LA-10960-MS

UC-70

Issued: December 1987

LA--10960-MS

DE88 005707

Summary of Sorption Measurements Performed with Yucca Mountain, Nevada, Tuff Samples and Water from Well J-13

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SUMMARY OF SORPTION MEASUREMENTS PERFORMED WITH YUCCA MOUNTAIN, NEVADA, TUFF SAMPLES AND WATER FROM WELL J-13*

by

Kimberly W. Thomas

ABSTRACT

The sorption studies undertaken from 1977 to 1985 by Los Alamos National Laboratory in support of the Nevada Nuclear Waste Storage Investigations project are summarized, and the data are tabulated in the Appendix. These studies of the sorptive behavior of Yucca Mountain, Nevada, area tuffs have been partly generic in nature (to understand the sorptive behavior of tuff as a function of many variables) and partly site specific (to obtain data for a possible repository site at Yucca Mountain). Sorption has been investigated as a function of mineralogy, temperature, particle size, waste-element concentration, water composition, sorption time, and other variables. The major elements studied were americium, cesium, neptunium, plutonium, thorium, uranium, strontium, technetium, tin, barium, radium, cerium, europium, and selenium.

I. INTRODUCTION

Yucca Mountain, Nevada, has been recommended by the US Department of Energy in its Environmental Assessment¹ as a candidate for site characterization; this characterization will determine the site's suitability as a permanent geologic repository for high-level nuclear waste. Yucca Mountain is located on the southwestern edge of the Nevada Test Site (NTS), on adjacent land controlled by the US Air Force, and on US Bureau of Land Management land (Fig. 1). The repository would be sited in the Topopah Spring Member in the unsaturated zone of Yucca Mountain at an average depth of 300 m below the mountain surface. The Topopah Spring Member, a compound cooling unit (ash-flow tuff), contains a thick interval of densely welded, devitrified tuff. It is underlain by several other tuff units, including the tuffaceous beds of Calico Hills, the Prow Pass and Bullfrog Members of the Crater Flat tuff, and the Tram and Lithic Ridge Formations. The tuffaceous beds of Calico Hills and the Prow Pass Member locally are above the groundwater table and are strongly zeolitized.

Fig. 1. Yucca Mountain site in southern Nevada.

The most likely mechanism for transport of radionuclides to the accessible environment is by dissolution of the stored solid-waste form and subsequent transport in water. Movement of water in the unsaturated zone is such a slow process that it is not possible to make direct measurements of radionuclide travel under repository conditions. Therefore, it is necessary to have an understanding of the mechanisms of radionuclide transport and retardation in tuff, as well as a data base of sorptive behavior, to perform the required performance-assessment calculations of possible releases from a repository. These data will be used to satisfy, in part, Key Issue 1 of the NNWSI Project Issue Hierarchy:² "Will the mined geological disposal system at Yucca Mountain isolate the radioactive waste from the accessible environment after closure in accordance with the requirements set forth in 40 CFR Part 191, 10 CFR Part 60, and 10 CFR Part 960?" and its Performance Issue 1.14: "Do the data collected in order to describe the present and expected geochemical characteristics provide the information required by the design and performance issues?" and Information Need 1.14.4: "Radionuclide retardation by sorption processes along flow paths to the accessible environment." The altered tuffs of Yucca Mountain and vicinity, with their high content of zeolites and clays, have great capacity for sorption of radionuclides. As water containing dissolved radionuclides moves away from the repository, it will contact these altered tuffs. Sorption can delay or retard the movement of radionuclides relative to the water flow. Thus, sorption processes can affect whether the Yucca Mountain environment meets the release limits specified by the Environmental Protection Agency (EPA) (40 CFR 191)³ and the Nuclear Regulatory Commission (10 CFR 60).⁴ The purpose of the sorption studies is to quantify the contribution of sorption processes toward reducing the transport of radionuclides from the repository to the accessible environment.

The sorption ratio, R_d , is used as a measure of sorption as a function of many parameters. It is defined as

$$R_d = \frac{\text{activity in solid phase per unit mass of solid}}{\text{activity in solution per unit volume of solution}} \quad (1)$$

and is expressed in units of $\text{m}\ell/\text{g}$. This ratio is often referred to as the distribution coefficient, K_d . Los Alamos prefers not to use this term, which implies equilibrium, because reversible equilibrium is usually not attained. If equilibrium is attained, then K_d is related to a retardation factor, R_f , in a uniform flowing system by

$$R_f = K_d(\rho/\epsilon) + 1, \quad (2)$$

where ρ is the bulk density and ϵ is the porosity of the rock.

The sorption studies outlined here were undertaken in support of the Nevada Nuclear Waste Storage Investigations (NNWSI) project. They were performed at the Los Alamos National Laboratory between 1977 and 1985. This report is a summary of work discussed in Refs. 5-16. These studies of the sorptive behavior of the Yucca Mountain area tuffs have been partly generic in nature (to understand the sorptive behavior of tuff as a function of many variables) and partly site specific (to obtain data for a possible repository site at Yucca Mountain). Sorption has been investigated as a function of mineralogy, temperature, particle size, waste-element concentration, water composition, sorption time, and other variables. The major elements studied were americium, cesium, neptunium, plutonium, thorium, uranium, strontium, technetium, tin, barium, radium, cerium, europium, and selenium. Barium was included as a chemical analogue for radium because ^{226}Ra samples must be handled carefully to avoid releasing the daughter, ^{222}Rn , which would cause extensive contamination of low-level counting facilities. Uranium and thorium are long-lived parents of radium. Cerium and europium have been included as analogues of any rare-earth elements that may eventually be included in the EPA critical element list.⁴ Selenium is included as a potentially important waste element.

The tuff samples studied have been obtained from various drill holes at Yucca Mountain and its environs (Fig. 2). The origin of the tuff samples and their mineralogic composition have been discussed in earlier reports (Refs. 5 and 17-21). A simple convention was adopted for labeling samples from the various drill holes. The prefix JA- indicates the sample was obtained from Drill Hole J-13; the prefix YM- from Drill Hole UE25a-1; and the prefix G# from Drill Hole USW-G#. The four numbers following the "USW-G" prefix give the depth (in feet) from which the sample was obtained.

The water used for the sorption studies was obtained from Well J-13 in western Jackass Flats at the NTS. This water was chosen as the reference groundwater for several reasons. Ideally, water from individual tuff units in Yucca Mountain would have been used; however, there were no producing wells at Yucca Mountain, and there was no way of obtaining formation water from specific tuff units at the time most of these studies were performed. Well J-13 was the nearest producing well. In addition, the approximate production horizon in Well J-13 is the Topopah Spring Member, the site of the proposed repository. (The average cation and anion composition of J-13 water is given in Table I.) Although it was expected that J-13 water would be in equilibrium with the Topopah Spring Tuff, when the water from Well J-13 was contacted with samples of crushed Topopah Spring Tuff, water composition changed. In fact, changes were observed in J-13 water composition when it was contacted with any of the tuff samples of Yucca Mountain (Table II). The changes were relatively minor and showed a trend toward decreasing the concentration of

Fig. 2. Yucca Mountain exploration block and drill sites.

the cations in solution.^{5,11,12,14} The equilibrated waters do not, however, fall outside the bounds of Yucca Mountain water compositions.²² There is no conclusive explanation for these changes, but several factors may apply: (1) the J-13 water may not be in equilibrium with the tuff after all; (2) the laboratory temperature is lower by 4°C than that in the field; and (3) the CO₂ concentration of the water in the laboratory is less than that at depth.

TABLE I
COMPOSITION OF WELL J-13 GROUNDWATER^a

Element	Concentration (mg/ℓ)	Anion	Concentration (mg/ℓ)
Ca	11.5	F ⁻	2.1
Mg	1.76	Cl ⁻	6.4
Na	45	SO ₄ ²⁻	18.1
K	5.3	NO ₂ ⁻	N.D. ^b
Fe	0.04	NO ₃ ⁻	10.1
Mn	0.001		
Si	30.0		
Li	0.06	pH	6.9
Al	0.03		

^a From Ref. 22.

^b N.D.= not detected.

Most experiments were performed under atmospheric and oxidizing conditions; no effort was made to obtain reducing conditions during the experiments because early data on Yucca Mountain waters suggested that these waters were oxidizing in the field. Recent results indicate that reducing conditions may indeed exist in some places beneath the proposed repository site;¹⁸ however, the assumption of oxidizing conditions leads to conservative estimates of sorption and precipitation for most, if not all, radionuclides of interest. Over time, the pH of the water in the laboratory experiments rose to between ~8 and 8.5, presumably as a result of CO₂ loss. Efforts were made to maintain the pH at ~7 for those experiments in which the solubility of the element in question was lower in

TABLE II
COMPOSITION OF WELL J-13 GROUNDWATER AFTER CONTACT WITH TUFF SAMPLES^a

Sample	Composition (mg/ℓ)											
	Ca	Mg	Na	K	Fe	Mn	Si	F ⁻	Cl ⁻	SO ₄ ²⁻	NO ₃ ⁻	HCO ₃ ⁻
GU3-433	9.3	2.1	49.8	9.5	0.06	0.02	22.4	2.8	9.2	19.3	7.1	120
GU3-855	9.3	2.14	37.5	7.8	0.010	0.014	24.1	3.5	8.7	21.0		
GU3-916	9.0	2.15	37.8	9.4	0.018	0.003	23.4	2.7	8.8	20.1		
GU3-1301	11.1	1.0	45.7	6.2	0.05	0.03	25.7	2.7	8.8	19.0	8.1	131
GU3-1203	11.9	1.8	50.9	5.1	0.14	0.03	25.5	2.8	8.7	19.3	8.2	
GU3-1436	11.1	1.45	37.8	4.2	0.017	0.022	26.2	2.6	9.3	20.02		
GU3-1531	13.4	0.87	36.9	2.4	<0.002	0.010	26.0	2.7	8.7	19.9		163
G2-547	8.7	2.5	43.3	4.3	0.04	0.02	30.0	2.7	8.1	17.3	5.8	203
G2-723	13.2	3.0	45.2	7.4	0.06	0.02	25.8	2.4	7.5	16.6	7.6	
G2-1952	12.8	1.4	45.2	5.8	0.05	0.02	26.7	2.4	7.7	16.1	7.3	
G4-1502	0.24	0.016	50.9	3.1	0.016	0.001	23.0	2.6	8.4	19.8		127
YM-5	15	4.1	51	8.2	0.01	0.001	35	2.5	7.9	23		
YM-22	13	2.4	54	5.3	0.01	0.001	34	2.6	7.3	24		
YM-30	14	1.5	53	2.5	0.01	0.001	30	2.5	7.0	23		
YM-38	14	0.1	57	5.8	0.01	0.001	32	2.5	7.5	26		
YM-42	15	0.5	59	2.2	0.04	0.001	28	2.4	6.9	27		
YM-45	14	1.2	53	5.6	0.04	0.001	34	2.5	6.8			
YM-46	15	1.1	51	3.9	0.02	0.002	34	2.4	7.5	24		
YM-48	18	1.2	50	2.5	0.03	0.03	37	2.5	6.7	24		
YM-49	20	1.2	49	2.6	0.03	0.002	36	2.5	6.9	25		
YM-54	14	1.4	56	5.9	--	0.001	37	2.6	6.8	24		

^aFrom Refs. 5, 11, and 12.

the laboratory pH range than it was at the original J-13 water pH of ~ 7 . These experiments were performed in a glove box, and the pH was kept at 7 by maintaining a sufficient concentration of CO_2 in the atmosphere.

