and low core-run numbers, and the depth interval of core samples present in that box. The cores are permanently stored in igloo 104, located approximately 1½ miles west of the 200 West Area.

All cores retrieved from these drill holes were immediately described and logged. Many of these remaining intact were wrapped in aluminum foil and sealed in paraffin. The logging geologist intended to preserve minerals as well as the physical integrity of the cores. Cores from below the water table are saturated with water and may crumble upon drying. They may contain minerals that oxidize upon drying. The dissolved solids in the water precipitate upon drying. Cores of unconsolidated rock crumbled immediately and were not sealed. The sealing process was fairly successful. Over 61 percent of the cored footage remained intact after coring, sealing, and transport as well as prolonged storage. Table 1 briefly reviews the recovery and survival rates for sediments and basalts by well.

Table 1 -- Recovery and survival rates of cored sediments and basalts.

Well Number		Core-run number range		Interval cored (ft)	% Recovery	% of Recovery still intact	Recovery footage still intact
		from	to				
DH-6	S ¹	1	113	415	91	55	209
	B ¹	114	115	10	100	100	10
DH-7	S	1	115	411	85	47	164
	B	116	117	14	100	100	14
DH-8	B ²	1	50	247	100	100	247
DH-9	S	1	29	68	90	27	17
	B	30	32	19	100	100	19
DH-9A	S	1	18	55	68	80	30
	B	19	20	13	100	100	13
DH-9B	S	1	55	243	92	81	182
	B	56	57	9.5	100	100	9.5

¹S = Sediments; B = Basalts

²This well cored mostly basalt yet some thermally metamorphosed interbeds are also present.

STUDY METHODS

Time and budget did not permit description of every sample in detail. We compiled the inventory and the macroscopic and microscopic descriptions of cores concomitantly.

Descriptions

We described the samples in a "down-hole" order. Every core was described in detail or, when the same as the previous core, noted as such. This expedited the description process by eliminating unnecessary duplicate descriptions. Fortunately, coring yields continuous samples and lithologic boundaries are clear. We handled each core only once. Samples were unsealed, when necessary, and resealed after description. We classified rocks as either sedimentary or volcanic.

Volcanic Rocks

Volcanic rocks appear in the samples both as trace fragments and as the major constituent. They occur in the Pasco Basin both as in-place massive, vesicular, and scoriaceous basalt flows, ash falls, and ash flows and as particles in the sedimentary rocks. The properties we described during the core examination were:

- (1) volcanic rock type;
- (2) degree of fracturing and weathering; and
- (3) degree and types of fracture mineralization.

We recognized cores from in-situ basalt flows by the high core-recovery rates, fractures across vugs, and absence of weathering rinds. Vesicular lava flows still had minerals and mineraloids present in vugs. Fracture mineralization had not been replaced with clays, though most basalt flows we inspected had a weathered zone above the fresh basalt layer. Some "weathered zones" have the texture of mudflows.

Basalt and ash weathered in-place or from transport contain fragments with weathering rinds and often show leached phenocrysts (ex., plagioclase) and leached mineraloids on exterior surfaces. Transported fragments commonly appear rounded or abraded. The composition of the basalt gravels ranged from exclusively basalt to subequal portions of "others" and basalt with a "salt and pepper" appearance.

Sedimentary Rocks

For the sedimentary rocks we recorded each rock type and:

- (1) texture and composition;
- (2) size range and shape;

- (3) quartz frosting;
- (4) color;
- (5) maturity;
- (6) induration;
- (7) trace fragments;
- (8) fracture mineralization; and
- (9) sedimentary fabric and structure.

Texture and composition. -- Texture refers to the particle-size distribution of granular material. We classified particle sizes according to the Wentworth Grade Scale and used a modified version of Folk's (1974) sediment classification (fig. 1) that was developed by Price and Fecht (1976) for use on the Hanford Reservation. To obtain an estimate of the particle-size distribution of the sample, during the core examination, we estimated the percentage of "fines," sand, and gravel. The "fines" included the silt and clay fractions. We divided both the sand and gravel into "basalt" and "other" and estimated the percent of each. Basalt gravel or sand consists of particles of basalt, whereas "other" gravel or sand consists of particles of other rock types, predominately quartzite, gravels, and quartzose sands.

The gravel was inspected with the naked eye. Sand and fines were estimated at 10X microscope magnification. The use of low magnification (10X and 20X) in this study prohibited identification of the clay- and silt-sized fractions individually.

Size range and shape. -- We described for the gravel and sand fractions their size range and roundness. Since quartzite and basalt were the two major contributors to the gravel fraction sphericity was ultraconstant. Quartz is the mineral we watch for the effects of transport in the sand range. It also has a consistently high to intermediate level of sphericity. We used visual estimates for determining both size range and shape. We reported the sand-gravel size range and the roundness of the quartz sand fraction.

Quartz frosting. -- Clear quartz is a common constituent of the "other" sands. It will appear with a frosted surface on the grains if it is from wind-transported sediments or if it is leached by meteoric solutions that favor the solution of silica. So for each "other" sand we noted the most abundant fraction of either frosted or unfrosted clear quartz. No note means that the amounts of each were not observable.

Figure 1.-- Classification of clastic sedimentary rocks
(PRICE and FECHT, 1976)

Color. -- The color we give in the description is the color of complete core material and reflects the mineral composition of that core interval. We recorded the color of each interval as it appears to the naked eye. Unlike drill cuttings the integrity of color in cores is very high and could be reliably used with other properties to distinguish between adjacent rock types.

In general the core-sample related to particle composition as follows:

- (1) black and dark grays are due to basalt fragments;
- (2) buffs, whites, and light grays are due to "other" fragments;
- (3) browns, tans, yellows, blues, greens, and reds are due to the silt and clay component;
- (4) whites, light yellows, and light tans are due to abundant caliche, diatomite, ash or quartz; and
- (5) "salt and pepper" is due to equal to subequal amounts of basalt and "others" sand and/or gravel.

Maturity. -- We noted each rock interval's textural maturity (modified after Folk, 1974). This textural maturity definition is a measure of ability for a sediment to come to equilibrium with its transport environment before final deposition. Clean fluviatile gravels and sands and lacustrine clays are examples of sediments that are close to a mechanical equilibrium at time of deposition. The gravels and sand, for example, show good size sorting, good mineral and/or rock-fragment sorting, higher intergranular porosity, and commonly have rounded grains. Examples of immature sediments include fanglomerate and mudflows deposits. They show poor sorting, poor mineral and/or rock-fragment segregation, low intergranular porosity, and commonly have angular grains.

Induration. -- We rated the induration of the rocks as unconsolidated, compacted, and lithified. Unconsolidated means grains were completely dissociated. Compacted means that cores occurred as friable aggregate clusters. Lithified means that the sample occurred in non-friable aggregate cores. Induration is a very prominent feature in core samples. Both the friability and interstitial fill are easily determined from core samples. Recovery and survival rates from sampling and storage also reflect the degree of induration.

The degree of induration is governed by the presence of interstitial clays and cements. Less frequently the lack of sorting, certain types of fracture mineralization (for example, calcium carbonate), and thermal metamorphism (in some interbeds) also contribute to the tenacity of these sedimentary rocks.

Cements occur individually, with interstitial clays and silt, and in a variety of superimposed combinations of cements and "fines." They include silica and calcium carbonate, as well as reduced and oxidized iron minerals. We noted the response of the sample to a few drops of dilute hydrochloric acid.

Trace fragments. -- Several types of minerals and clastic debris significantly contribute to the group of distinguishing properties. Gypsum, mica, caliche, diatomaceous earth, pyroclastic rock particles, plus several unusual sedimentary clasts such as interclasts, intraclasts, and schistose boulders are recorded in our descriptions. Their presence and abundance fall in one of the following categories:

- (1) not present,
- (2) present ($1\% \leq x < 10\%$), and
- (3) abundant ($x \geq 10\%$).

These constituents have discrete (and in some cases mutually exclusive) environmental and/or transport regimes. Our genetic segregation between primary and secondary forms in core samples is very reliable. Though the presence of trace fragments is not uncommon, our ability to spot them is often hampered with intact cores due to the lack of surfaces available for scrutiny.

"Primary" forms appeared to us as angular and uncoated (i.e. unweathered) pebble-sized fragments. Pyroclastic rock fragments include ash, obsidian, and rhyolite shards. Primary gypsum appeared as euhedral to subhedral, unetched, sand sized crystals. This form of primary gypsum is consistent with Allmendinger and Titus's (1973) observation of primary gypsum forming in playa lake deposits in New Mexico.

"Secondary" forms show up as coated, rounded, and/or partially etched or dissolved pebble, sand, and silt sized grains of gypsum, diatomaceous earth, caliche, and volcanic ash shards.

Mica is always secondary and includes light and dark fragments. Most appear as degraded and/or abraded forms.

Fracture mineralization. -- Fractures were encountered in basalts and sedimentary rocks. When these fractures were filled, we recorded the types of minerals and clastic debris present. We also noted the degree and order of mineralization and mineral alteration.

Sedimentary fabric and structure. -- We saw several fabrics and structures in the cores. These features (not seen in cuttings) aid in discriminating between adjacent, texturally identical rock types. Alluvial-fan deposits and tilloids are examples of "dirty" gravels. Palouse deposits, fluvial silts and lacustrine clayey silts are examples of "fines" with different origins.

Sedimentary petrographers define fabric as an arrangement or orientation of rock components. In this report we are concerned with those depositional or "primary" fabrics caused by various transport mechanisms and the resulting sequence and distribution (in time and space) of sedimentary grain textures, because no other fabrics can be seen in the cores. Imbrication, grain-size range and sorting and distribution of textures are examples of features affected by fluid transport. These, in turn, are closely linked to more general features such as porosity and induration. Interbedding of glaciofluvial gravels and silts, lack of any bedding in the glaciofluvial gravels, and rhythmic bedding in slack waters of proglacial Lake Lewis are examples of fabrics cited by Newcomb and others (1972) which we observed in the cores.

Sedimentary petrologists recognize three classes of structures in sedimentary rocks; mechanical, chemical, and organic. Mechanical or "primary" structures that we observed include graded bedding, laminations, mud cracks, interclasts, and intra-clasts. Chemical or "secondary" structures we observed in cores include concretions, vugs, and veinlets. We also noted vug and veinlet fillings. Organic structures we observed included root casts and organic stains. In outcrops, Newcomb and others (1972) observed:

- (1) interclasts along the erosional contact between the Ringold and glaciofluvial sediment;
- (2) channelization resulting in some erosional contacts between older and younger sediments; and
- (3) an extensive caliche layer capping the Ringold Formation.

Persistent relief along some edges of the Pasco Basin caused certain alluvial fans to be the site of continual deposition since late Pleistocene time. At these sites no local erosional contact exist.

Final Descriptive Log

The description presented here derives from our preliminary description. We recorded these descriptions as a standard columnar format for sedimentary and volcanic rocks.

Each table presents a title identifying the contents, well number, and location (when they are known). From left to right, each page contains:

- (1) depth range of the interval;
- (2) rock classification;
- (3) core runs, percent recovery, and percent survival of the interval; and
- (4) the rock type with a written description.

Written descriptions include all those features noted above.

Summary Log

Preceding the descriptions for each well there is a summary log printed on 9 x 11 inch manila paper.

The oversized paper serves as an index tab, exposing the well number written along the length of the page in the upper right hand corner. On the summary log we give:

- (1) routine information including
 - (a) plant coordinates,
 - (b) altitude, and ~
 - (c) a listing of other data used in interpretation;
- (2) a graphic log at a vertical scale of 1 inch = 50 feet, that is split vertically into two parts (on the left is a percent basalt log and on the right is a lithologic log. Adjacent to the right side of the column are symbols disclosing the maturity, mica content, and the presence of frosting on clear quartz. Figure 2 displays the graphic and written symbols used on the summary logs); and
- (3) written descriptive matter as required including color, fossils, trace constituents, total drilled depth, and any other nonstandard features observed.

Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

Altitude _____

Other Data used in
Interpretation

Figure 2

Symbols Used on Summary Logs

% 0-100 Symbolic
description

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Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

N 075000

W 043000

Altitude _____

Other Data used in
Interpretation

(1) driller's log

(2) geologist's log

brownish grey
medium brown

greyish brown

greyish brown

brown
greyish brown
light brown

buff grey to greyish brown

greyish brown

dark grey

buff grey

greyish brown

greyish buff

greyish buff

brownish buff

greyish brown

greyish brown (gypsum sand)

brownish buff

greyish buff (gypsum sand)

greyish brown

greyish buff

brownish to greenish grey

W. K. Summers & Associates

Well 299 - W11 - 26

DH-6

Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

Altitude _____

Other Data used in
Interpretation

Table 2 -- Descriptive log of well no. DH-6 (299-W11-26, N043000, W075000)¹.

1. personal communication with Roy Gephart, 8-19-76

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
90	93	sand	1	100	94	SAND, brownish gray, very fine to medium sand, 63% other sand (subrounded), 34% basalt sand, and 3% silt, unconsolidated, frosted quartz, submature, fractured, micaceous throughout
93	94	silt	2	50	50	SILT, medium brown, very fine to medium sand, 10% other sand (subrounded), 2% basalt sand, and 88% silt and clay, unconsolidated, fractured, immature, micaceous throughout
94	103		2	0	0	no sample
103	106	slightly gravelly silty sand	3	100	83	SLIGHTLY GRAVELLY SILTY SAND, grayish brown, very fine to very coarse sand, 5% basalt gravel, 56% other sand (rounded), 14% basalt sand, and 25% silt and clay, unconsolidated, immature, slightly calcareous, fractured, micaceous throughout
106	111		4	0	0	no sample
111	125	silty sand	5-9	76	75	SANDSTONE, grayish brown, very fine sand to fine pebbles, 1% basalt gravel, 58% other sand (subangular), 9% basalt sand, and 32% silt, unconsolidated to lithified by silt and calcium carbonate, immature, unfrosted quartz, fractured, micaceous throughout
125	134	silty sand	10-12	67	67	SANDSTONE, brown, very fine sand to pebbles, 2% basalt gravel, 64% other sand (subangular), 14% basalt sand, and 20% silt, lithified by silt and calcium carbonate, immature, fractured, micaceous throughout

Table 2 -- Descriptive log of well no. DH-6 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
134	137	sand	12	42	33	SAND, grayish brown, very fine to medium sand, 76% other sand (subrounded), 19% basalt sand, and 5% silt, unconsolidated, fractured, submature, micaceous throughout
137	141	sandy silt	13	17	21	SANDY SILT, light brown, very fine to fine sand, 24% other sand (subrounded), 6% basalt sand, and 70% silt, compacted, fractured, immature, micaceous throughout
141	169	gravel	14-29	94	8	GRAVEL, buff gray to grayish brown, very fine sand to boulders, 21% other gravel, 73% basalt gravel, 4% other sand (subrounded), 2% basalt sand, unconsolidated, submature, fractured, micaceous throughout
169	190	silty sandy gravel	30-34	100	31	CONGLOMERATE, grayish brown, very fine sand to small cobbles, 50% other gravel, 25% basalt gravel, 12% other sand (subrounded), 8% basalt sand, 5% silt and clay, compacted to lithified by caliche, silt and clay, fractured, immature, with a 4-inch silt unit capping this bed
190	199	gravel	35-40	100	0	GRAVEL, dark gray, very fine sand to large cobbles, 27% other gravel, 68% basalt gravel, 2% other sand (well rounded), 1% basalt sand, and 2% silt and clay, unconsolidated, submature, fractured
199	218	gravel	41-45	92	51	GRAVEL, buff gray, very fine sand to boulders, 68% other gravel, 18% basalt gravel, 10% other sand (subrounded), 4% basalt sand, unconsolidated, frosted quartz, immature, with iron oxide stains, fractured, a few iron concretions, micaceous throughout

Table 2 -- Descriptive log of well no. DII-6 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
218	223	gravel	45-46	100	25	CONGLOMERATE, grayish brown, very fine sand to small cobbles, 59% other gravel, 25% basalt gravel, 10% other sand (subrounded), 2% basalt sand, and 4% silt and clay, lithified by iron minerals, silt, and clay, immature, fractured, iron concretions present, micaceous throughout
223	267	gravel	47-59	100	28	GRAVEL, grayish buff, very fine sand to boulder, 78% other gravel, 15% basalt gravel, 5% other sand (subrounded), 1% basalt sand, and 1% silt and clay, compacted to unconsolidated, iron oxide and caliche coatings, fractured, iron concretions 223-255, unfrosted and frosted quartz, submature, micaceous throughout
267	272	sandy gravel	60	100	68	SANDY GRAVEL, grayish buff, medium sand to small cobbles, 20% other gravel, 20% basalt gravel, 48% other sand (subrounded), and 12% basalt sand, compacted, frosted quartz, immature, fractured, micaceous throughout
272	335.5	gravel	61-76	96	59	CONGLOMERATE, brownish buff, very fine sand to boulders, 66% other gravel, 17% basalt gravel, 13% other sand (subrounded), 2% basalt sand, and 2% silt and clay, lithified by iron oxide minerals, silt and clay, trace of disseminated calcium carbonate, submature, subequal frosted and unfrosted quartz, iron concretions present, fractured, micaceous throughout

Table 2 -- Descriptive log of well no. DH-6 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
335.5	356.5	silty sandy gravel	78-83	95	29	CONGLOMERATE, grayish brown, very fine sand to large cobbles, 54% other gravel, 19% basalt gravel, 16% other sand (subrounded), 4% basalt sand, and 7% silt and clay, lithified by iron oxides, silt, and clay, immature, frosted quartz, fractured, iron concretions present, micaceous throughout
356.5	369	silty sandy gravel	83-86	97	67	CONGLOMERATE, grayish brown, very fine sand to boulders, 47% other gravel, 33% basalt gravel, 13% other sand, 3% basalt sand, and 4% silt and clay, lithified by iron oxides, silt and clay, fractured, immature, gypsum sand present 356.5-358, with iron concretion present, micaceous throughout
369	386	sand	86-89	96	95	SANDSTONE, brownish buff, very fine sand to very coarse sand, 47% other sand (subrounded), 48% basalt sand, and 5% silt and clay, lithified by silt and clay, and disseminated calcium carbonate, submature, unfrosted quartz present
386	430	silty sandy gravel	89-98	90	73	CONGLOMERATE, grayish buff, very fine sand to very coarse pebbles, 43% other gravel, 36% basalt gravel, 12% other sand (subangular), 4% basalt sand, and 5% silt and clay, lithified by iron oxides, silt, and clay, immature, some fractures present, frosted quartz, gypsum sand present 408-411.5, micaceous throughout

Table 2 -- Descriptive log of well no. DH-6 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
430	466	gravel	98-105	98	64	CONGLOMERATE, grayish brown, very fine sand to boulders, 51% other gravel, 34% basalt gravel, 9% other sand (subrounded), 1% basalt sand, and 5% silt and clay, lithified by iron oxides, silt, and clay, immature, frosted quartz, some fractures present, slightly micaceous
466	472	gravel	105-106	100	69	CONGLOMERATE, grayish buff, very fine sand to small cobbles, 78% other gravel, 7% basalt gravel, 9% other sand (subangular), 1% basalt sand, and 5% silt, lithified by iron oxides, silt, and clay, immature, some fractures present, frosted quartz, iron concretions present, micaceous throughout
472	505	gravel	107-113	99	72	CONGLOMERATE, brown to greenish gray, very fine sand to boulders, 38% other gravel, 43% basalt gravel, 9% other sand (subrounded), 1% basalt sand, and 9% silt and clay, lithified by disseminated calcium carbonate, silt, and clay, some fractures present, immature, frosted quartz, faint imbrication present, slightly micaceous
505	515	basalt	114-115	100	100	BASALT, black, vesicular, fractured, fractures filled with silt and clay, weathered basalt zone greater than 5 feet thick with mineraloids still in vugs throughout

Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

N 075000

W 037000

Altitude

Other Data used in
Interpretation

(1) driller's log

(2) geologist's log

Well 299 - W/9 - 10 DH-7

W. K. Summers & Associates

DH-7

Plant Coordinates

Altitude

Other Data used in Interpretation

grey (salt & pepper)

greenish grey
green to black

Table 3 -- Descriptive log of well no. DH-7 (299-W19-10, N037000, W075000)¹.

1. personal communication with Roy Gephart, 8-19-76

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
148	171	silty sand	1-5	100	67	SANDSTONE, brownish buff, very fine to very coarse sand, 40% other sand (angular), 11% basalt sand, 49% silt and clay, lithified by calcium carbonate, silt, and clay, micaceous, immature, caliche veins and fragments present
171	281	gravel	5-48	93	24	GRAVEL, "salt and pepper," silt to boulders, 44% other gravel, 46% basalt gravel, 1% basalt sand, and 9% other sand (well rounded) and silt, compacted to unconsolidated, submature, 6-inch caliche zone within 225-227, gypsum pebbles present 242-244, micaceous throughout sandy portions
281	287	sand	48-49	100	50	SAND, buff, well rounded, medium to coarse sand, 80% other sand (well rounded), and 20% basalt sand, unconsolidated, very mature, frosted quartz, micaceous throughout
287	303	sandy gravel	50-53	73	39	CONGLOMERATE, grayish brown, very fine sand to boulders, 55% other gravel, 13% basalt gravel, 26% other sand (well rounded), and 6% basalt sand, lithified, frosted quartz, immature
303	307	sand	53-54	88	40	SAND, grayish buff, very fine sand to boulders (?), 5% basalt gravel, 65% other sand (subrounded), 29% basalt sand, and 1% silt and clay, unconsolidated, immature, frosted quartz, trace of gypsum (?) present

Table 3 -- Descriptive log of well no. DH-7 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
307	340	sandy gravel	54-63	74	32	CONGLOMERATE, brownish buff, very fine sand to pebbles, 50% other gravel, 23% basalt gravel, 19% other sand (well rounded), 6% basalt sand, and less than 2% clay (bentonite?), compacted with some calcium carbonate cement present, immature, unfrosted quartz, massive gypsum 310-313, schist pebbles 335-340, micaceous throughout
340	350	gravelly sand	64-65	71	63	SANDSTONE, brownish buff, very fine sand to pebbles, 14% other gravel, 5% basalt gravel, 68% other sand (subrounded), 12% basalt sand, and less than 1% silt, lithified, frosted quartz, micaceous throughout
350	413	sandy gravel	66-81	80	32	CONGLOMERATE, grayish buff, very fine sand to small cobbles, 67% other gravel, 11% basalt gravel, 17% other sand (rounded), 3% basalt sand, and 2% silt and clay, immature, lithified by iron oxides, frosted quartz, iron concretions 350-392 and 406-413, fibrous gypsum present 395-398, gypsum pebbles present 402-406, micaceous throughout
413	423		82-83	0	0	no sample
423	458	gravel	84-94	79	47	CONGLOMERATE, grayish buff, very fine sand to very coarse pebbles, 80% other gravel, 9% basalt gravel, 8% other sand (rounded), 2% basalt sand, and 1% silt and clay, lithified by iron oxides, silt, and clay, immature, frosted quartz, iron concretions present 423-453, exotic volcanoclastics present 437-458, micaceous throughout

Table 3 -- Descriptive log of well no. DH-7 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
458	465	slightly gravelly sandy silt	94-95	94	90	MUDSTONE, greenish brown, very fine sand to very coarse pebbles, 7% other gravel, 14% other sand (subangular), 5% basalt sand, and 74% silt and clay, lithified by iron oxides, silt, and clay, fractured, immature, unfrosted quartz, micaceous throughout
465	482	sandy silt	96-99	90	85	MUDSTONE, greenish brown to purplish brown, very fine to very coarse sand, 34% other sand (angular), 5% basalt sand, and 61% silt and clay, fractured, lithified by silt and clay, immature, frosted quartz, slightly micaceous throughout
482	485	sand	99	100	44	SANDSTONE, brown, angular, very fine to coarse sand, 88% other sand (angular), 10% basalt sand, and 2% silt, lithified by silt, frosted quartz, fractured, gypsum sand present 482-484, submature, micaceous throughout
485	523	silty sandy gravel	100-107	99	61	CONGLOMERATE, greenish gray, very fine sand to boulders, 71% other gravel, 11% basalt gravel, 12% other sand (well rounded), 3% basalt sand, and 3% silt and clay, lithified by iron oxides, silt, and clay, immature, unfrosted quartz, micaceous throughout
523	548	sandy gravel	108-113	98	48	CONGLOMERATE, gray "salt and pepper," very fine sand to boulders, 27% other gravel, 54% basalt gravel, 14% other sand (well rounded), 2% basalt sand, 3% silt and clay, immature, lithified by iron oxides, silt, and clay, unfrosted quartz, iron concretions present, micaceous throughout

