

37

WM Record File  
102

WM Project 11  
Docket No.   
PDR   
LPDR

102/ML/83/03/15/0

Distribution:   
- 1 -   
(Return to WM, 623-SS)   
MAR 9 0 1983 - 02

DISTRIBUTION

WM s/f ✓   
WMHT r/f   
NMSS r/f   
CF   
REBROWNING   
MBELL   
PALTOMARE   
HJMILLER   
PSJUSTUS   
MLOGSDON & r/f

MEMORANDUM FOR: NNWSI Hydrology and Geochemistry Teams  
FROM: Mark Logsdon  
High-Level Waste Technical  
Development Branch  
Division of Waste Management  
SUBJECT: CLARIFICATION OF <sup>36</sup>Cl/Cl DATA FROM NNWSI

I called Harold Bentley of the University of Arizona on March 11, 1983 to clarify questions about the information on chlorine-36 age dating brought to our attention by Fred M. Phillips (see my conversion record of 3/4/83). Bentley is the scientist who performed the analyses, and he is generally considered to be North America's foremost authority on chlorine-36 dating of groundwater. Bentley's principal points are given below:

- (1) The meteoric input has a ratio of  $640 \times 10^{-15}$  based on cosmogenic and atmospheric production of <sup>36</sup>Cl (see University of Arizona groundwater dating reports).
- (2) A single near-surface sample from water in tuffaceous alluvium (sampled as part of the Cambric Experiment) has a ratio of  $636 \times 10^{-15}$ , in excellent agreement with the theoretical ratio.
- (3) A single deep sample from Well UE25B1-H, collected below the static water level in the Bullfrog Member of the Crater Flat Tuff, has a ratio of  $320 \times 10^{-15}$ . Note: UE25B1-H is the well in which Al Ogard of LANL performed the experiment to measure the concentration of dissolved oxygen as a function of pumping time (see the viewgraphs from the NNWSI geochemistry workshop of January 12-13, 1983).
- (4) The decrease in <sup>36</sup>Cl/Cl (from  $636 \times 10^{-15}$  to  $320 \times 10^{-15}$ ) corresponds to a groundwater model age of approximately 300,000 years.

8311220065 830330  
PDR WASTE  
WM-11 PDR

NV833269

00033

- (5) No duplicate samples were run. However, on the basis of about 200 analyses performed by the Arizona group at the Universities of Rochester and Arizona, the precision of the method is  $\pm 10\%$  at  $^{36}\text{Cl}/\text{Cl} = 10^{-15}$ . (The high precision of the method is due to the excellent resolution (i.e., separation of nuclides) using tandem Van de Graaf accelerator mass spectrometry (see University of Arizona groundwater dating reports)). Therefore, Bentley believes that the difference between the ratios of the shallow and deep samples is significant and probably indicates very old groundwater in the Bullfrog Member.
- (6) The samples were collected using a down-hole sampler and were introduced directly into the extraction system. Therefore, contamination in sampling or sample preparation is considered insignificant.
- (7) A nonmeteoric source of Cl in the Bullfrog cannot be ruled out. Although the total chlorinity is low, the factor of two difference between the ratio in the shallow sample and the ratio in the deep sample could be due to water-rock interaction that increases the dissolved Cl concentration (e.g., "leaching" of Cl from micas - Ellis and Mahon, 1964, Geochim. Cosmochim. Acta, v. 28, p. 1323-1357). Addition of "dead" Cl would reduce the ratio and give a spuriously old model age.

There are two major implications of the  $^{36}\text{Cl}/\text{Cl}$  data:

- (1) Although the results are preliminary, the chlorine-36 method for dating groundwater appears to be applicable at NNWSI.
- (2) Although more samples are needed to confirm the preliminary results and although the possibility of nonmeteoric Cl sources must be examined, it apparently has taken approximately 300,000 years for water to move from the recharge point to the sampling point in the Bullfrog Member at Well UE25B1-H. If DOE can establish the recharge area and flow path, they could use chlorine-36 age dating to support calculated pre-placement groundwater travel times.

In conclusion, it seems likely that DOE will include chlorine-36 age dating data in the NNWSI Site Characterization Plan. NRC staff should become familiar with the literature on chlorine-36 to evaluate data submitted by DOE. I urge the hydrogeology and geochemistry teams to

OFC	:	WMHT	:	WMHT	:	WMHT	:	:	:	:
NAME	:	MLogsdon:dm	:	PSJustus	:	HJMiller	:	:	:	:
DATE	:	03/ /83	:	03/ /83	:	03/ /83	:	:	:	:

102.1/ML/83/03/15/0

- 3 -

designate one person to be responsible for reviewing chlorine-36 dating of groundwater for NNWSI.

**"ORIGINAL SIGNED BY"**

Mark Logsdon  
High-Level Waste Technical  
Development Branch  
Division of Waste Management

DesireeM 83/03/29

OFC	: WMHT	:	<i>[Signature]</i>	:	<i>[Signature]</i>	:	:	:	:
NAME	: MLogsdon: dm	:	PSUstus	:	HJMiller	:	:	:	:
DATE	: 03/24/83	:	03/29/83	:	03/29/83	:	:	:	: