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THE HANFORD EXPLORATORY DEEP WELL

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HANFORD EXPLORATORY DEEP WELLI. INTRODUCTION

A "deep" well is being drilled on the Hanford project to obtain rock and water samples to evaluate the geologic and hydrologic characteristics of the underlying rock strata.

This information is needed to determine whether or not the deep basalt flows are thick enough and impermeable enough to store radioactive wastes for hundreds to thousands of years in mined out caverns where they will be isolated from the biosphere.

During the past 25 years of producing plutonium at Hanford, large volumes of radioactive waste solutions from the chemical processing plants have been accumulated in large storage tanks about 10 feet beneath the surface of the ground. At the present time the wastes are stored in 149 tanks ranging in size from 50,000 gallons to 1,000,000 gallons. These wastes are now being dried to a salt cake in these tanks to reduce the mobility and to increase the certainty of containment for long-term isolation from the biosphere.

The majority of the radioactive elements in the wastes decay rapidly to non-radioactive elements. However, strontium-90 and cesium-137, chemically similar to calcium and sodium in life processes, have half-lives of 28.8 and 30 years, respectively. The half-life is the period during which $1/2$ of the material transforms to another chemical element by emitting energy in the form of heat and radiation such as beta rays and gamma rays. If these wastes are stored for 20 half-lives (about 600 years), only a millionth (0.000001) of the original quantity will remain. This quantity will, of course, be distributed throughout the many millions of gallons of waste and, at the correspondingly low concentrations, strontium-90 and cesium-137 should no longer be of concern to the biosphere.

Caverns, mined out of basalt, and surrounded by several hundred feet of material through which radioactive elements will not migrate, is an alternative mode of storage which may provide the necessary long-term safe confinement and isolation of radioactive wastes should present practices prove to be unsatisfactory. Figure 1 illustrates this concept. (Fig. 1). Figure 2 illustrates the inferred geology of the Columbia basin. (Fig. 2).

II. DISCUSSION

A. The Standard Oil Company Well in Rattlesnake Hills

Before a cavern is constructed for storing radioactive wastes, it is necessary to know the degree of isolation that will be afforded by the underground formations. Preliminary evaluation of the deep basalt formations was made available by the Standard Oil Company of California. The Standard Oil Company of California had drilled a 9-inch diameter "wild cat" well to 10,655 feet below ground level at the Anderson Ranch on Rattlesnake Hills in 1957 and 1958. Permission was given to the AEC to enter the well and conduct geophysical logging and hydrological testing "to measure the geological and hydrological characteristics of the basalt section that are pertinent to radioactive waste storage considerations." Messrs. J. R. Raymond and D. D. Tillson of the Pacific Northwest Laboratory (operated by Battelle Northwest for the AEC) completed their studies and published their results in the "Evaluation of a Thick Basalt Sequence in South Central Washington" in April, 1968, (USAEC Document No. BNWL-776).

Raymond and Tillson concluded that "waste disposal by cavern or tunnel methods might be possible in some of the relatively unfractured basalt flows. Typical upper and mid depth zones potentially suitable for such disposal occur at 1,520, 2,140, 2,720, and 3,200 feet below ground surface at the (Rattlesnake Hills) well site."

The Rattlesnake Hills Unit No. 1 well is located about 15 miles southwest of the major chemical separations plant and, while we feel confident that basalt flows in the Columbia Basin extend over thousands to tens of thousands of square miles, it is essential that we fully understand the geology and hydrology of the specific locality in which waste caverns might be mined. Having obtained encouraging indications from the Rattlesnake Hills well, the USAEC decided that an exploratory deep well should be drilled on the Hanford Project in the vicinity where wastes are now generated and/or stored. Figure 3 shows the location of the deep well on the Hanford project. (Fig. 3)

B. The Hanford Deep Well - Responsibilities

On April 12, 1969, Calvert Western Exploration Company accepted the AEC contract to drill a 9 7/8 inch well (designated ARH-DC-1) to 7,500 feet below ground level. The AEC Chemical Processing Division is managing the project and the AEC Engineering and Construction Division is administering the contract. The Atlantic

Richfield Hanford Company (ARHCO) is responsible for overall project technical direction. The U. S. Geological Survey has the responsibility to conduct hydrological tests and act as consultants to the Project Manager and to ARHCO. Fenix and Scisson, Inc., provide consulting services relative to drilling methods and problems. Many other companies get involved through service contracts and supplies, and Table I is a list of the companies and the services provided. (Table I).