II. EXPERIMENT PROCEDURES

A variety of techniques have been used to study sorption processes that lead to the removal of radionuclides from solution through interactions with tuff. Such processes, including ion exchange phenomena, chemisorption, and diffusion into the rock matrix, may ultimately end in a variety of precipitation or coprecipitation reactions. The most extensively used procedure in these studies has been a batch technique. Other techniques have been used to verify batch results and to provide additional information on kinetics, solution-to-solid ratios, effects of crushed tuff vs solid core, and other parameters. The batch technique used is described below; other techniques are also discussed and their results are compared with batch results.

A. Batch Measurement Technique

In these measurements, the distribution of a radionuclide between groundwater and crushed tuff is measured as a function of such parameters as contact time, concentration of sorbing element, particle size, temperature, atmosphere, and mineralogy. A considerable amount of time and effort was expended developing a satisfactory procedure; studies of the actinides have been particularly difficult, both in preparation of traced solution and in separation of aqueous and solid phases. In fact, work is still being done on the preparation of actinides in known, controlled oxidation states.

In the standard batch sorption procedure, the crushed-tuff sample is pretreated by contact with Well J-13 groundwater for at least 2 weeks. The groundwater used to prepare the traced feed solution (the solution containing the radionuclides) is pretreated by contacting it for at least 2 weeks with tuff from the same sample used in the batch measurements. Both the crushed-tuff sample and the pretreated water sample are centrifuged at the end of pretreatment to separate the phases; the pretreated water is filtered through a $0.05\text{-}\mu\text{m}$ polycarbonate Nuclepore membrane. This water is then used to prepare the traced feed solutions. Contact of the pretreated tuff sample with the traced feed solutions is started within 2 to 24 h by adding 20 ml of traced feed to 1 g of pretreated tuff in a polyethylene or polycarbonate tube. The two phases are mixed thoroughly, and the sample tube is placed on an orbital shaker and agitated at 200 rpm. A discussion of the effect of the solution-to-solid ratio can be found in Ref. 5, pp. 137-142.

Contact times for the batch measurements were varied to study the effect of time on measured sorption coefficients. A standard 6-week contact was chosen for those studies

where time was not a variable. This choice was a compromise between reaching equilibrium, if that were even possible, and completing the measurements within a reasonable time. The R_d measurements *vs* time indicated a leveling off or at least a very small positive slope sometime after 3 weeks. Twelve weeks (the time required for both sorption and desorption measurements) seemed to be the maximum reasonable time to allow for an experiment, considering the large number of required measurements. At the end of the contact time, the samples are centrifuged for 1 h at 12 000 rpm (28 000 g). The top 15-18 ml of the aqueous phase are removed by pipetting and are transferred to a clean polypropylene or polycarbonate tube. Extreme care must be exercised during the removal of this aqueous sample to ensure that no fine particulate matter is included in the final aqueous phase. Such contamination of the aqueous phase could significantly affect the measured sorption ratio in cases where the activity is strongly sorbed on the solid phase. The development of the centrifugation requirements is discussed in Ref. 5, pp. 44-52.

The removed aqueous phase is centrifuged for 1 h at 12 000 rpm. The liquid remaining with the solid phase is removed and saved for pH measurements. The tube containing the solid phase is weighed and prepared for counting. After the centrifuging, the top 12-16 ml of the aqueous phase are carefully removed, transferred to a clean tube, and centrifuged for 2 h at 12 000 rpm. The remaining liquid is added to the pH sample. After this final centrifugation, the top 9-10 ml are removed and an appropriate aliquot is taken for counting. Any remaining liquid is added to the pH sample.

After the solid phase has been sampled for counting or when counting is complete, the desorption measurements can begin. Twenty milliliters of tuff-treated water are added to the remaining solid phase. The tube is capped and weighed and the two phases are thoroughly mixed. The sample is placed in a shaker and agitated at ~200 rpm for a predetermined length of time, after which the phases are separated and counted by the same procedures used for the sorption experiments.

Depending upon the element being studied, either the entire solid phase is counted or a fraction is taken. Corrections are made for the amount of aqueous phase still present in the solid sample by carefully weighing the sample while it is wet and after it has been dried. After both the aqueous and solid phases have been counted, subtractions are made from the solid phase data to account for the activity of the entrapped aqueous phase. In cases of extremely low sorption ratios, it is possible to calculate *negative* sorption ratios resulting from the statistical errors in the counting data or, perhaps, from the assumption that any retained water has the same radionuclide concentration as the aqueous phase. These negative values are typically reported as 0 ml/g; however, the appendix data compilation does report some *negative* sorption values for technetium. In actual fact, there cannot be

a negative sorption value because such a value would require the *creation* of activity; that is, there would be more activity measured after completion of the experiment than was added initially.

The tracer activity in the separated phases is determined in several ways, depending upon the radiations of the radionuclides being studied. For gamma-emitting actinides, the entire solid phase is counted in a NaI(Tl) well detector. Standards are prepared by using a known amount of the appropriate activity in a geometry and conditions identical to those of the samples; these standards are counted each time samples are counted. The liquid phase is counted by transferring 3 ml to a counting vial, acidifying with 1 ml of concentrated HCl, and counting both in the NaI(Tl) well counter and in an automatic gamma scintillation counter. Alternative methods for counting alpha-emitting tracers include radiochemical analysis of both the liquid and the dissolved solid sample, liquid scintillation counting of both fractions, and gross alpha counting. Uranium sorption ratios require only counting of the liquid phase. When the tracer is ^{237}U , a portion of the liquid phase is placed in a vial and gamma counted with a Ge(Li) detector. When natural uranium is the tracer, the liquid samples are counted by a delayed neutron counting method. For the remaining elements, a fraction of the solid phase is dried, weighed, and then counted with a Ge(Li) counter. Liquid samples are acidified and then Ge(Li) counted. The sorption ratio, R_d , is calculated using Eq. (1) above.

B. Tracer Preparation

Traced feed solutions containing barium, strontium, cesium, cerium, europium, iodine, nickel, cobalt, sodium, tin, iron, manganese, or selenium are prepared using commercially produced nuclides. The final concentrations of the elements studied in these feed solutions generally range from 10^{-6} to 10^{-9} M. The tracer is evaporated at room temperature in a polyethylene or polycarbonate container. After a few drops of HCl are added, a second evaporation is carried out. The appropriate amount of pretreated groundwater is added, the container is capped, and the traced solution is agitated in a shaker for 1 or 2 days. The traced feed solution is filtered through a $0.05\text{-}\mu\text{m}$ Nuclepore membrane just before use.

Exceptions to the above general procedure include technetium, uranium, and the actinides. Because technetium volatilizes when heated in acid solution and is more stable in base, the tracer is delivered in 0.1 M NH_4OH solution. It is added in a small volume to the appropriate tuff-treated water to produce 10^{-3} to 10^{-9} M feed solutions. After dilution, the solution is equilibrated for a few days and passed through a $0.05\text{-}\mu\text{m}$ filter just before use.

Uranium feed solutions are made from a dilution of a stock solution; this stock solution is prepared by dissolving a weighed amount of uranyl nitrate in water that has been purified

with a Millipore deionizing system and filtered through a $0.05\text{-}\mu\text{m}$ membrane. The final feed solution is prepared by adding an appropriate amount of uranium stock solution to tuff-treated groundwater, shaking the mixture for as long as a week, and passing it through a $0.05\text{-}\mu\text{m}$ filter just before use.

Americium and neptunium feed solutions are prepared by drying tracers in air at room temperature in a polycarbonate or polypropylene container. Before it is dried, the plutonium tracer is treated with 10 M NaNO_2 to obtain the (IV) oxidation state; however, as will be discussed later, this treatment does not guarantee the (IV) oxidation state of plutonium. The dried activity is removed from the container by a minimum of three 1-min contacts with the pretreated groundwater using a vibrator or an ultrasonic bath. After each contact, the tracer is removed to a clean, large polyethylene bottle. Contacts are repeated until tracer is no longer removed from the drying container. Sufficient rock-equilibrated groundwater is added to the large container to attain the desired volume. Finally, the tracer solution is shaken for 1 to 2 days and filtered as described above just before use.

Because thorium exhibits very low solubility in the pH range of our normal laboratory experiments, the tracer must be prepared in acid solution and then neutralized to obtain the required pH. Further, the experiments must be performed in the CO_2 -controlled atmosphere box to maintain the pH at ~ 7 . Thorium-230 tracer in 1 M HNO_3 is added to pretreated groundwater. The pH is adjusted to ~ 6 with NH_4OH just before filtering, and the experiment is begun immediately in the controlled atmosphere box. The pH of the samples is monitored, and if the pH exceeds $\sim 7.2\text{--}7.5$, the experiment is terminated and the sorption ratio is calculated. Thorium solubility under these experiment conditions decreases dramatically at pH values greater than 7.5. The experiments are terminated because sorption ratios measured at higher pH would not be conservative.

C. Sorption Ratio Calculations

As stated earlier, Los Alamos scientists measure a sorption coefficient that does not imply equilibrium: Eq. (1). In fact, Los Alamos data indicate that equilibrium is not achieved in many instances. The sorption ratio is a measurement of an element's distribution between phases under specified conditions, although not necessarily at equilibrium. Sorption from near-neutral groundwater onto rock such as tuff is complicated; it may involve competing cations and complexed or hydrated species. Many equilibria would have to be described in equations leading to the thermodynamic quantities for sorption of an element. Some simplifying assumptions applied in relationships between an equilibrium constant and the distribution coefficient will be mentioned later and have been discussed in detail in Ref. 5.

Average values are calculated for measured sorption ratios because measurements are made in duplicate. The uncertainties associated with averages of sorption data are the standard deviations of the mean σ_m , defined by

$$\sigma_m = \frac{(\sum d_i^2)^{1/2}}{n(n-1)} ,$$

where

d_i is the deviation from the mean of the i^{th} experimental value, and
 n is the number of values.

The standard deviation of the mean is used rather than the standard deviation of the sample or the population. This practice avoids including zero in the range of uncertainty when, for example, averaging a large range of R_d values from individual determinations, all of which indicate a high sorption ratio. The total spread of values averaged in the measurements is often a factor of 5 larger than σ_m . This spread is the result of the choice of σ_m just discussed, the nonweighted averaging, and the simplifying assumption that the samples belong to the same population when averaging results for different times, particle sizes, etc. These uncertainties should not necessarily be used in assessment calculations as bounds for K_d values within a given unit because they do not include a complete picture of experiment uncertainties and experiment reproducibility.

A more realistic estimate of the magnitude of the errors in the sorption ratios listed in the Appendix would be $\pm 50\%$. This estimate is arrived at by considering the many analytical measurements made during the experiments, and, more importantly, the observed reproducibility over time, from one sorption measurement to another. This is not a rigorously determined error, but represents a "best estimate" by the scientists responsible for making the sorption measurements.

III. RESULTS

All the sorption and desorption data collected are listed in the Appendix. This listing represents data reported in Refs. 5-17 as well as more recent, unpublished results. *It is an unrefined data set*; for example, data are included that were generated while the experiment conditions and procedures were being developed. Thorough examination of such data has shown that some of these measurements are not reliable and should not be used for performance assessment calculations. Systematic identification of suspect data is currently in progress. The refined data set will be available as part of the Reference Data Base for Yucca Mountain that is being compiled by Sandia National Laboratories. The

complete data set will be available in the Tuff Data Base at Sandia, and explanations will be provided for data that are not included in the Reference Data Base.

Parameters reported in the Appendix include contact time (in days), atmospheric conditions, concentration of the sorbing element (in moles/liter), particle-size range of the crushed tuff (particle minimum to particle maximum in micrometers), and temperature (in °C). The headings "srd1" and "srd2" and "drd1" and "drd2" represent duplicate sorption and desorption ratios, respectively. When duplicate measurements are averaged, which is how these ratios are usually reported, the standard deviation of the mean is used to represent an error estimate. In some cases, ratios may be reported as *greater than* some value. These values are the result of poor counting statistics that can occur in cases of very high sorption ratios where very little activity is left in the aqueous solution. Occasionally, negative sorption ratios are calculated—again, the result of poor counting statistics. Although negative values have no realistic meaning, they are reported when duplicate measurements have been made to properly reflect the error involved in those measurements. When only one measurement is available, a negative value is reported as "0".

Table III lists the four major rock groups used to classify the tuff sample mineralogy: (1) devitrified assemblage—composed primarily of quartz and alkali feldspar; (2) zeolitized—dominated by an alteration assemblage of zeolites; (3) glass—high percentage of original glass in sample (not devitrified or altered to zeolites); and (4) clays—clays are the major alteration assemblage. Each of the major groups can be further classified according to the subgroups listed in the table. In Table IV, the tuff samples are categorized according to these mineralogic types. Greater detail on tuff mineralogy is contained in Refs. 5 and 14-21. Available cation-exchange capacities (CEC) are given in Table V.

IV. DISCUSSION

A. Sorption as a Function of Tuff Mineralogy

One of the primary objectives of these studies is to determine if sorption ratios can be correlated with tuff mineralogy. Although a comprehensive, statistical analysis of the data has not yet been performed, some observations can be made about sorption as a function of tuff mineralogy, and these observations are given below. All comments refer to sorption coefficients measured at 6-week contact times, under ambient temperature, and atmosphere and on 75- to 500- μ m particles, unless otherwise stated. A large number of radionuclides other than those discussed below have been tested with selected tuff samples. There are not enough data to draw conclusions, but the available data are included in this report.

TABLE III
CLASSIFICATION OF TUFF SAMPLES

FOUR MAJOR ROCK GROUPS

1. DEVITRIFIED

composed primarily of quartz and alkali feldspar

2. ZEOLITIZED

dominated by an alteration assemblage of zeolites

3. GLASS

high percentage of original glass in sample (not devitrified or altered to zeolites)

4. CLAYS

clays are the major alteration assemblage

SUBGROUPS

1. DEVITRIFIED - <10% clays, <10% zeolites

DEVIT1- >10% clays, <10% zeolites

DEVIT2- <10% clays, >10% zeolites

2. ZEOLITIZED - >20% zeolites, <10% clays, <10% glass

ZEOLIT1- >20% zeolites, >10% clays, <10% glass

ZEOLIT2- >20% zeolites, <10% clays, >10% glass

3. GLASS - >40% glass, <10% clays, <10% zeolites

GLASS1- >40% glass, >10% clays, <10% zeolites

GLASS2- >40% glass, <10% clays, >10% zeolites

4. CLAYS- >40% clays

TABLE IV
CLASSIFICATION OF YUCCA MOUNTAIN TUFF SAMPLES

<u>DEVITRIFIED</u>	<u>DEVIT1</u>	<u>DEVIT2</u>
G1-1883	G1-2901	YM-30
G1-1982	JA-32	
G1-2333	YM-54	
G1-2363		
G1-2410		
G1-2476		
G1-2840		
G1-2854		
G1-2954		
GU3-0433		
GU3-0855		
GU3-0916		
GU3-1531		
YM-22		
YM-45		
YM-46		
<u>ZEOLITIZED</u>	<u>ZEOLIT1</u>	<u>ZEOLIT2</u>
G1-1436	G1-2233	YM-48
G1-1854	G1-2689	
G1-2278	G1-2698	
G1-2289	G1-3116	
G2-1952	G2-3933	
G2-2017		
G4-1502		
G4-1608		
GU3-1937		
JA-26		
JA-28		
YM-38		
YM-42		

TABLE IV (cont)

<u>GLASS</u>	<u>GLASS1</u>	<u>GLASS2</u>
G1-1292	G2-0547	JA-18
GU3-1203		YM-49
GU3-1301		
GU3-1436		
<u>CLAYS</u>		
G1-3658		
JA-08		
JA-37		
<u>UNCLASSIFIED</u>		
G2-0723 (40% calcite)		

1. Cesium, Strontium, and Barium. A positive correlation has been shown between zeolite content and sorption of simple cations such as cesium, strontium, and barium (used as an analogue of radium).⁵ This result is not surprising because zeolites are strong cation exchangers. Strontium, cesium, and barium show very high sorption for a sample that is 40-60% smectite (G1-3658), but they do not exhibit high sorption with another high-smectite sample (JA-08). A third sample (JA-37) has a large percentage of smectite in the core material; however, the sorption studies were performed on a fraction from which much of the clay had been removed. The sorption ratios for these elements on JA-37 are very similar to those obtained with sample JA-08. Sorption on glass samples having <10% zeolites (GLASS and GLASS1) is as much as one order of magnitude lower than for zeolitized samples. However, sorption on GLASS2 samples (>10% zeolites) appears to be the same as sorption on zeolitized samples. Devitrified samples exhibit the same or, often in the case of strontium, less sorption than the glass samples containing no zeolites. Again, the effect of zeolites can be seen in the case of the DEVIT2 sample YM-30 (>10% zeolites), which shows higher sorption than any of the other devitrified samples. In summary, these elements sorb strongly on zeolitic tuffs and less so on glass and devitrified samples. The results for smectite are inconclusive.

2. Cerium, Europium, and Tin. Correlations of sorption with mineralogy for cerium, europium, and tin and those elements whose discussions follow are much less evident than

TABLE V
CATION-EXCHANGE CAPACITIES^{a,b}

Sample	Particle Size (μm)	CEC by NH_4 OAc (meq/100 g)	CEC by Sum Cations ^c (meq/100 g)	Sum of Bases ^d (%)				Extractable Acidity of CEC (%)
				Ca	Mg	Na	K	
JA-8	75-500	28.4	33.8	81	12	3	4	5
JA-18	106-150	78.7	79.0	29	—	28	42	7
JA-18	355-500	69.8	(75.3)	29	—	28	42	9
JA-26	<75	3.3	9.3	25	4	67	5	9
JA-28	75-500	3.6	4.7	36	3	62	tr	17
JA-32	150-180	2.8	3.3	45	3	39	12	—
JA-32	250-355	2.5	(3.2)	44	3	44	9	—
JA-37	<106	26.7	(56.9)	86	5	6	3	—
JA-37	150-180	23.8	(49.6)	87	5	5	3	—
YM-5	75-500	23.6	29.1	65	29	3	4	5
YM-22	75-500	0.8	5.8	58	16	16	10	47
YM-22	<75	1.4	4.4	48	13	23	18	9
YM-30	75-500	8.7	12.0	70	12	12	6	10
YM-38	<500	151.7	(151.5)	47	0.6	19	33	—
YM-38	75-500	122.0	(118.8)	46	0.8	21	33	—
YM-42	75-500	52.7	66.3	72	2	15	11	2
YM-45	106-500	5.5	9.5	85	4	5	3	16
YM-46	75-500	3.8	8.9	61	4	18	17	19
YM-48	106-500	46.0	48.4	52	1	33	14	2
YM-49	106-250	111.9	(106.0)	54	2	28	16	—
YM-49	75-500	118.7	117.0	58	3	24	15	1
YM-54	75-500	2.3	4.5	93	3	3	3	11
G1-1292	75-500	—	(5.3)	94 ^e	2	4	—	—
G1-1436	<500	165.6	174.8	11	0.6	46	43	0.3
G1-1854	<75	126.5	(130.0)	19	0.3	52	29	—
G1-1854	75-500	104.1	114.9	18	0.3	52	29	0.2
G1-1883	<106	0.5	4.9	46	17	29	7	16
G1-1982	<38	14.5	(22.0)	34	5	52	10	—
G1-1982	<500	16.4	7.5	28	3	52	17	5

TABLE V (cont.)

Sample	Particle Size (μm)	CEC by NH_4 OAc (meq/100 g)	CEC by Sum Cations ^c (meq/100 g)	Sum of Bases ^d (%)				Extractable Acidity of CEC (%)
				Ca	Mg	Na	K	
G1-2233	<38	55.6	(136.0)	19	0.4	57	24	—
G1-2233	<500	88.2	(90.5)	19	0.3	57	23	—
G1-2233	106-500	68.6	(70.7)	18	0.1	59	22	—
G1-2289	<500	132.4	(144.3)	37	0.1	53	9	—
G1-2334	<38	6.8	7.5	64	7	23	7	tr
G1-2334	75-355	5.0	(5.5)	53	2	38	7	—
G1-2334	355-500	3.6	(4.2)	60	2	31	7	—
G1-2363	<500	4.8	8.0	74	1	25	tr	1
G1-2410	106-500	0.4	4.9	78	—	22	—	—
G1-2476	75-500	0.4	3.8	49	—	41	11	3
G1-2698	<500	116.4	(118.9)	15	0.3	69	15	—
G1-2840	<38	6.3	(7.3)	71	4	18	7	—
G1-2840	<106	5.1	(6.2)	61	2	31	6	—
G1-2840	150-355	3.9	(4.8)	67	tr	29	4	—
G1-2840	75-500	0.3	4.3	74	—	24	3	—
G1-2840	355-500	3.4	(3.8)	76	3	16	5	—
G1-2854	75-500	0.9	3.8	74	—	24	3	—
G1-2901	<500	0.5	—	() ^f	(—)	(1.2)	(0.3)	(—)
G1-3116	<500	23.8	28.4	24	0.4	72	4	0.4
G1-3658	<500	50.8	(57.4)	37	5	57	1	—
G2-332	<500	73.6	(78.3)	81 ^c	16	1	1	—
G2-339	<500	29.8	36.3	79	18	1	2	8
G2-547	75-500	33.7	36.1	76	13	6	5	8
G2-723	<500	9.9	—	() ^g	(1.3)	(0.6)	(0.8)	—
G2-770	<500	2.9	2.8	40	8	20	32	11
G2-1951	<500	139.1	138.0	48	3	25	25	1
G2-1952	75-500	123.5	124.0	46	0.4	30	23	1
G2-2000	<500	120.9	50	2	30	18	1	—
G2-3308	<500	42	3.3	47	—	41	13	3

TABLE V (cont)

Sample	Particle Size (μm)	CEC by		CEC by Sum Cations ^c (meq/100 g)	Sum of Bases ^d (%)				Extractable Acidity of CEC (%)
		NH ₄	OAc		Ca	Mg	Na	K	
G2-3933	75-500	7.1		—	() ^h	(6.2)	(4.1)	(1.0)	—
GU3-433	<500	1.9		2.6	35	10	30	25	23
GU3-855	<500	3.1		4.4	45	13	24	18	14
GU3-855	75-500	2.9		4.5	49	13	21	18	13
GU3-916	75-500	3.1		3.9	38	15	26	21	13
GU3-1203	75-500	2.3		2.3	70	9	13	9	—
GU3-1301	75-500	1.1		1.2	73	—	18	9	8
GU3-1437	75-500	2.7		2.5	64	—	24	12	—
GU3-1531	75-500	11.9		12.7	77	1	14	8	6
GU3-1937	<500	150.39		149.3	10	—	54	35	1
G3-3005	<500	3.9		—	() ^e	(1.5)	(0.7)	—	—
G3-4868	<500	—		—	() ^f	—	—	—	—
G3-4907	<500	7.1		(11.8)	54	1	40	5	—
G4-1502	75-500	157.8		163.8	14	—	46	41	1

^a From Refs. 5 and 13.

