Sandia National Laboratories
Albuquerque, New Mexico 87185

March 29, 1984

Mr. Peter M. Ornstein
Geotechnical Branch
Division of Waste Management
U.S. Nuclear Regulatory Commission
7915 Eastern Avenue
Silver Spring, MD 20910

Dear Mr. Ornstein:

Attached is our response to the comments in your letter dated February 28, 1984. We appreciate your comments on the parameters to be considered in the Repository Site Data Report for unsaturated tuff.

If you have any questions concerning this response, please feel free to call me or Pei-lin Tien.

Sincerely,

Nestor R. Ortiz

NRO:6430:vr

Following is Sandia response to the comments in your letter dated February 28, 1984.

1) Additional Parameters

Fractures

Data on fracture interconnectivity in tuffs may not exist. We will review the literature and summarize the findings in the RSD report.

"Scale of REVs for equivalent porous media and dual porosity approaches to analyzing fracture flow" is an area of past and ongoing research, and may not be appropriate to include in the RSD report. We recommend that the literature be reviewed and that the findings be summarized in a separate letter report.

Moisture Content

Moisture content data with respect to matrices and fractures in tuff is difficult to obtain directly. Unsaturated flow in fractures has been studied, but not necessarily for fractured tuffs. Literature regarding moisture content with respect to unsaturated flow in various matrices and fractures will be reviewed, and if applicable, will be summarized in the RSD report.

Hydraulic Properties

It is anticipated that temperature will have an effect on the soil-moisture characteristic curves. With respect to hydraulic conductivity and moisture content curve, temperature effect on the fluid density and dynamic viscosity portions of the hydraulic conductivity parameter are well documented and will be presented in the final report. Intrinsic permeability is generally related to either grain size distribution of a porous medium or aperture of a fracture. In addition, heat changes may change the stress field that may also change the intrinsic permeability of a matrix, and thus may affect the characteristic curves. Changes in intrinsic permeability or hydraulic conductivity with respect to stress changes for porous media and fractures are available in the literature, which will be reviewed and summarized in the final report. If any data regarding temperature impacts on intrinsic permeability or grain size distributions are available, these also will be documented.

Permeability to air for porous media is available either as data or as equations with respect to pore size. The equations may be useful for tuff if the pore size can be determined. They will be summarized in the final report. Air permeability data for tuffs will be reported, if available in the literature.

Matrix potential for tuffs will be reviewed to determine availability of this data, and it will be summarized in the final report if applicable.

Geochemical Properties

At present there are few site-specific geochemical data for unsaturated tuff. Each geochemistry subsection of the RSD report for unsaturated tuff (cf proposed Table of Contents) will consist of three parts:

1. Compilation of available geochemical data specific to unsaturated tuff.

2. A discussion of the relation between geochemical parameters and processes relating to the unsaturated zone versus those for the saturated zone.

3. Compilation or annotated bibliography of data obtained under saturated conditions that can be extrapolated to the unsaturated zone.

Geologic analysis based on field evidence of the transport of metals in the unsaturated zone (e.g., Ni- or Mn-laterites) will be discussed in a separate subsection. Calculations of possible changes in pore water composition due to wet/dry cycling at NTS will be included under subsection 1. Each section will contain theoretical justification for any data extrapolation. Recommendation for future geochemical research will be described in a separate section.

The geochemical data needs described in the program plan will be addressed in all three parts. Radionuclide solubilities could be estimated for several different potential pore water compositions using PHREEQE. The relationship between sorption and pore water composition will be assessed from available experimental sorption data (cf NUREG/CR2937, p. 299). The proposed level of funding will allow only a cursory review of available kinetics data for solubility and sorption processes. Extrapolation of data for homolog elements in the saturated zone may be carried out under another project (FIN A-1756) in FY 85. Additional funds ($24K) would be required to expand this analysis for conditions in the unsaturated zone. Evaluation of matrix diffusion in unsaturated zone will require examination of the dependence of diffusion coefficients on solution composition. A literature review of relevant chemistry sources must be conducted and would require additional funds ($24K) above the projected level of funding.

Thermomechanical Properties

The additional parameters requested under the "Thermomechanical Properties" heading are all relevant to the RSD. It may, however, be difficult to find data at temperatures other than ambient. Also, any data on rock fracture properties is expected to be very sparse.

2) I have assigned Dr. Pei-lin Tien as coordinator of this project. He is also responsible for developing, editing and producing this RSD report. Dr. Tien can be reached by phone , FTS 844-0076.

3) We are planning to obtain the services of a consultant in the field of soil physics. A potential candidate is Dr. Peter Wierenga, Department of Crop and Soil Sciences, New Mexico State University.

4) We have corrected the word from "in" to "for" in the title.

5) We will include the Desert Research Institute (University of Nevada), the University of Arizona and other institutions as sources for data on unsaturated tuffs.

Tentative outline for "Repository Site Data Report for Unsaturated Tuff, Yucca Mountain, Nevada."

INTRODUCTION

CHAPTER 1. REGIONAL SETTING

- 1.1 Climate
- 1.2 Physiographic Setting
- 1.3 Surface Geologic Processes
- 1.4 Tectonic Setting
- 1.5 Igneous Activity
- 1.6 Geothermal Gradient
- 1.7 Seismicity
- 1.8 Natural Resources

CHAPTER 2 PETROLOGY AND MINERALOGY

- 2.1 Classification of Tuffs
- 2.2 Lithologic Description
- 2.3 Mineralogic Description
- 2.4 Secondary Minerals and their Distribution
  - 2.4.1 Zeolites
  - 2.4.2 Non-zeolites

CHAPTER 3 STRATIGRAPHY

- 3.1 Alluvium and Colluvium
- 3.2 Paintbrush Tuff
  - 3.2.1 Tiva Member
  - 3.2.2 Yucca Mountain Member
  - 3.2.3 Pah Canyon Member
  - 3.2.4 Topopah Spring Member
- 3.3 Bedded Tuff of Calico Hills
- 3.4 Stratigraphic Units Older than the Bedded Tuff of Calico Hills

CHAPTER 4 GEOLOGIC STRUCTURES

- 4.1 Faults
- 4.2 Folds
- 4.3 Other Geologic Structures

CHAPTER 5 GEOCHEMISTRY

- 5.1 Geochemical Environment
- 5.2 Sorption of radionuclides
- 5.3 Solubilities of radioelements
- 5.4 Diffusion of radionuclides in unsaturated tuff
- 5.5 Geochemical analogs for transport of radionuclides in unsaturated tuff.

CHAPTER 6 HYDROLOGY OF UNSATURATED TUFFS

PROJECT: Repository Site Data Report for Unsaturated Tuff, Yucca Mountain, Nevada

Contributors:	Responsible for:	% Time Committed
Bonano, Tito	Geochemistry	10
Guzowski, Bob	Geologic Structure Reviewing	25
Siegel, M. D.	Geochemistry	25
Tien, Pei-lin	Introduction Regional Setting Petrology Mineralogy Stratigraphy Coordinating & Editing	100
Updegraff, C. D.	Hydrology	20
Wahi, K.	Thermomechanics	20