C. Progress

On April 27, 1969, the Calvert Western Exploration Company was rigged-up and spudded-in. Figure 4 shows the drill rig in place. (Fig. 4). By May 1, 1969, a 17 1/2 inch diameter hole had been drilled through 154 feet of alluvium and 210 feet of the upper layers of basalt and basalt interbeds, then 362 feet of 13 3/4 inch diameter surface pipe was installed and cemented in place to exclude the sands, gravels and water from the uppermost aquifers. Thereafter the well has been drilled open-hole with a 9 7/8 inch bit. As of July 12, 1969, the well was 4,282 feet deep where drilling was stopped temporarily as is done periodically to permit geophysical logging, hydrological testing and coring.

1. Geophysical Logging

"Well logging" consists of recording descriptive data of the formations encountered in the bore-hole as a function of depth. Geophysical logging consists of lowering various signal generators and/or detectors into the bore hole and continuously recording the response of the detectors to the signals reflected or emanating from and influenced by the formations as a function of depth. The following figures show examples of the geophysical logs that are being obtained from ARH-DC-1. (Figs. 5 and 6).

2. Hydrological Testing

Hydrological tests are conducted by the U. S. Geological Survey with assistance provided by Vitro and ARHCO personnel.

Drilling was stopped for hydrological tests at 712, 1,188, 2,242, 3,103, 3,216, 3,451, 3,597, and 4,282 feet below ground surface. Specific zones through the drilled intervals were selected from the Birdwell geophysical logs for testing. The zones to be tested were then isolated using Lynes Company inflatable packers and the USGS conducted their tests and

collected water samples for chemical analysis and age dating measurements. It should be noted that the odor of hydrogen sulfide gas was strong in water samples collected after the well had reached 1190 feet below ground surface.

3. Coring

Rock cores were to be taken periodically while drilling to provide massive samples of rock for mechanical and petrological analyses. These data were to be used to identify basalt flows in different localities to demonstrate the continuity of the thick impermeable layers of basalt and to provide information pertinent to mining out the caverns. Unfortunately, the basalt was found to be extremely tough and difficult to core using drilling methods that were most favorable to hydrological testing. Diamond core drills were rapidly damaged due to the brittle nature of diamonds and steel bits wore out rapidly. Figures 7, 8, 9, and 10 show the bits before and after use. These bits cost from about \$400.00 to almost \$4,000.00. (Figs. 7, 8, 9, and 10).

Because it was imperative to obtain core samples, another contract was let to drill a thousand feet of continuous NX type core using conditions that would assure that core samples would be obtained. Figure 11 shows the locations of the NX drill rig near ARH-DC-1. Another 600 feet of continuous core is tentatively scheduled to be drilled near the Rattlesnake Hills Unit No. 1 well. These cores will be used to identify the near surface basalts so as to correlate them with the known basalts found exposed in the surrounding area and to provide stratigraphic references. Boyles Brothers Drilling Company was the successful bidder and is currently drilling cores on the Hanford project near ARH-DC-1. (Fig. 11).

III. PRELIMINARY FINDINGS

Information obtained so far indicates that several layers of basalt are thick enough to mine out and appear to be impermeable enough to assure that wastes will not migrate through the rock into more permeable zones and hence into the biosphere by some other unknown force or act of man.

Zones which might be useful for mining are illustrated on the density log. High density is indicative of low porosity and highly impermeable rock. Thus, by inspection, the most favorable zones appear to be from about 1,750 feet to 2,000 feet, from 2,180 to 2,300, from 2,400 to 2,600, from 3,000 to 3,160, from 3,850 to 3,960 and from 4,020 to 4,170 feet.

It should be noted that the maximum depth that can be mined will be limited by the temperature of the rock. Mining consultants have stated that the maximum temperature that should be considered on an economic basis is 140°F. An inspection of the temperature log shows that the rock reaches 140°F at about 4,170 feet below ground level. Thus, we have probably reached a practical depth limitation with respect to cavern locations; however, the hydrological and rock characteristics of the underlying strata must be determined to provide information that will be useful in evaluating the long-term safety of this waste storage mode.

Additional wells will be drilled to evaluate regional hydrological characteristics such as piezometric gradients and transmissivity characteristics of the basalt interbeds. Additional core drilling will be required to confirm the identity and continuity of basalt flows. As you will note, ARH-DC-1 is just the start of our program to evaluate a new concept for isolating radioactive wastes from the biosphere.

LONG-TERM STORAGE OF SALT SLURRY IN UNDERGROUND CAVERNS

FIGURE 1

GEOLOGIC CROSS-SECTION OF YAKIMA AND PASCO BASINS

DEEP WELLS IN REGION

> 1,000'	79
> 2,000'	7
> 3,000'	4
> 4,000'	2
> 10,000'	1

FIGURE 2

FIGURE 3

TABLE I

Companies Providing Services On ARH-DC-1 Exploratory Well

<u>CONTRACTOR</u>	<u>FUNCTION</u>
Calvert Western Exploration Co.	Prime contractor - furnishes rig for drilling.
Texoma Air	Compress air for drilling w/maximum capacity of 3000 CFM @ 1500 psi. Also proportions soap and inhibitor.
Magcobar	Mud, Mud engineering, Soap & Inhibitor.
Baroid	Mud logging (Cuttings analysis, etc.)
Halliburton	Volume and high pressure pumping (Mostly cement).
Central Reddi-Mix Company	Bulk Cement.
Williams Diamond Bit Co.	Diamond Core heads, barrels, & operator.
Christensen Diamond Bit Co.	Same as above.
Hycalog	Same as above.
Dicor, Inc.	Operator for coring services. Will use any available equipment but normally recommends Hycalog.
Byron-Jackson (B/J)	Down hole electrical pumps.
Lynes, Inc.	Furnish and operate packers for hydrological testing.
Birdwell	Electrical logging.
Schlumberger	Same as above.
Taylor Drilling Co.	Rental of core barrel.
Hughes Tool Co.	Drill bits.
Security Engineering	Drill bits.
Reed Roller Bit (A. W. Murphy)	Drill bits.
Smith Bit Company	Drill Bits
Shaffer Tool Works	Stripper rubbers in rotating head.

CONTRACTOR

FUNCTION

Dresser OME

Reaming Tools.

Haney's Supply

Casing.

American Oil Company

Lemon Wax (wrapping cores).

McNutt Tool Company

Rental Rotating Head.

#Tri-City Oil Company

Diesel fuel.

#Doxol

Propane gas.

National Supply Company

Tubular goods (tubing).

#Big Pierre Lumber Company

Cellar boards and cement.

#Griggs Department Store

Sack cement.

#Mico Mobile Sales

Trailer rental.

Fenix and Scisson, Inc.

Engineering.

Phillips 66

Deisel fuel.

Washington State University

Electrical logging.

In addition we have use of all services performed by:

Atomic Energy Commission

Atlantic Richfield Hanford Company

Pacific Northwest Laboratories

J. A. Jones

Vitro Engineering

International Telephone and Telegraph (Federal Support Services)

FIGURE 4

Figure 5

Geophysical Logs - 3800 to 4100 Feet

FIGURE 6

BATTELLE-NORTHWEST
PHOTOGRAPHY UNIT - 300 AREA

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DIAMOND BIT
FEET CORED PER BIT (RANGE) 0 TO 6-1/2

BEFORE

AFTER

FIGURE 7

TUNGSTEN-CARBIDE INSERT BIT (ROLLER CONE TYPE)
FEET CORED 10 FEET RECOVERED 0

FIGURE 8

TUNGSTEN CARBIDE IMPREGNATED BIT FEET CORED PER
BIT (RANGE 0 TO 11)

BEFORE

AFTER

FIGURE 9

MILLED CARBON-STEEL BIT (ROLLER CONE TYPE)
FEET CORED 2 FEET RECOVERED 2

BEFORE

AFTER

FIGURE 10

FIGURE 11