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HEALTH AND SAFETY RESEARCH DIVISION

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RESULTS OF THE RADIOLOGICAL SURVEY AT 4 HANCOCK STREET, LODI, NEW JERSEY (LJ060)

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MASTER

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ABSTRACT

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 4 Hancock Street, Lodi, New Jersey (LJ060), was conducted during 1985 and 1986.

Gamma logging results found during this survey and during a previous survey conducted by Bechtel National, Incorporated, strongly indicated radionuclide concentrations in subsurface soil in excess of DOE remedial action criteria. This finding, coupled with the fact that adjacent properties have been found to be contaminated and that Lodi Brook apparently flows under the property, suggests that it be considered for inclusion in the DOE remedial action program.

RESULTS OF THE RADIOLOGICAL SURVEY AT 4 HANCOCK STREET (LJ060), LODI, NEW JERSEY*

INTRODUCTION

From 1916 to 1956, process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores were generated by the Maywood Chemical Works (MCW), Maywood, New Jersey. During the latter part of this period, MCW supplied rare earth metals and thorium compounds to various government agencies. In the 1940s and 1950s, MCW produced thorium and lithium, under contract, for the Atomic Energy Commission (AEC). These activities ceased in 1956, and approximately three years later, the 30-acre real estate was purchased by the Stepan Company. The property is located at 100 Hunter Avenue in a highly developed area in Maywood and Rochelle Park, Bergen County, New Jersey.

During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities. In the early 1930s, these areas were separated from the rest of the property by the construction of New Jersey State Highway 17. The Stepan property, the interim storage facility, and several vicinity properties have been designated for remedial action by the Department of Energy (DOE).

The waste produced by the thorium extraction process was a sandlike material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. During the years 1928 and 1944 to 1946, area residents used these process wastes mixed with tea and cocoa leaves as mulch in their lawns and gardens. In addition, some of the contaminated wastes were apparently eroded from the site into Lodi Brook and carried downstream.

Lodi Brook is a small stream flowing south from Maywood with its headwaters near the Stepan waste storage site. Approximately 150 ft after passing under State Route 17, the stream has been diverted underground through concrete or steel culverts until it merges with the Saddle River in Lodi, New Jersey. Only a small section near Interstate 80 remains uncovered. From the 1940s to the 1970s when the stream was being diverted underground, its course was altered several times. Some of these changes resulted in the movement of contaminated soil to the surface of a few properties, where it is still in evidence. In other instances, the contaminated soil was covered over or mixed with clean fill, leaving no immediate evidence on the surface. Therefore, properties in question may be drilled in search of former stream bed material, even in the absence of surface contamination.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the property discussed in this report and properties in its vicinity contaminated with residues from the former MCW, were included as a decontamination research and development project under the DOE Formerly Utilized Sites Remedial Action Program. As part of this project, DOE is conducting radiological surveys in the vicinity of the site to identify properties contaminated with residues derived from

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

the MCW. The principal radionuclide of concern is thorium-232. The radiological survey discussed in this report is part of that effort and was conducted, at the request of DOE, by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory (ORNL).

A radiological survey of the private property at 4 Hancock Street, Lodi, New Jersey, was conducted by ORNL on September 18, 1986. The reported results are augmented by hole logging data obtained during a separate, independent investigation of the property by Bechtel National Incorporated (BNI) on November 6, 1986.

SURVEY METHODS

The radiological survey of the property included the collection of subsurface soil samples and gamma profiles of auger holes. Because logging results clearly indicated the presence of contamination in excess of the applicable guideline, the customary surface scanning of the entire property for gamma exposure rates was not conducted. No indoor survey measurements were performed.

To define the extent of possible subsurface soil contamination, the ORNL protocol included the drilling of auger holes to depths of approximately 1.8 m. A plastic pipe was placed in each hole, and a NaI scintillation probe was lowered inside the pipe. The probe was encased in a lead shield with a horizontal row of collimating slits on the side. This collimation allows measurement of gamma radiation intensities resulting from contamination within small fractions of the hole depth. If the gamma readings in the hole were elevated, a soil sample was scraped from the wall of the auger hole at the point showing the highest gamma radiation level. The auger hole loggings were used to select locations where further soil sampling would be useful. A split-spoon sampler was used to collect subsurface samples at known depths. In some auger holes, a combination of split-spoon sampling and side-wall scraping was used to collect samples. These survey methods followed the plan outlined in Reference 1. A comprehensive description of the survey methods and instrumentation has been presented in another report.[2]

SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.[3] The normal background radiation levels for the northern New Jersey area are presented in Table 2. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 0 to 183 cm in auger holes (A) drilled at three separate locations indicated in Fig. 1. The results of analyses of these samples are given in Table 3 (A1A-A3D). Concentrations of ^{226}Ra and ^{232}Th in soil samples from the auger holes ranged from 0.50 to 2.2 and 0.60 to 2.0 pCi/g, respectively. Radionuclide concentrations exceed background levels but are below the DOE criterion for subsurface soil (Table 1).