^b Blank = not determined; dash = not detected.

^c Values in parentheses represent only the sum of bases; extractable acidity was not determined.

^d Values in parentheses are in meq/100 g.

^e Trace CaCO₃.

^f 3% CaCO₃.

^g 29% CaCO₃.

^h 1% CaCO₃.

those for the simple cations. Cerium sorption coefficients for zeolitized tuff are generally very high, >10 000 ml/g. Data from a single clay sample gave an R_d of >1000 ml/g. There does not appear to be much difference between sorption on glass (coefficients of ~100 ml/g or more) and on devitrified samples (coefficients of several hundred milliliters per gram).

Europium sorption coefficients on zeolitized samples are also high: >1000 and often >10 000 ml/g. The few clay samples indicate an R_d of >1000 ml/g. The lowest sorption coefficients for europium are measured on glass samples with sorption coefficients ~100 ml/g. Devitrified samples give ratios ≥ 500 ml/g and generally >2000 ml/g.

There are not enough measurements of tin to draw any correlations of sorption with mineralogy. However, the tin sorption coefficients measured to date on the four main mineralogic types are several hundred milliliters per gram.

3. Technetium, Selenium, Uranium, and Neptunium. For all intents and purposes, technetium sorption coefficients under oxidizing conditions on all the tuff mineralogies studied are extremely low: <1 ml/g; to be conservative, they should be considered zero. Technetium sorption measured under a nitrogen atmosphere (Sec. IV.E) gave significantly higher sorption coefficients: 4 ml/g or more. These conditions, however, were not representative of those expected at Yucca Mountain and should not be used for performance assessment calculations.

Selenium and uranium do not differ much in their sorption behavior. Sorption coefficients for these two elements on zeolitized tuff are ~ 5 ml/g. Uranium gave an R_d of 4 ml/g on a clay sample, but no data are available for selenium on clay. Glassy samples give sorption coefficients of ~ 3 ml/g for selenium and range from 0 to 20 ml/g for uranium. Devitrified samples for uranium are ~ 2 ml/g; they range from 3 to 30 ml/g for selenium, and most values are ~ 10 . When sorption coefficients were measured for these elements under a controlled- CO_2 atmosphere (see Sec. IV.E), uranium sorption increased, but selenium sorption showed no significant change.

Neptunium does not display any significant differences in sorption among the four major rock groups. The sorption coefficients measured under oxidizing conditions for neptunium are ~ 5 ml/g. No significant changes in sorption were noted under the CO_2 atmosphere.

4. Thorium, Plutonium, and Americium. Because thorium solubility is expected to be low at the laboratory pH of 8-8.5, most of the thorium sorption measurements were made in the controlled- CO_2 atmosphere where the pH was maintained at 7. Sorption times were sometimes shorter than 6 weeks. No correlations with mineralogy are evident for thorium. The sorption coefficients measured for zeolitized, glassy, and devitrified tuff exceed several hundred milliliters per gram. No data are available for clay.

Considerable time and effort already has been devoted to understanding actinide speciation at neutral pH. We are now attempting to investigate actinide sorption by preparing tracers in known oxidation states. The data contained in this document were obtained by preparing the actinide tracers as described in Sec. II.B. Although this method was intended to prepare the actinides (plutonium in particular) in a single oxidation state, it is not always successful. Tests on the plutonium tracer revealed that Pu(IV) , (V) , and (VI) can be present in our tracer. Therefore, the plutonium sorption data presented here

represent a *grand-average* sorption ratio for these three oxidation states of plutonium. Our current effort is aimed at studying sorption of specific oxidation states of plutonium.

Plutonium sorption values for zeolitized tuff range from 60 to 1600 ml/g. The limited clay data yield an R_d of ~ 500 ml/g, and glass and devitrified samples give sorption coefficients >100 ml/g. Some of the variation in the data for similar rock types may be a result of tracer preparation anomalies.

Americium does not display any correlation of sorption with mineralogy. With two exceptions, americium sorption coefficients exceed 1000 ml/g. These exceptions are the devitrified tuffs JA-32 and YM-54, which have sorption ratios of 80 ml/g and 150 ml/g, respectively.

B. Desorption Experiments: Reversibility

If equilibrium were established, and if observed R_d values for tuffs were true K_d values, the same R_d values should be obtained from desorption and sorption experiments. These R_d values, however, are usually not the same, and the desorption values are almost always higher. Some of these differences arise from the large ranges in individual determinations; the averaging process, which assumed that the samples represent the same population, may not have been appropriate for such cases. Desorption ratios greater than the corresponding sorption ratios may also indicate kinetic problems or that precipitation has occurred. Other results may represent truly irreversible sorption. If such is the case, the use of these R_d measurements would underestimate retardation because of the contribution of irreversible sorption onto tuff. However, if precipitation is occurring, then the measured sorption ratio has overestimated the amount of sorption actually taking place. Desorption ratios lower than the related sorption ratios may indicate dissolution of a precipitate whose solubility was exceeded during the sorption experiment. To rule out such explanations, sorption and desorption isotherms must be measured.

C. Effects of Elevated Temperature

The effects of 70°C temperatures compared to those of room temperature are discussed in Ref. 5. The values at 70°C are generally similar to but higher than those at room temperature by factors up to 5. A regression modeling of the strontium, cesium, barium, cerium, and europium data indicates a very positive correlation of increasing R_d with elevated temperature. The limited data for 85°C also show higher sorption. (See Ref. 5, page 110.)

D. Effects of Particle Size on Sorptive Behavior

Particle-size effects on sorption ratios are discussed in Ref. 5. It was concluded that the presence of very fine particles ($<38 \mu\text{m}$) could lead to larger sorption ratios (by factors of 2 to 5), especially for samples of devitrified tuff. As a result, only particles in

the 75- to 500- μm range are currently used for sorption experiments. Errors caused by excluding these fine particles should result in R_d values that are too low and are, therefore, conservative. A large body of data does exist, however, for particle sizes $<500\ \mu\text{m}$, which includes very fine particles. (Wherever these R_d values are used in discussions, the particle size is noted.)

A regression model analysis of data for barium, cerium, cesium, strontium, and europium and tuff samples from G1-1883, G1-1982, G1-2289, G1-2363, G1-3658, JA-18, JA-32, JA-37, YM-22, YM-38, YM-45, YM-48, YM-49, and YM-54 showed no particle-size effects among four particle-size ranges studied: 106 to 150, 106 to 500, 250 to 500, and 355 to 500 μm . Data from the 75- to 500- μm range will be included in a later analysis, but the above result indicates that particle size is not a major factor in our data set.

E. Comparison of Batch Studies Made Under Atmospheric and Controlled-Atmosphere Conditions

Because reducing conditions are expected for some groundwater/rock systems, the sorptive behavior of some elements in such systems may differ from their behavior under normal atmospheric conditions. A summary of sorption values measured under a nitrogen atmosphere (≤ 0.2 ppm oxygen and ≤ 20 ppm CO_2) is given in Ref. 5, and a comparison with laboratory atmosphere results is given in Table VI. Because it has a low CO_2 content, this N_2 atmosphere is not necessarily representative of deep geologic systems, but it does represent a nonoxidizing atmosphere. With the exception of manganese and tin, sorption ratios for elements measured under the nitrogen conditions were either the same as or slightly higher than those in the more oxidizing conditions of the laboratory atmosphere. Therefore, the laboratory atmosphere measurements, with the exceptions noted, underestimate the sorption ratio compared to measurements under these less oxidizing conditions.

Experiments performed in the laboratory at Los Alamos display a gradual increase in pH to values of 8-8.5. This increase is assumed to be a result of loss of CO_2 from solution. In an effort to maintain the pH of some sorption experiments at a level closer to 7, which is the field pH of J-13 well water, a controlled-atmosphere box was designed to keep the pH of a sample of J-13 water at ~ 7 by increasing the amount of CO_2 in the atmosphere whenever necessary. The resulting atmosphere is enriched in CO_2 by $\sim 5\%$.

Sorption ratios have been measured for uranium, neptunium, selenium, and thorium in the CO_2 -controlled atmosphere. Uranium is the only element studied that showed a significant difference in sorption behavior between controlled and ambient atmospheres; ambient conditions (pH ~ 8.8) gave sorption ratios factors of 3 to 8 times lower than those measured under the controlled conditions (Ref. 16). We conclude that the sorption

TABLE VI
COMPARISON OF SORPTION RATIOS (R_d) MEASURED UNDER AMBIENT
ATMOSPHERE AND CONTROLLED-ATMOSPHERE CONDITIONS^{a,b}

Element	Effect on R_d Value
Cs	None
Sr	None
Ba	None
Ce	None
Eu	None
Na	None
Se	None
Mn	Lower in CA (factors of 3 to 4)
Sn	Lower in CA (factor of 2)
Am	None
Pu	Higher in CA (factor of 2)
Tc	Higher in CA (factor of ≥ 10)
U	Higher in CA ^c (factors of 2 to 3)
Np	Higher in CA (factor of 2)

^a From Ref. 5.

^b CA = controlled atmosphere: nitrogen, ≤ 0.2 ppm oxygen, and ≤ 20 ppm CO₂

^c With YM-38 (zeolitized) tuff only; otherwise there is no effect.

ratios measured in the laboratory under ambient conditions will yield conservative, that is, underestimated sorption ratios; however, we will continue to monitor sorption behavior under these controlled conditions, especially for elements that have an R_d of <10 ml/g.

F. Comparison of Sorption Ratios Measured by Batch, Circulating Column, Crushed-Rock Column, Wafer, and Solid-Core Methods

Critics have charged that batch measurements on crushed tuff consistently overestimate sorption ratios by large factors. This is not the case, although there may be a bias toward higher batch values. Agreement among various sorption ratio methods is good when sorption times are comparable. Recent evidence does suggest, however, that kinetics may be an important factor. Previous disagreements may have resulted from comparisons between long-term batch and short-term column measurements.

Batch sorption and circulating column measurements generally agree within a factor of 2, as is shown in Table VII. The circulating column method uses a column that holds the solid phase stationary and prevents possible contribution from self-grinding, which may be present in the batch measurements. The eluent is recirculated through the column until the experiment is terminated. The large disagreements for americium with sample JA-37 and barium with sample YM-22 remain unexplained. However, the presence of very fine clay particles in the batch sample JA-37, which has a relatively high concentration of smectite, could lead to a high sorption value. Crushed-rock columns do not recirculate the eluent, and the radioisotopes to be studied are loaded as a spike onto the column. The contact time of the eluent with the column material is determined by the flow rate. The rock-to-solution ratio is ~3:1 for the columns as compared to 1:20 for the batch measurements. Results for strontium, cesium, and barium are compared for batch and crushed-rock methods in Table VIII. The value in parentheses represents the factor by which the listed method exceeds the other. Again, the agreement is good for these three elements.

TABLE VII
COMPARISON OF AVERAGE SORPTION RATIOS FROM BATCH AND
CIRCULATING-SYSTEM SORPTION MEASUREMENTS^a

	Ratio of Batch R_d to Circulating-System R_d				
	Sr	Cs	Ba	Am	Pu
JA-37 ^a	0.74(0.04) ^b	0.03(0.03)	0.88(0.18)	8.2(3.3)	1.4(0.3)
YM-49				2.0(0.7)	0.40(0.15)
YM-22	2.0(0.2)	0.59(0.09)	7.5(0.7)		
YM-54	1.3(0.2)	1.3(0.3)	1.6(0.6)		
G1-1883				1.4(0.1)	1.4(0.4)

^aFrom Ref. 5.

^bValues in parentheses are the errors.

TABLE VIII
SUMMARY OF DIFFERENCES IN SORPTION RATIOS BETWEEN
CRUSHED-ROCK COLUMN AND BATCH MEASUREMENTS^a

Column	⁸⁵ Sr	¹³⁷ Cs	¹³³ Ba
YM54	0 ^b	0	0
YM38		C > B (1.45)	
YM22	C > B ^c	0	C < B ^c
JA-37	C < B (2.08)	C > B (1.36) ^c	
JA-32	0		
G1-3658	C < B (11.8)	C < B (1.18)	C < B (1.91)
G1-3116	C < B	C < B	[0]
G1-2901	C < B	C < B	C < B
G1-2476	C < B	[C < B]	C < B
G1-2363	0	C < B	C < B
G1-2233	[0]	[C > B]	[0]
G1-1982	0	0	C < B (1.18)
G1-1883	0	0	C < B (123)
G1-1292	0	[C > B]	[C < B]

^a From Ref. 23.

^b "0" indicates that the column R_d value fell within the range of measured batch values or that the ranges overlapped (if more than one column measurement was made). Brackets indicate that the column R_d value(s) was obtained by sectioning the column. C < B or C > B indicates that the column R_d value was less than or greater than the batch R_d value. If a number follows in parentheses, it is the factor by which column and batch values differ. Numbers are not given when only batch data on unwashed fractions are available for comparison; the apparent difference between column and batch values may not be real.

^c C = B when results from the circulating type of batch measurements are included.

The results are quite different, however, for neptunium, plutonium, and americium. Sorption ratios determined from the crushed-rock columns are significantly lower than those determined by the batch method. From 10–50% of the input radionuclide activity appeared with the solvent front or quite close to it for the column runs. Table IX lists the tuffs studied and their batch and column sorption values. The amount of actinide in these experiments is generally $\sim 10^{-8}$ M. Thorough checks of the columns showed that their behavior was reproducible and that they were otherwise operating correctly. Several short-term batch experiments were performed to discover if there were kinetic effects. Tuff USW GU-3-1301 had previously yielded sorption values of 1500–2000 ml/g for 6-week contact periods, but the results for batch contact times of 6 h, 24 h, and 8 days were 54, 84, and 2000 ml/g, respectively.¹⁵

Several explanations may account for the appearance of the actinides in the effluent with the solvent front. A contact time longer than a few hours may be required for sorption of all the input species. This theory is consistent with the short-term batch results. The species originally present in the feed solution may not sorb completely but may change slowly over a period of days to a more sorbable species. In addition, the activity appearing with the solvent front may be due to colloid-size particles carrying sorbed radioactivity as they wash from the column.

Speciation changes are certainly possible with plutonium, but that explanation does not seem to be applicable to americium, which presumably exists in only one oxidation state. Colloidal transport of the activity seems a less likely explanation in light of a follow-up experiment using one column that was flooded with colloids and another column from which all colloids had been removed. Both columns behaved similarly, but the colloid column eluted somewhat less activity. We concluded that because large quantities of colloidal material did not appreciably change the elution behavior, the presence of relatively small amounts of colloidal material could not cause the breakthrough of any large fraction of the input activity. However, other colloidal transport experiments are continuing.

The evidence thus far indicates that actinide sorption may involve one or more time-dependent steps. More experimental work should be directed toward resolving the uncertainties associated with this kinetic effect. It may be necessary to modify models of actinide transport to include the possibility that source material could move farther over short time periods than would be predicted solely on the basis of long-term batch measurements.

A third method using intact tuff wafers can be compared to batch techniques. Thin (2- to 3-mm thick) tuff wafers are suspended in pretreated groundwater that has a rock-to-solution ratio of 1:20—the same as that for batch experiments. The sorption ratios

TABLE IX
KINETIC STUDIES OF SORPTION COLUMNS^a

Experiment	Tuff	Type	Constituents	R _d Values	
				Batch	Column
Plutonium	JA-37	Welded	Clay, glass, feldspar, cristobolite	4 x 10 ²	4
	YM-49	Partially welded			
	USW G1-1883	Partially welded	Feldspar, quartz, cristobolite	8 x 10 ¹	0.3
	U12G	Zeolitized	Clinoptilolite, feldspar	3 x 10 ²	0.5
	USW G1-1292	Welded	Glass, feldspar,	6 x 10 ^{2b}	<1
Americium	USW G1-1292	Welded	Glass, feldspar, cristobolite	3 x 10 ^{4b}	<1
	USW G1-1436	Zeolitized	Clinoptilolite, quartz, cristobolite, feldspar	2 x 10 ³	<1
	USW GU3-1301	Vitric	Glass, feldspar, cristobolite, quartz		<1
Neptunium	JA-37	Welded	Clay, glass, feldspar, cristobolite	2 x 10 ¹	4
	YM-49	Partially welded	Glass, feldspar, clinoptilolite	8	2
	USW G1-1883	Partially welded	Feldspar, quartz, cristobolite	6	0.5

^aFrom Ref. 15.

^bEstimated value.

measured after 4 weeks of contact are compared to those of batch measurements in Table X. The agreement differs by much less than a factor of 2 in all cases.

A few solid-core experiments have been performed. Strontium gave a sorption ratio within a factor of ~2.5 of the ratio for batch results, and plutonium gave values within a factor of 10 (Ref. 5). These results are considered in reasonable agreement because of the large uncertainties in the solid-core data.

When we compare batch and wafer experiments on the same time scale, we conclude that use of the batch technique is valid for tuff sorption measurements. It appears, however, that a kinetic factor is present in the sorption process. This kinetic effect must be investigated further, and it may be necessary to incorporate it into modeling codes for actinide transport.

TABLE X
R_d COMPARISON: TUFF WAFERS *vs* CRUSHED TUFF^a

<u>Tuff Sample</u>	<u>Element</u>	<u>R_d (Wafer) (ml/g)</u>	<u>R_d (Batch) (ml/g)</u>
G1-1883 (sorption)	Sr	27	22
	Cs	230	190
	Ba	210	180
G1-1982 (sorption)	Sr	80	62
	Cs	1 000	1 200
	Ba	800	800
G1-1436 (desorption)	Sr	96 500	87 000
	Cs	14 900	24 000

^aFrom Ref. 13.

G. Sorption Isotherms

One of the key purposes for measuring the dependence of sorption coefficients on sorbing element concentration (isotherms) is to provide the information necessary to accurately model retardation of waste elements under various source-term and groundwater conditions. Thermodynamic parameters, such as equilibrium constants, can sometimes be extracted from isotherm data, thus providing a data base for correlating sorption coefficients with other variables of interest. In most transport codes, sorption is treated as a linear isotherm; that is, the sorption coefficient does not depend upon the element concentration. This treatment should be appropriate for ion-exchange equilibrium at tracer levels with zeolitic tuffs; however, it may not hold for nonzeolitized tuffs. In these cases, it may be necessary to consider other approaches such as Langmuir, Freundlich, or mass-action isotherms. Additionally, it is not unexpected that hysteresis will be observed when desorption isotherms are measured. If such is the case, isotherm measurements take on an

even greater importance. According to Genuchten and Cleary,²⁴ the exclusion of hysteresis effects in the calculation of concentration distributions can cause serious discrepancies between the actual and calculated distributions. In other words, predictive models of sorption will need to account for hysteresis effects, which must be experimentally measured. A discussion of isotherm data and calculations for Yucca Mountain tuff samples is contained in Ref. 5. Recent isotherm measurements for neptunium are included in this data set but have not been analyzed to determine which type of isotherm may apply. The tuff samples used for these studies are G4-1608 and GU3-433.

Sorption isotherm measurements can be useful in other ways. Preliminary statistical analysis of some of our sorption data revealed that often trends could not be predicted because there are too many variables. Frequently, the analysis could narrow the problem down to two variables—one of which was commonly concentration. Using data obtained from isotherm measurements, we have been able in many cases to rule out concentration as a contributing factor. As stated in Sec. B (Desorption Experiments), isotherm measurements are necessary to rule out the possibility that precipitation contributed to the measured sorption ratio.

V. SUMMARY

Los Alamos has compiled an extensive sorption data base for radionuclides on Yucca Mountain tuff; these data, when refined, will contribute to estimations of the movement and transport of radionuclides in groundwater at Yucca Mountain. This data base will grow as the Project continues its investigations of Yucca Mountain. The next major addition to this data base will be information being collected on the effect of groundwater composition on sorption ratios. Additional effects still to be determined include sorption of other radionuclides, sorption on colloids and bacteria and their subsequent transport, other effects of bacteria on sorption (such as the release of complexing agents), sorption under Vadose groundwater conditions, and sorption isotherms.

ACKNOWLEDGEMENTS

The following people made significant contributions to the data collection and the interpretations used in this report. Sorption experiments: B. P. Bayhurst, M. R. Cisneros, W. R. Daniels, S. D. Knight, F. O. Lawrence, A. J. Mitchell, R. S. Rundberg, and K. Wolfsberg; water chemistry: A. E. Ogard and P. L. Wanek; mineralogy/petrology: D. L. Bish, B. M. Crowe, and D. T. Vaniman; statistical evaluation and data interpretation: R. Beckman, B. M. Crowe, and R. S. Rundberg; column experiments: N. A. Raybold, E. N. Treher, and J. L. Thompson; and speciation of actinides: D. E. Hobart, T. W. Newton, P. Palmer, and V. L. Rundberg.

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APPENDIX
BATCH SORPTION RATIOS FOR TUFFS OF THE YUCCA MOUNTAIN AREA
AND WELL J-13 WATER

GLOSSARY

element = chemical symbol for the element in question

temp = temperature at which the measurements were made (room $\sim 25 \pm 3^\circ\text{C}$)

Atm = atmosphere

air = ambient atmosphere

ca = controlled atmosphere: N_2 ; ≤ 0.2 ppm O_2 ; ≤ 20 ppm CO_2

CO_2 = atmosphere enriched in CO_2 $\sim 5\%$; pH of J-13 groundwater was maintained at ~ 7

Stime = time of sorption measurements in days

srd1/srd2 = sorption ratios measured in duplicate

dtime = time of desorption measurement in days

drd1/drd2 = desorption ratios measured in duplicate

conc = concentration of sorbing element in Molarity

pmin/pmax = the minimum and maximum particle size in μm of the crushed tuff

BATCH SORPTION RATIOS FOR TUFFS OF THE YUCCA
MOUNTAIN AREA AND WELL J-13 WATER

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-1292											
Ba	room	air	21.000	1800.0	2200.0	42.000	1700.0	1400.0	7.00-6.		500.
			42.000	2800.0	1500.0	21.000	1400.0	15000.0	7.00-6.		500.
Ce	room	air	21.000	54.0	79.0	42.000	1200.0	510.0	7.00-8.		500.
			42.000	82.0	50.0	21.000	610.0	94.0	7.00-8.		500.
Cs	room	air	21.000	390.0	450.0	42.000	560.0	500.0	3.00-9.		500.
			42.000	500.0	380.0	21.000	470.0	520.0	3.00-9.		500.
Eu	room	air	21.000	140.0	160.0	42.000	780.0	510.0	1.00-7.		500.
			42.000	160.0	100.0	21.000	490.0	620.0	1.00-7.		500.
Ra	room	air	42.000	1500.0	1400.0				3.60-7.	75.	500.
Sr	room	air	21.000	200.0	200.0	42.000	120.0	110.0	2.00-7.		500.
			42.000	220.0	190.0	21.000	110.0	130.0	2.00-7.		500.
Th	room	air	84.000	566.0	389.0				5.40-8.	75.	500.
U	room	air	42.000	0.2	-1.6				5.00-6.	75.	500.
<u>Core</u>											
G1-1436											
Ba	room	air	21.000	150000.0	140000.0	42.000	300000.0	110000.0	8.00-6.		500.
			42.000	93000.0	210000.0	21.000	450000.0	500000.0	8.00-6.		500.
Ce	room	air	21.000	58000.0	62000.0	42.000	5900.0	5500.0	1.00-7.		500.
			42.000	41000.0	74000.0	21.000	8000.0	7200.0	1.00-7.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-1436											
Cs	room	air	21.000	7000.0	7900.0	42.000	29000.0	18000.0	3.00-9.		500.
			42.000	7400.0	9000.0	21.000	26000.0	23000.0	3.00-9.		500.
Eu	room	air	21.000	30000.0	32000.0	42.000	4200.0	4500.0	1.00-7.		500.
			42.000	25000.0	34000.0	21.000	6500.0	6100.0	1.00-7.		500.
Ra	room	air	42.000	79000.0	130000.0				3.60-7.	75.	500.
Se	room	air	42.000	11.0	14.0				1.00-10.	75.	500.
Sr	room	air	21.000	31000.0	36000.0	42.000	100000.0	55000.0	1.00-7.		500.
			42.000	33000.0	45000.0	21.000	110000.0	83000.0	1.00-7.		500.
U	room	air	42.000	12.0	10.0				5.00-6.	75.	500.
<u>Core</u>											
G1-1854											
Ba	room	air	21.000	63000.0		42.000	140000.0		1.00-7.		75.
			21.000	34000.0		42.000	130000.0		1.00-7.	75.	500.
			42.000	48000.0		21.000	250000.0		1.00-7.		75.
			42.000	34000.0		21.000	87000.0		1.00-7.	75.	500.
Cs	room	air	21.000	15000.0		42.000	14000.0		4.00-9.		75.
			21.000	11000.0		42.000	11000.0		4.00-9.	75.	500.
			42.000	15000.0		21.000	18000.0		4.00-9.		75.
			42.000	10000.0		21.000	15000.0		4.00-9.	75.	500.
Eu	room	air	21.000	>130000.0		42.000	4800.0		3.00-8.		75.
			21.000	120000.0		42.000	3000.0		3.00-8.	75.	500.
			42.000	>110000.0		21.000	6500.0		3.00-8.		75.
			42.000	14000.0		21.000	4800.0		3.00-8.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-1854											
Sr	room	air	21.000	71000.0		42.000	71000.0		3.00-8.		75.
			21.000	32000.0		42.000	95000.0		3.00-8.	75.	500.
			42.000	92000.0		21.000	38000.0		3.00-8.		75.
			42.000	43000.0		21.000	51000.0		3.00-8.	75.	500.
<u>Core</u>											
G1-1883											
Am	room	air	21.000	4200.0		84.000	5900.0		1.00-7.	106.	250.
			42.000	4500.0		63.000	6900.0		1.00-7.	106.	250.
			84.000	5300.0		21.000	8900.0		1.00-7.	106.	250.
Ba	room	air	21.000	750.0					7.00-6.		38.
			21.000	230.0					7.00-6.		38.
			21.000	4300.0	250.0	42.000	440.0	420.0	8.00-6.		500.
			21.000	210.0					7.00-6.	38.	106.
			21.000	200.0					7.00-6.	38.	106.
			21.000	160.0					7.00-6.	106.	500.
			21.000	160.0					7.00-6.	106.	500.
			42.000	480.0	490.0	21.000	450.0	460.0	8.00-6.		500.
Ce	room	air	21.000	150.0	150.0	42.000	2000.0	2100.0	7.00-8.		500.
			42.000	300.0	250.0	21.000	2200.0	2300.0	7.00-8.		500.
Cs	room	air	21.000	720.0					4.00-9.		38.
			21.000	310.0					4.00-9.		38.
			21.000	380.0	350.0	42.000	420.0	430.0	3.00-9.		500.
			21.000	200.0					4.00-9.	38.	106.
Cs	room	air	21.000	180.0					4.00-9.	38.	106.
			21.000	180.0					4.00-9.	106.	500.
			21.000	190.0					4.00-9.	106.	500.
			42.000	440.0	440.0	21.000	430.0	440.0	3.00-9.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-1883											
Eu	room	air	21.000	650.0					3.00-8.		38.
			21.000	370.0					3.00-8.		38.
			21.000	180.0	180.0	42.000	1300.0	1500.0	1.00-7.	500.	
			21.000	110.0					3.00-8.	38.	106.
			21.000	120.0					3.00-8.	38.	106.
			21.000	150.0					3.00-8.	106.	500.
			21.000	170.0					3.00-8.	106.	500.
			42.000	330.0	300.0	21.000	1300.0	1300.0	1.00-7.		500.
Mn	room	air	14.000	160.0		28.000	140.0		1.00-11.		500.
			14.000	120.0					1.00-11.		500.
			28.000	140.0	390.0	14.000	160.0	950.0	1.00-11.		500.
Na	room	air	14.000	0.93	3.0	28.000	4.2	1.3	2.00- 3.		500.
			28.000	3.7	1.6	14.000	3.8	1.7	2.00- 3.		500.
Np	room	air	21.000	5.3		84.000	24.0		9.00-11.	106.	250.
			42.000	6.9		63.000	29.0		9.00-11.	106.	250.
			91.000	7.1		21.000	56.0		9.00-11.	106.	250.
Pu	room	air	21.000	51.0		84.000	830.0		4.00-12.	106.	250.
			42.000	52.0	91.0	56.000	740.0	1100.0	4.00-12.	106.	250.
			91.000	82.0	107.0	21.000	960.0	850.0	4.00-12.	106.	250.
Se	room	air	14.000	1.5		28.000	60.0	20.0	1.00-9.		500.
			28.000	16.0	3.6	14.000	72.0	30.0	1.00-9.		500.
Sn	room	air	14.000	230.0		28.000	2600.0	2100.0	8.00-9.		500.
			28.000	620.0	290.0	14.000	2400.0	2700.0	8.00-9.		500.
Sr	room	air	21.000	80.0					3.00-7.		38.
			21.000	26.0					3.00-7.		38.
			21.000	58.0	59.0	42.000	58.0	56.0	2.00-7.		500.
			21.000	22.0					3.00-7.	38.	106.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-1883											
			21.000	22.0					3.00-7.	38.	106.
			21.000	22.0					3.00-7.	106.	500.
			21.000	22.0					3.00-7.	106.	500.
			42.000	57.0	58.0	21.000	60.0	62.0	2.00-7.		500.
<u>Core</u>											
G1-1982											
Ba	room	air	14.000	10000.0					4.00-6.		38.
			14.000	670.0					4.00-6.	38.	75.
			14.000	570.0					4.00-6.	75.	250.
			14.000	690.0					4.00-6.	250.	500.
			21.000	10000.0					4.00-6.		38.
			21.000	2500.0	2200.0	42.000	2600.0	3100.0	4.00-6.		500.
			21.000	840.0					4.00-6.	38.	75.
			21.000	780.0					4.00-6.	75.	250.
			21.000	780.0					4.00-6.	250.	500.
			42.000	3100.0	3200.0	21.000	2800.0	2600.0	4.00-6.		500.
Ce	room	air	21.000	520.0	450.0	42.000	5900.0	5600.0	1.00-7.		500.
			42.000	640.0	600.0	21.000	9400.0	7200.0	1.00-7.		500.
Cs	room	air	14.000	3800.0					3.00-9.		38.
			14.000	1200.0					3.00-9.	38.	75.
			14.000	960.0					3.00-9.	75.	250.
			14.000	1200.0					3.00-9.	250.	500.
			21.000	3500.0					3.00-9.		38.
			21.000	1400.0	1400.0	42.000	2900.0	2000.0	3.00-9.		500.
			21.000	1300.0					3.00-9.	38.	75.
Cs	room	air	21.000	1100.0					3.00-9.	75.	250.
			21.000	1200.0					3.00-9.	250.	500.
			42.000	1800.0	1800.0	21.000	2100.0	2100.0	3.00-9.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-1982											
Eu	room	air	14.000	1200.0					1.00-7.		38.
			14.000	530.0					1.00-7.	38.	75.
			14.000	610.0					1.00-7.	75.	250.
			14.000	860.0					1.00-7.	250.	500.
			21.000	2500.0					1.00-7.		38.
			21.000	1500.0	1300.0	42.000	6100.0	6500.0	1.00-7.		500.
			21.000	880.0					1.00-7.	38.	75.
			21.000	1300.0					1.00-7.	75.	250.
			21.000	1100.0					1.00-7.	250.	500.
			42.000	2000.0	1900.0	21.000	800.0	6500.0	1.00-7.		500.
Se	room	air	42.000	2.7	2.4				1.80-11.	75.	500.
Sr	room	air	14.000	1200.0					2.00-7.		38.
			14.000	59.0					2.00-7.	38.	75.
			14.000	49.0					2.00-7.	75.	250.
			14.000	51.0					2.00-7.	250.	500.
			21.000	1200.0					2.00-7.		38.
			21.000	430.0	430.0	42.000	340.0	330.0	2.00-7.		500.
			21.000	66.0					2.00-7.	38.	75.
Sr	room	air	21.000	53.0					2.00-7.	75.	250.
			21.000	66.0					2.00-7.	250.	500.
			42.000	450.0	450.0	21.000	310.0	310.0	2.00-7.		500.
U	room	air	42.000	2.5	2.3	42.000		4.1	2.70-6.	75.	500.
<u>Core</u>											
G1-2233											
Ba	room	air	21.000	200000.0	210000.0	42.000	460000.0	100000.0	6.00-6.		500.
			42.000	330000.0	250000.0	21.000	160000.0	220000.0	6.00-6.		500.
Ce	room	air	21.000	840.0	1300.0	42.000	59000.0	14000.0	7.00-8.		500.
			42.000	2100.0	1200.0	21.000	2200.0	4900.0	7.00-8.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-2233											
Cs	room	air	21.000	13000.0	11000.0	42.000	31000.0	29000.0	3.00-9.		500.
			42.000	15000.0	14000.0	21.000	6500.0	25000.0	3.00-9.		500.
Eu	room	air	21.000	520.0	920.0	42.000	3900.0	9400.0	9.00-8.		500.
			42.000	1300.0	890.0	21.000	1700.0	3300.0	9.00-8.		500.
Mn	room	air	14.000	5800.0		28.000	9300.0		2.00-11.		500.
			21.000	6800.0		28.000	10000.0		2.00-11.		500.
			28.000	6400.0					2.00-11.		500.
			28.000	5000.0					2.00-11.		500.
	room	ca	14.000	2600.0	2300.0	28.000	1600.0	1400.0	2.00-11.		500.
			28.000	550.0	710.0	14.000	3400.0	2800.0	2.00-11.		500.
	room	air	14.000	130.0	140.0	28.000	150.0	170.0	2.00- 3.		500.
			28.000	150.0					2.00- 3.		500.
			28.000	140.0					2.00- 3.		500.
Se	room	air	14.000	140.0	150.0	28.000	150.0	170.0	2.00- 3.		500.
			28.000	140.0	160.0	14.000	170.0	130.0	2.00- 3.		500.
			14.000	16.0		28.000	51.0		1.00-9.		500.
			14.000	8.5		28.000	41.0		1.00-9.		500.
	room	ca	28.000	8.7					1.00-9.		500.
			28.000	10.0					1.00-9.		500.
			42.000	1.8	1.7				1.80-11.	75.	500.
			14.000	6.6	21.0	28.000	63.0	72.0	1.00-9.		500.
Sn	room	air	28.000	9.5	18.0	14.000	200.0	58.0	1.00-9.		500.
			56.000	.8	1.2				1.80-10.	75.	500.
			14.000	480.0	840.0	28.000	650.0	500.0	3.00-8.		500.
			28.000	250.0					3.00-8.		500.
			28.000	280.0					3.00-8.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-2233											
		Ca	14.000	190.0	380.0	28.000	480.0	520.0	3.00-8.		500.
			28.000	110.0	170.0	14.000	1300.0	660.0	3.00-8.		500.
Sr	room	air	21.000	40000.0	55000.0	42.000	75000.0	190000.0	1.00-7.		500.
			42.000	49000.0	50000.0	21.000	13000.0	82000.0	1.00-7.		500.
Th	room	air	12.000	266.0	421.0				1.10-7.	75.	500.
U	room	air	42.000	6.0	5.0	42.000	9.1	6.6	2.70-6.	75.	500.
		CO ₂	56.000	17.7	16.1				5.50-6.	75.	500.
<u>Core</u>											
G1-2278											
Mn	room	air	14.000	10000.0	10000.0	28.000	10000.0	10000.0	1.00-11.		500.
<u>Core</u>											
G1-2289											
Ba	room	air	21.000	110000.0					1.00- 7.		38.
			21.000	170000.0					1.00- 7.		38.
			21.000	54000.0					1.00- 7.	38.	106.
			21.000	48000.0					1.00- 7.	38.	106.
			21.000	90000.0					1.00- 7.	106.	500.
			21.000	70000.0					1.00- 7.	106.	500.
Cs	room	air	21.000	43000.0					4.00- 9.		38.
			21.000	27000.0					4.00- 9.		38.
			21.000	34000.0					4.00- 9.	38.	106.
			21.000	29000.0					4.00- 9.	38.	106.
			21.000	72000.0					4.00- 9.	106.	500.
			21.000	12000.0					4.00- 9.	106.	500.
Eu	room	air	21.000	1400.0					2.00- 8.		38.
			21.000	1600.0					2.00- 8.		38.
			21.000	780.0					2.00- 8.	38.	106.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-2289											
			21.000	820.0					2.00- 8.	106.	500.
			21.000	810.0					2.00- 8.	106.	500.
Mn	room	air	28.000	6000.0	7300.0	14.000	>10000.0	>10000.0	1.00-11.	500.	
Na	room	air	14.000	230.0	220.0	28.000	230.0	250.0	3.00-3.		500.
			28.000	230.0	230.0	14.000	260.0	270.0	3.00-3.		500.
Ra	room	air	42.000	70000.0	22000.0				3.60-7.	75.	500.
Se	room	air	14.000	24.0	8.8	28.000	21.0	32.0	8.00-10.		500.
			28.000	10.0	12.0	14.000	58.0	48.0	8.00-10.		500.
			42.000	9.0	8.0				1.00-10.	75.	500.
Sn	room	air	14.000	1100.0	560.0	28.000	1000.0	1000.0	1.00-8.		500.
			28.000	550.0	640.0	14.000	1400.0	1500.0	1.00-8.		500.
Sr	room	air	21.000	12000.0					3.00-8.		38.
			21.000	17000.0					3.00-8.		38.
			21.000	6300.0					3.00-8.	38.	106.
			21.000	6400.0					3.00-8.	38.	106.
			21.000	8400.0					3.00-8.	106.	500.
			21.000	7800.0					3.00-8.	106.	500.
Th	room	air	12.000	140.0	146.0				5.90-8.	75.	500.
U	room	air	42.000	2.5	2.6				5.00-6.	75.	500.
			21.000	820.0					2.00-8	106.	500.
			21.000	810.0					2.00-8	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G1-2333

Ba	room	air	21.000	1900.0		42.000	1700.0		3.00-7.		75.
			21.000	1200.0		42.000	1400.0		3.00-7.	75.	500.
			42.000	1800.0		21.000	1600.0		3.00-7.		75.
			42.000	1100.0		21.000	1100.0		3.00-7.	75.	500.
Cs	room	air	21.000	1700.0		42.000	1400.0		5.00-9.		75.
			21.000	1200.0		42.000	1100.0		5.00-9.	75.	500.
			42.000	1500.0		21.000	1300.0		5.00-9.		75.
			42.000	1100.0		21.000	1000.0		5.00-9.	75.	500.
Eu	room	air	21.000	2000.0		21.000	1200.0		3.00-8.		75.
			21.000	1400.0		42.000	9800.0		3.00-8.	75.	500.
			42.000	3100.0		21.000	11000.0		3.00-8.		75.
			42.000	2900.0		21.000	6800.0		3.00-8.	75.	500.
Sr	room	air	21.000	220.0		42.000	160.0		1.00-6.		75.
			21.000	150.0		42.000	130.0		1.00-6.	75.	500.
			42.000	220.0		21.000	160.0		1.00-6.		75.
			42.000	140.0		21.000	110.0		1.00-6.	75.	500.

Core

G1-2363

Ba	room	air	21.000	920.0					1.00-7.		38.
			21.000	860.0					1.00-7.		38.
			21.000	880.0	830.0	42.000	800.0	870.0	8.00-6.		500.
			21.000	250.0					1.00-7.	38.	106.
			21.000	240.0					1.00-7.	38.	106.
			21.000	210.0					1.00-7.	106.	500.
			21.000	230.0					1.00-7.	106.	500.
			42.000	920.0	930.0	21.000	780.0	830.0	8.00-6.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-2363											
Ce	room	air	21.000	290.0	270.0	42.000	140000.0	120000.0	3.00-8.		500.
			42.000	370.0	310.0	21.000	139999.0	130000.0	3.00-8.		500.
Cs	room	air	21.000	1400.0					4.00-9.		38.
			21.000	1300.0					4.00-9.		38.
			21.000	1300.0	1200.0	42.000	1200.0	1300.0	7.00-9.		500.
			21.000	520.0					4.00-9.	38.	106.
			21.000	550.0					4.00-9.	38.	106.
			21.000	380.0					4.00-9.	106.	500.
			21.000	410.0					4.00-9.	106.	500.
			42.000	1400.0	1400.0	21.000	1200.0	1200.0	7.00-9.		500.
Eu	room	air	21.000	5600.0					5.00-8.		38.
			21.000	5400.0					5.00-8.		38.
			21.000	1300.0	1300.0	42.000	5700.0	450.0	8.00-8.		500.
			21.000	790.0					5.00-8.	38.	106.
			21.000	780.0					5.00-8.	38.	106.
			21.000	580.0					5.00-8.	106.	500.
			21.000	780.0					5.00-8.	106.	500.
			42.000	1900.0	1600.0	21.000	5900.0	6700.0	8.00-8.		500.
Ra	room	air	42.000	480.0	590.0				3.60-7.	75.	500.
Se	room	air	42.000	30.0	19.0	42.000			1.00-10.	75.	500.
Sr	room	air	21.000	180.0					5.00-7.		38.
			21.000	170.0					5.00-7.		38.
			21.000	170.0	180.0	42.000	140.0	160.0	4.00-7.		500.
			21.000	74.0					5.00-7.	38.	106.
			21.000	62.0					5.00-7.	38.	106.
			21.000	58.0					5.00-7.	106.	500.
			21.000	61.0					5.00-7.	106.	500.
			42.000	170.0	170.0	21.000	1400.0	150.0	4.00-7.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G1-2363

Th	room	air	12.000	940.0	1484.0				6.50-8.	75.	500.
U	room	air	42.000	-0.7	0.5				5.00-6.	75.	500.

Core

G1-2410

Ba	room	air	21.000			42.000	3000.0		2.00-7.		75.
			21.000			42.000	1900.0		2.00-7.	75.	500.
			42.000	3000.0		21.000	3000.0		2.00-7.		75.
			42.000	1800.0		21.000	1600.0		2.00-7.	75.	500.
Cs	room	air	21.000	2000.0		42.000	1800.0		4.00-9.		75.
			21.000	1200.0		42.000	1200.0		4.00-9.	75.	500.
			42.000	2000.0		21.000	1800.0		4.00-9.		75.
			42.000	1300.0		1.000	1000.0		4.00-9.	75.	500.
Eu	room	air	21.000	390.0		42.000	10000.0		2.00-8.		75.
			21.000	360.0		42.000	8700.0		2.00-8.	75.	500.
			42.000	440.0		21.000	5700.0		2.00-8.		75.
			42.000	510.0		21.000	3300.0		2.00-8.	75.	500.
Sr	room	air	21.000	280.0		42.000	250.0		4.00-7.		75.
			21.000	170.0		42.000	150.0		4.00-7.	75.	500.
			42.000	280.0		21.000	240.0		4.00-7.		75.
			42.000	170.0		21.000	130.0		4.00-7.	75.	500.