Table 3 -- Descriptive log of well no. DH-7 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
548	554	sand	113-114	97	11	SAND, greenish gray very fine to very coarse sand, 65% other sand (rounded), 35% basalt sand, mature, unconsolidated, frosted quartz, micaceous throughout
554	559	silty sandy gravel	115	58	52	CONGLOMERATE, green to black, very fine sand to boulders, 16% other gravel, 64% basalt gravel, 6% other sand (very angular), 4% basalt sand, and 10% silt and clay, lithified by silt and clay, immature, frosted quartz, micaceous throughout
559	573	basalt flow	116-118	100	<100	BASALT, black, vesicular, fractured, with first 5.5 feet weathered zone and remainder "fresh" basalt, mineraloids in vugs, clay filled fractures throughout

Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

Well 699 - 61 - 55
DH-8

reddish brown, green & grey mottled
black
reddish brown to greyish green
reddish brown to greyish green (ANHYDRITE)

Altitude 460

Other Data used in Interpretation

green

(1) driller's Log

(2) geologist's Log

reddish brown to black

grey, green & red mottled
greenish tan to greenish grey
greenish grey

Table 4 -- Descriptive log of well no. DH-8 [699-61-55 (DH-8A)]¹
 1. personal communication with Roy Gephart, 8-19-76

Depth (ft)		Classification	runs	Cores		Description
From	To			%recovery	%intact	
0	3.5	silty sandy gravel	1	100	≤100	CONGLOMERATE, reddish brown, green, and gray mottled, very fine sand to boulders, 30% basalt gravel, 30% sand (subangular), and 40% silt and clay, lithified by a mild thermal metamorphism, lacks bedding
3.5	14	gravel (?)	1-2	100	≤100	BOULDER (?), black, fractured, vesicular basalt with secondary, crystalline quartz in vugs
14	16	sand	2	100	≤100	SANDSTONE, reddish brown to grayish green, hornfelsic, lithified with crystalline quartz in vugs
16	21	gravel (?)	2-3	100	≤100	BOULDER (?), black, vesicular basalt with secondary, crystalline quartz in vugs
21	39	silty gravel	3-6	100	≤100	CONGLOMERATE, reddish brown to greenish gray, clay to boulders, hornfelsic with crystalline quartz in vugs, clay interclasts, anhydrite present, gravel is exclusively vesicular basalt
39	68	basalt	7-12	100	100	BASALT, gray, massive to fractured, with baked, clay, fracture fill grading from no fill to black hornfelsic fill in less fractured basalt
68	71	silt	12-13	100	100	CLAY, green, mildly baked yet lithified
71	124	basalt	13-25	100	100	BASALT, black, massive, fractured, with black, vitreous, very fine grained to hornfelsic fracture fill sporadically occurring between zones of clean fractures, few to no fractures with a trace of copper minerals, possibly chrysocolla, at bottom of flow

Table 4 -- Descriptive log of well no. DH-8 cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
124	131	silty sandy gravel	25-26	100	100	RUBBLE ZONE, reddish brown to black, baked, made of scoriaceous to vesicular klinker and flow fragments in a silt-clay matrix, copper mineralization is present along fractures and in vugs
131	223	basalt	26-45	100	100	BASALT, black, vesicular, vitreous, fractured, with filled fractures at 131-156 and at 161-176, clean or partially mineralized fractures complete the flow interval as follows: 156-161 (bornite); 176-191; 191-213 (thin, dark green coatings); 213-218 euhedral pyrite); and 218-223 (euhedral quartz), apparent autobreccia zone at 154-156
223	228	silty sandy gravel	46	100	100	RUBBLE ZONE (10%), mottled gray, green, and red baked, made of angular basalt fragments and red sandstone interclasts (?), lithified from thermal alteration this rests unconformably on SILTSTONE (90%), greenish gray, mildly baked, silt to medium sand, fractured, lithified, immature, and very micaceous
228	244.5	sand	47-50	100	100	SANDSTONE, greenish tan to greenish gray, very fine sand to very coarse sand sized, greater than 10% silt and clay, immature, mildly baked, lithified, micaceous and tuffaceous throughout
244.5	247	sandy silt	50	100	100	MUDSTONE, greenish gray, mildly baked, tuffaceous, less than 25% sand, 75% silt and clay, very fine to very coarse sand, immature, lithified, with angular unfrosted quartz present, micaceous throughout

Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

N 049426

W 100348

Altitude 793

Other Data used in
Interpretation

(1) driller's log

(2) geologist's log

greyish brown

grey (salt & pepper)
tan to yellowish grey
first 10' weathered basalt

Table 5 -- Descriptive log of well no. DH-9 (699-49-100A, N049426, W100348, 792.6 feet msl)^{1 2}

1. casing elevation

2. personal communication with Roy Gephart, 11-20-75

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
342	402.5	gravel	1-26	89	25	GRAVEL, grayish brown, very fine sand to boulders, 21% other gravel, 60% basalt gravel, 10% other sand (rounded), 1% basalt sand, and 8% silt and clay, unconsolidated to lithified, submature, frosted grading to unfrosted quartz, micaceous throughout, cemented by silt and clay and a minor amount of iron oxide minerals, gypsum sand present 393-402.5
402.5	406	sand	26-27	98	50	SAND, "salt and pepper," very fine sand to fine pebbles, 1% other gravel, 4% basalt gravel, 54% other sand (subangular), 36% basalt sand, and 5% silt and clay, unconsolidated, unfrosted quartz, submature, micaceous throughout
406	410	silty gravel	27-28	100	100	CONGLOMERATE (interbedded), tan to yellowish gray, very fine sand to very coarse pebbles, 27% other gravel, 30% basalt gravel, 4% other sand (subrounded), 2% basalt sand, and 37% silt and clay, sequence of interbedded gravelly silts and clays, and silty gravels, lithified by silt and clay, fractured, immature, micaceous throughout
410	429	basalt	28-32	100	100	BASALT, gray to black, fractured, vesicular to massive, first 10 feet weathering zone with silt-clay fracture fill and remaining 19 feet shows iron oxides in fractures, no mineraloids in vugs except in bottom foot, 428-429

N 043049

W 041716

Altitude 565

Other Data used in Interpretation

(1) driller's Log

(2) geologist's log

Well 699 - 43 - 42 DH-9-A

greyish brown

dark brown
dark brown
brownish black, DIATOMACEOUS

TD 222

Table 6 -- Descriptive log of well no. DH-9A (699-43-42, N043049, W041716, 564.48 feet msl¹, Hanford Wells, 1973).

1. casing elevation

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
154	185	gravel	1-12	56	19	GRAVEL, grayish brown, very fine sand to large cobbles, 58% other gravel, 27% basalt gravel, and 15% sand, silt, and clay, unconsolidated to compacted, immature, fractures present, micaceous throughout, with some current graded bedding 157-159
185	197	silt	13-15	77	76	CLAY, dark brown, very fine sand to very fine pebbles, 2% basalt gravel, 2% total sand, and 96% silt and clay, lithified by silt and clay, submature
197	202	gravel	16	100	47	CONGLOMERATE, dark brown, very fine sand to cobbles, 28% other gravel, 60% basalt gravel, and 12% sand, silt, and clay, lithified by silt and clay, immature
202	209	gravel	17-18	100	100	CONGLOMERATE, brownish black, very fine sand to large cobbles, 85% basalt gravel and 15% silt and clay, lithified by silt and clay, immature, diatomite present throughout
209	222	basalt	18-20	100	100	BASALT, black to gray, fractured, vesicular, with yellow mineraloids in fractures and clean vugs

Depth
(ft.)

Graphic Log

Sample Description

Plant Coordinates

N 053873

W 017345

Altitude 404

Other Data used in
Interpretation

(1) Driller's Log

(2) Geologist's Log

brownish tan

brownish buff

brownish buff

buff tan

brownish buff to reddish tan

brownish buff

brownish buff

dark brown

dark brown

medium to dark brown

buff

brownish buff

buff brown
greenish grey
brownish buff

light to dark brown

black

TD 355

Table 7 -- Descriptive log of well no. DH-9B (699-54-17C, N053873, W017345, 404.4 feet msl¹)².

1. casing elevation

2. personal communication with Roy Gephart, 11-20-75

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
103	118	sandy silt	1-3	100	75	MUDSTONE, brownish tan, very fine sand to fine pebbles, 4% basalt gravel, 15% other sand (angular), 2% basalt sand, 79% silt and clay, lithified with disseminated calcium carbonate and caliche, immature, micaceous, fractures present, caliche occurs as coatings in vugs and as sand and pebbles
118	122.5	slightly silty sand	4	100	67	SANDSTONE, brownish buff, very fine to fine sand, 76% other sand (angular), 9% basalt sand, and 15% silt and clay, lithified by silt and clay, immature, micaceous, fractured, organic (?) stains present
122.5	128	silt	4-5	100	100	MUDSTONE, brownish buff, very fine to fine sand, 4% other sand (angular), 1% basalt sand, and 95% silt and clay, lithified by silt and clay, submature, micaceous, fractures present
128	140	sand	6-8	100	100	SAND, buff tan, fine to medium sand sized, 89% other sand (angular), less than 10% basalt sand, and less than 1% silt (no clay), unconsolidated, submature, frosted quartz, micaceous throughout
140	153.4	silt	8-11	97	97	MUDSTONE (interbedded), brownish buff to reddish tan, very fine to medium sand, 4% other sand (subangular), trace of basalt sand, and 96% silt and clay, lithified by calcium carbonate (in silt layers only), submature, frosted quartz, micaceous, laminations of silt-clay and sand interbeds 143-145, sands contain red sandstone intra-clasts

Table 7 -- Descriptive log of well no. DH-9B cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
153.4	193	sand	11-18	100	100	SAND, brownish buff, very fine sand to fine pebbles, less than 1% basalt gravel, 87% other sand (subangular), 5% basalt sand, 7% silt and clay, compacted, submature, frosted quartz, fractured, micaceous, thin sand-silt and clay interbeds 153.4-158
193	202	slightly gravelly sand	19-21	67	11	SAND-CONGLOMERATE (interbedded), brownish buff, very fine sand to large cobbles, 7% other gravel, 79% other sand (subrounded), 9% basalt sand, and 5% clay (with little to no silt), compacted, immature, unfrosted quartz, micaceous, fractured, with interstitial limonite, hematite, and clay cementing interbedded gravels, clay in first sand occurs as angular interclasts, remainder of unit has disseminated clays
202	247.9	silt	22-31	97	93	MUDSTONE, dark brown, very fine sand to fine pebbles, 2% basalt gravel, 17% other sand (subrounded), 2% basalt sand, and 79% silt and clay, lithified by caliche, silt, and clay, fractured, immature, frosted quartz, micaceous, abundant caliche, root or twig casts 202-207; mud cracks and resulting clay intraclasts present 207-207.4; more caliche present in vugs and cracks 217-222, no caliche below 237 and no vugs from 242 to 247.9
247.9	258	gravelly silt	31-33	97	39	MUDSTONE-CONGLOMERATE, dark brown, very fine sand to small cobbles, 6% other gravel, 8% basalt gravel, 13% other sand (rounded), 1% basalt sand, and 72% silt and clay, lithified by silt and clay, immature, micaceous, fractured, thin interbeds of pebbly silts and silty clays

Table 7 -- Descriptive log of well no. DH-9B cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
258	267	silt	34-35	100	89	MUDSTONE, medium to dark brown, very fine to medium sand, 2% other sand (rounded), trace of basalt sand, and 98% silt and clay, lithified by caliche, silt and clay, submature, fractured, micaceous, with caliche along cracks and vugs
267	289	sand	35-40	100	51	SANDSTONE, buff, very fine to medium sand sized, 66% other sand (subrounded), 15% basalt sand, and 19% silt and clay, unconsolidated to lithified as clay and silt first occur as abundant (less than or equal to 25%) interclasts 267-268 and then are present as disseminated, interstitial material, immature, frosted quartz, fractured, micaceous throughout
289	294	silty sandy gravel	41	60	23	CONGLOMERATE, brownish buff, very fine sand to large cobbles, 52% other gravel, 13% basalt gravel, 16% other sand (rounded), 4% basalt sand, and 15% silt and clay, lithified by interstitial iron oxides, silt and clay, immature, frosted quartz, graded bedding, micaceous, with abundant iron oxide stains and iron concretions
294	306		42-44	0	0	no sample
306	309	gravelly silty sand	45	100	56	SANDSTONE, buff brown, very fine sand to very coarse pebbles, 13% other gravel, 7% basalt gravel, 40% other sand (rounded), 10% basalt sand, and 30% silt, lithified by silt, immature, micaceous throughout

Table 7 -- Descriptive log of well no. DH-9B cont

Depth (ft)		Classification	Cores			Description
From	To		runs	%recovery	%intact	
309	312	silt	45-46	100	61	MUDSTONE, greenish gray, 100% silt and clay occurring as a varved clay sequence that is lithified, submature, micaceous throughout
312	314	sand	46	100	92	SANDSTONE, brownish buff, rounded, very fine to fine sand, 88% other sand, 10% basalt sand, and less than 2% silt and clay, lithified by iron oxides, silt, and clay, submature, iron concretions present 312-312.5, micaceous throughout
314	336	silt	47-52	71	32	MUDSTONE, light to dark brown, very fine to fine sand, 4% other sand (well rounded), trace of basalt sand, and 96% silt and clay, lithified by silt and clay, submature, frosted quartz, micaceous throughout, faint graded bedding 314-318
336	339		53	0	0	no sample
339	345.5	silty gravel	54-56	50	46	CONGLOMERATE, black, very fine sand to large cobbles, 3% other gravel, 52% basalt gravel, 5% other sand (angular), trace of basalt sand, 40% silt and clay, lithified by disseminated calcium carbonate, caliche, and silt and clay, immature, with caliche in fractures and vugs
345.5	355	basalt	56-57	100	<100	BASALT, black, vesicular to massive, fractured, caliche and silt and clay are present along fractures and lack mineraloids 345.5-350, with little to no fracture fill and mineraloids present in vugs 350-355

Location of wells for which core samples are described