Gamma logging was performed by ORNL in each of the three auger holes to characterize and further define the extent of possible contamination. The logging technique used here is not radionuclide specific. However, logging data, in conjunction with soil analyses data, may be used to estimate regions of elevated radionuclide concentrations in auger holes when compared with background levels for the area. Following a comparison of these data, it appears that any shielded scintillator readings of 1000 counts per minute (cpm) or greater generally indicate the presence of elevated concentrations of ^{226}Ra and/or ^{232}Th. Data from the gamma profiles of the logged auger holes are graphically represented in Figs. 2 through 4. No measurements exceeded 700 cpm in hole 1. Readings at depths between 1.1 and 1.8 m were greater than 1,000 cpm in auger hole 2, with a maximum reading of 1,500 cpm at 1.8 m. Readings in auger hole 3 were elevated between 0.76 and 1.8 m, with a maximum of 3,300 cpm at 1.8 m. The areas of highest gamma readings correspond to the greatest concentrations of radionuclides shown in Table 3.

Seven auger holes [A(BNI)] were drilled by BNI in the locations indicated in Fig. 1. Gamma logging was conducted in this case with a partially shielded scintillation probe rather than with the shielded instrument used by ORNL. According to BNI,[4] a value greater than 40,000 cpm using their system usually indicates that the DOE criterion of 15 pCi/g for ^{226}Ra and/or ^{232}Th has been exceeded. Holes A(BNI)4 and A(BNI)6 had gamma levels indicating significant contamination with maximum measurements of 375,000 and 115,000 cpm, respectively. Both readings were obtained at a depth of 195 cm. Gamma logging results for holes 4 and 6 are given in Table 4. No measurements above 13,000 cpm were observed in holes 5, 7, and 9. The maximum gamma levels in holes 8 and 10 were 15,000 cpm at a depth of 46 cm, and 35,000 cpm at 195 cm, repectively.

SIGNIFICANCE OF FINDINGS

Analysis values for soil samples taken at 4 Hancock Street show that radionuclide concentrations are elevated above background but are below DOE criteria. However, elevated gamma levels were found on this property at subsurface depths as indicated by the auger hole logging results obtained by both ORNL and BNI. Furthermore, the adjacent property has been designated for inclusion in the DOE program, and Lodi Brook apparently flows under the property. Thus, it is recommended that this site be considered for inclusion in the DOE remedial action program.

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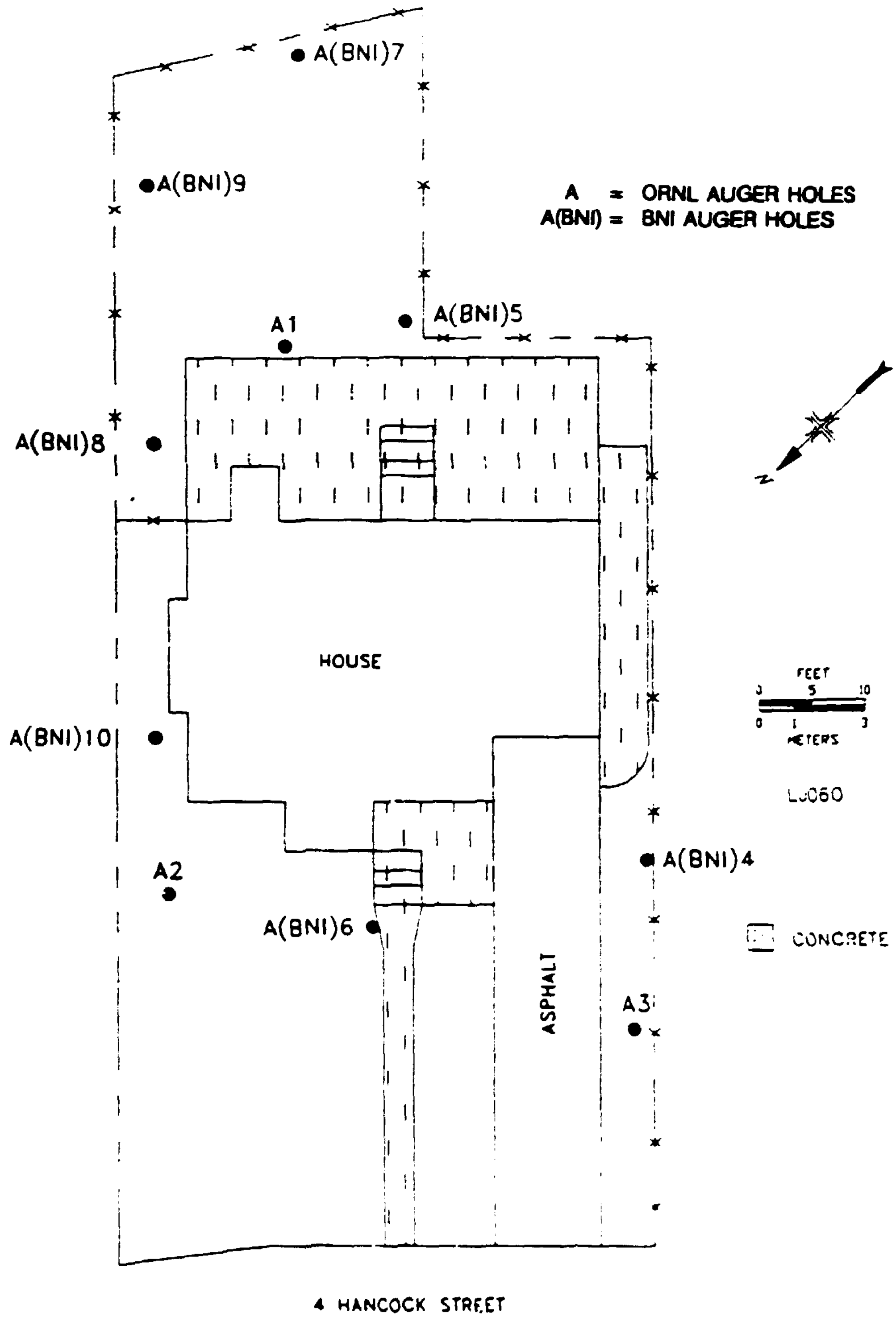


Fig. 1. Diagram show'ng locaticns of soil samples taken at 4 Hancock Street. Lodi, New Jersey (LJ060).

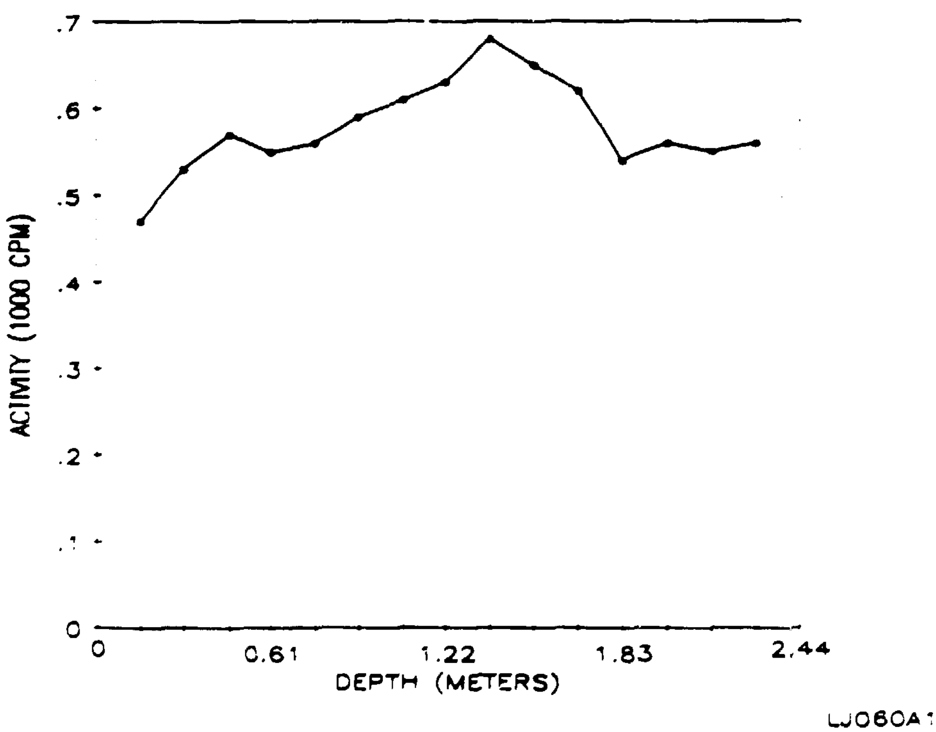
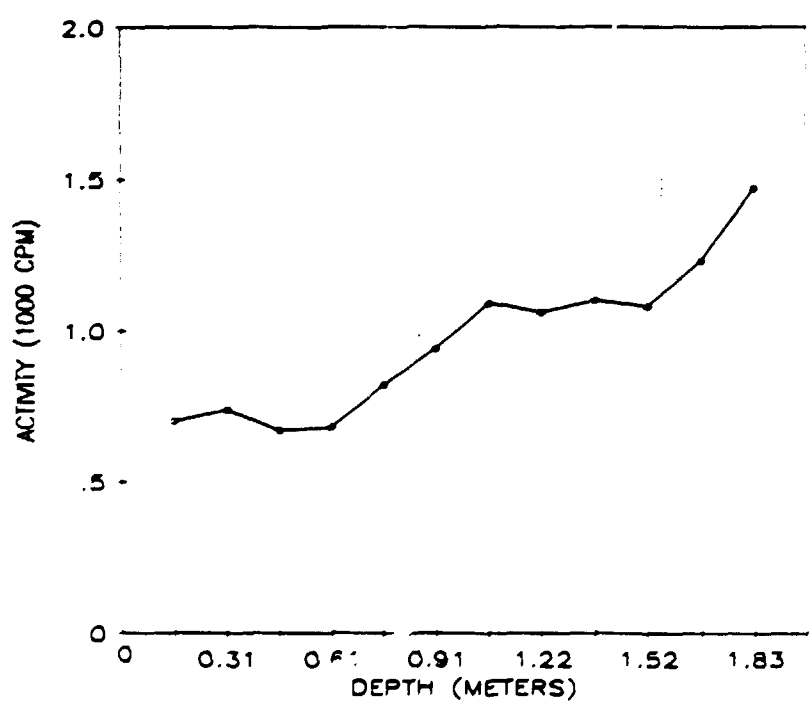


Fig. 2. Gamma profile for auger hole 1 (LJ060A1) at 4 Hancock Street, Lodi, New Jersey.



LJ060A2

Fig. 3. Gamma profile for auger hole 2 (LJ060A2) at 4 Hancock Street, Lodi, New Jersey.

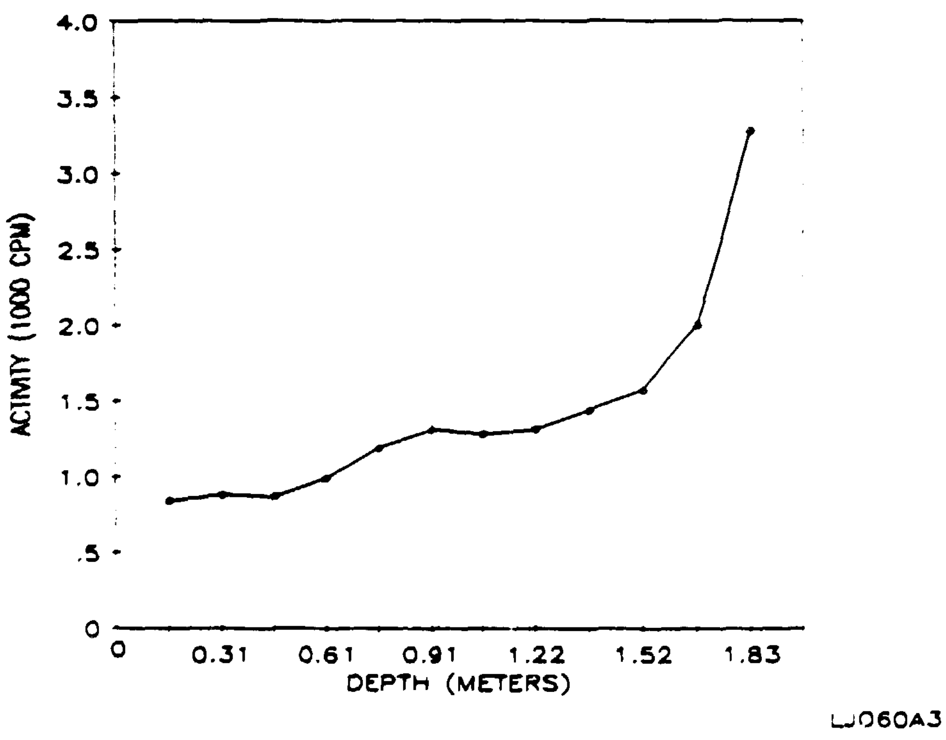


Fig. 4. Gamma profile for auger hole 3 (LJ060A3) at 4 Hancock Street, Lodi, New Jersey.

Table 1. Applicable guidelines for protection against radiation[a]

Mode of exposure	Exposure conditions	Guideline value
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over a 100 m^2 area ^{232}Th ^{230}Th ^{228}Ra ^{226}Ra	5 pCi/g averaged over the first 15-cm of soil below the surface; 15 pCi/g when averaged over 15-cm thick soil layers more than 15 cm below the surface

[a]U. S. Department of Energy, *Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites* (Rev. 2, March 1987).

Table 2. Background radiation levels for the northern New Jersey area[a]

Type of sample	Radionuclide concentration
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9
^{238}U	0.9
^{226}Ra	0.9

[a]Reference 5.

Table 3. Concentrations of radionuclides in soil at 4 Hancock Street, Lodi, New Jersey (LJ060)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)	
		^{226}Ra[b]	^{232}Th[b]
		Auger samples[c]	
A1A	60–90	0.72±0.2	0.96±0.1
A1B	120–150	0.64±0.1	0.88±0.1
A1C	150–185	0.74±0.06	0.86±0.2
A2A	0–30	0.50±0.06	0.60±0.04
A2B	60–90	0.56±0.06	0.78±0.1
A2C	120–150	2.1 ±0.1	1.7 ±0.2
A2D	150–185	2.0 ±0.09	1.5 ±0.3
A3A	0–30	1.0 ±0.04	1.1 ±0.05
A3B	60–90	1.6 ±0.2	1.8 ±0.09
A3C	120–150	2.1 ±0.3	1.8 ±0.2
A3D	150–185	2.2 ±0.1	2.0 ±0.5

[a]Locations of soil samples are shown on Fig. 2.

[b]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$).

[c]Auger samples are those taken from holes drilled to further define the depth and extent of radioactive material. Holes are drilled where the surface may or may not be contaminated.

Table 4. BNI scintillation probe loggings for auger holes at 4 Hancock Street, Lodi, New Jersey (LJ060)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)4	0.0	16,000	A(BNI)5	0.0	9,000
	0.15	13,000		0.15	10,000
	0.3	18,000		0.3	12,000
	0.46	21,000		0.46	13,000
	0.61	24,000		0.61	13,000
	0.76	28,000		0.76	12,000
	0.91	29,000		0.91	13,000
	1.1	29,000		1.1	12,000
	1.2	30,000		1.2	13,000
	1.4	32,000		1.4	12,000
	1.5	38,000		1.5	12,000
	1.7	73,000		1.7	11,000
	1.8	190,000		1.8	11,000
	2.0	375,000		2.0	10,000
	2.1	198,000		2.1	10,000
	2.3	72,000		2.3	10,000
	2.4	29,000		2.4	12,000
A(BNI)6	0.0	11,000	A(BNI)7	0.0	6,000
	0.15	11,000		0.15	8,000
	0.3	12,000		0.3	11,000
	0.46	13,000		0.46	12,000
	0.61	14,000		0.61	12,000
	0.76	17,000		0.76	13,000
	0.91	20,000		0.91	11,000
	1.1	19,000		1.1	10,000
	1.2	19,000		1.2	9,000
	1.4	22,000		1.4	9,000
	1.5	24,000		1.5	9,000
	1.7	31,000		1.7	10,000
	1.8	41,000		1.8	10,000
	2.0	115,000		2.0	10,000
	2.1	82,000		2.1	11,000
	2.3	30,000		2.3	9,000
	2.4	29,000		2.4	7,000
	2.6	14,000			
	2.7	11,000			

Table 4. (continued)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)8	0.0	10,000	A(BNI)9	0.0	7,000
	0.15	9,000		0.15	8,000
	0.3	14,000		0.3	10,000
	0.46	15,000		0.46	13,000
	0.61	14,000		0.61	13,000
	0.76	13,000		0.76	12,000
	0.91	14,000		0.91	12,000
	1.1	12,000		1.1	13,000
	1.2	13,000		1.2	12,000
	1.4	12,000		1.4	13,000
	1.5	12,000		1.5	13,000
	1.7	9,000		1.7	12,000
	1.8	9,000		1.8	10,000
	2.0	9,000		2.0	9,000
	2.1	11,000		2.1	9,000
	2.3	9,000		2.3	8,000
	2.4	8,000		2.4	10,000
A(BNI)10	0.0	12,000			
	0.15	14,000			
	0.3	14,000			
	0.46	14,000			
	0.61	12,000			
	0.76	12,000			
	0.91	12,000			
	1.1	13,000			
	1.2	16,000			
	1.4	21,000			
	1.5	21,000			
	1.7	20,000			
	1.8	23,000			
	2.0	35,000			
	2.1	17,000			
	2.3	12,000			
	2.4	9,000			
	2.6	9,000			
	2.7	8,000			

[a]Locations of holes are shown on Fig. 1.

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