Core

G1-2476

Ba	room	air	21.000	480.0		42.000	3200.0		1.00-7.		75.
			21.000	370.0		42.000	3800.0		1.00-7.	75.	500.
			42.000	520.0		21.000	3500.0		1.00-7.		75.
			42.000	400.0		21.000	3600.0		1.00-7.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core
G1-2476

Cs	room	air	21.000	810.0		42.000	1600.0		5.00-9.		75.
			21.000	660.0		42.000	1500.0		5.00-9.	75.	500.
			42.000	920.0		21.000	1800.0		5.00-9.		75.
			42.000	740.0		21.000	1500.0		5.00-9.	75.	500.
Eu	room	air	21.000	4600.0		42.000	9300.0		6.00-8.		75.
			21.000	3300.0		42.000	15000.0		6.00-8.	75.	500.
			42.000	5100.0		21.000	12000.0		6.00-8.	75.	
			42.000	3100.0		21.000	15000.0		6.00-8.	75.	500.
Sr	room	air	21.000	49.0		42.000	200.0		9.00-7.		75.
			21.000	41.0		42.000	210.0		9.00-7.	75.	50.
			42.000	51.0		21.000	220.0		9.00-7.		75.
			42.000	40.0		21.000	200.0		9.00-7.	75.	500.

Core
G1-2689

U	room	air	42.000	4.2	4.5	42.000	1.3	1.7	2.70-6.	75.	500.
Ba	room	air	21.000	61000.0	56000.0	42.000	47000.0	390000.0	8.00-6.		500.
			42.000	77000.0	58000.0	21.000	62000.0	270000.0	8.00-6.		500.
Ce	room	air	21.000	220.0	170.0	42.000	2800.0	2400.0	1.00-7.		500.
			42.000	270.0	310.0	21.000	1600.0	1200.0	1.00-7.		500.
Cs	room	air	21.000	8200.0	7400.0	42.000	15000.0	16000.0	5.00-9.		500.
			42.000	8500.0	6600.0	21.000	20000.0	17000.0	5.00-9.		500.
Eu	room	air	21.000	180.0	130.0	42.000	2100.0	1900.0	4.00-7.		500.
			42.000	230.0	260.0	21.000	1000.0	850.0	4.00-7.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtype	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-2689											
Se	room	CO ₂	42.000	2.82	2.59				1.90-9	75.	500.
Sr	room	air	21.000	49000.0	39000.0	42.000	200000.0	170000.0	2.00-7.		500.
			42.000	43000.0	37000.0	21.000	350000.0	130000.0	2.00-7.		500.
U	room	CO ₂	42.000	17.9	18.6				1.07-6	75.	500.
<u>Core</u>											
G1-2840											
Ba	room	air	21.000	2300.0		42.000	2700.0		2.00-7.		75.
			21.000	2000.0		42.000	2300.0		2.00-7.	75.	500.
			42.000	2600.0		21.000	2800.0		2.00-7.		75.
			42.000	2100.0		21.000	2300.0		2.00-7.	75.	500.
Cs	room	air	21.000	49.0	45.0				6.30-5.	75.	500.
			21.000	65.0	68.0				1.60-5.	75.	500.
			21.000	24.0	25.0				6.30-4.	75.	500.
			21.000	182.0	179.0				1.60-6.	75.	500.
			21.000	371.0	366.0				6.30-7.	75.	500.
			21.000	942.0	961.0				1.30-7.	75.	500.
			21.000	1330.0	1580.0				6.98-9.	75.	500.
			21.000	1430.0	1130.0				1.80-9.	75.	500.
			21.000	19.0	21.0				1.30-3.	75.	500.
			21.000	78.0	81.0				6.30-6.	75.	500.
			21.000	31.0	32.0				1.60-4.	75.	500.
			21.000	1170.0	1060.0				6.30-8.	75.	500.
			21.000	2800.0		42.000	2500.0		5.00-9.		75.
			21.000	2400.0		42.000	2000.0		5.00-9.	75.	500.
			42.000	2500.0		21.000	2500.0		5.00-9.		75.
			42.000	2000.0		21.000	2100.0		5.00-9.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-2840											
Eu	room	air	21.000	5000.0		42.000	12000.0		3.00-8.		75.
			21.000	4500.0		42.000	8000.0		3.00-8.	75.	500.
			42.000	6200.0		21.000	7900.0		3.00-8.		75.
			42.000	5300.0		21.000	7900.0		3.00-8.	75.	500.
Se	room	air	42.000	2.8	3.4				1.80-11.	75.	500.
		CO ₂	56.000	1.5	1.9				1.80-10.	75.	500.
Sn	room	air	42.000	124.0	442.0	42.000	910.0	650.0	2.00-8.	75.	500.
Sr	room	air	21.000	61.7	61.2				2.80-6.	75.	500.
			21.000	9.2	9.7				1.40-3.	75.	500.
			21.000	39.5	38.1				2.10-4.	75.	500.
			21.000	47.0	51.0				7.70-5.	75.	500.
			21.000	30.5	30.7				3.30-4.	75.	500.
			21.000	55.3	56.4				2.40-5.	75.	500.
			21.000	56.7	57.1				1.20-5.	75.	500.
			21.000	59.0	57.0				8.10-7.	75.	500.
Sr	room	air	21.000	21.9	19.9				6.00-4.	75.	500.
			21.000	14.8	15.9				8.50-4.	75.	500.
			21.000	46.6	47.3				8.30-5.	75.	500.
			21.000	59.6	63.6				1.40-6.	75.	500.
			21.000	170.0		42.000	150.0		1.00-6.		75.
			21.000	160.0		42.000	130.0		1.00-6.	75.	500.
			42.000	170.0		21.000	160.0		1.00-6.		75.
			42.000	159.0		21.000	130.0		1.00-6.	75.	500.
Th	room	CO ₂	42.000	3900	2600				2.20-7	75.	500.
U	room	air	42.000	0.3	0.7	42.000			2.70-6.	75.	500.
		CO ₂	56.000	3.9	4.5				5.50-6.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G1-2854

Ba	room	air	21.000	1600.0		42.000	3700.0		1.00-7.		75.
			21.000	950.0		42.000	1300.0		1.00-7.	75.	500.
			42.000	6500.0		21.000	1600.0		1.00-7.		75.
			42.000	1000.0		21.000	1300.0		1.00-7.	75.	500.
Cs	room	air	21.000	1700.0		42.000	1900.0		5.00-9.		75.
			21.000	1200.0		42.000	1100.0		5.00-9.	75.	500.
			42.000	510.0		21.000	1300.0		5.00-9.		75.
			42.000	950.0		21.000	1200.0		5.00-9.	75.	500.
Eu	room	air	21.000	1100.0		42.000	7200.0		2.00-8.		75.
			21.000	1100.0		42.000	4800.0		2.00-8.	75.	500.
			42.000	2600.0		21.000	3100.0		2.00-8.		75.
			42.000	1500.0		21.000	5200.0		2.00-8.	75.	500.
Sr	room	air	21.000	120.0		42.000	130.0		5.00-7.		75.
			21.000	94.0		42.000	96.0		5.00-7.	75.	500.
			42.000	60.0		21.000	92.0		5.00-7.		75.
			42.000	93.0		21.000	97.0		5.00-7.	75.	500.

Core

G1-2901

Ba	room	air	21.000	1900.0	1200.0	42.000	1900.0	2000.0	1.00-6.		500.
			42.000	1900.0	1900.0	21.000	2000.0	2000.0	1.00-6.		500.
Ce	room	air	21.000	40000.0	35000.0	42.000	38000.0	40000.0	9.00-9.		500.
			42.000	45000.0	49000.0	21.000	37000.0	40000.0	9.00-9.		500.
Cs	room	air	21.000	1400.0	950.0	42.000	1300.0	1400.0	6.00-9.		500.
			42.000	1400.0	1400.0	21.000	1400.0	1400.0	6.00-9.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G1-2901

Eu	room	air	21.000	195000.0	230000.0	42.000	220000.0	200000.0	4.00-8.		500.
			42.000	210000.0	210000.0	21.000	210000.0	200000.0	4.00-8.		500.
Mn	room	air	14.000	>10000.0	>10000.0	28.000	>10000.0	>10000.0	1.00-11.		500.
			28.000	>10000.0	>10000.0	14.000	>10000.0	>10000.0	1.00-11.		500.
Na	room	air	14.000	3.5	1.4	28.000	5.5	5.5	2.00-3.		500.
			28.000	3.7	4.5	14.000	6.9	6.5	2.00-3.		500.
Se	room	air	14.000	7.3	10.0	28.000	64.0	69.0	8.00-10.		500.
			28.000	4.0	13.0	14.000	94.0	69.0	8.00-10		500.
	room	CO ₂	42.000	7.22	5.76				1.90-9	75.	500.
Sn	room	air	42.000	16800.0	26700.0	42.000	30100.0	45700.0	1.00-7.	75.	500.
			14.000	>10000.0	>10000.0	28.000	>10000.0	>10000.0	6.00-9.		500.
			28.000	>10000.0	>10000.0	14.000	>10000.0	>10000.0	6.00-9.		500.
Sr	room	air	21.000	68.0	66.0	42.000	67.0	66.0	1.00-6.		500.
			42.000	69.0	71.0	21.000	69.0	740.0	1.00-6.		500.
Th	room	CO ₂	42.00	3700	3400				1.60-7	75.	500.
U	room	CO ₂	42.000	4.75	4.03				1.07-6	75.	500.

Core

G1-3116

Ba	room	air	21.000	120000.0	130000.0	42.000	23000.0	709999.0	9.00-6.		500.
			42.000	120000.0	130000.0	21.000	280000.0	190000.0	9.00-6.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-3116											
Ce	room	air	21.000	89.0	80.0	42.000	180.0	5600.0	1.00-7.		500.
			42.000	100.0	120.0	21.000	4200.0	3100.0	1.00-7.		500.
Cs	room	air	21.000	7600.0	7000.0	42.000	6200.0	21000.0	5.00-9.		500.
			42.000	5500.0	6200.0	21.000	7900.0	8500.0	5.00-9.		500.
Eu	room	air	21.000	680.0	660.0	42.000	600.0	1400.0	2.00-7.		500.
			42.000	790.0	900.0	21.000	9400.0	8900.0	2.00-7.		500.
Se	room	air	42.000	3.4	3.2				1.80-11.	75.	500.
		CO ₂	56.000	2.8	2.9				1.80-10.	75.	500.
Sr	room	air	21.000	2500.0	2500.0	42.000	3100.0	58000.0	2.00-7.		500.
			42.000	2200.0	2400.0	21.000	3500.0	32000.0	2.00-7.		500.
Th	room	CO ₂	42.000	20900	26700				1.10-7	75.	500.
U	room	air	42.000	3.9	3.6	42.000	1.4	1.9	2.70-6.	75.	500.
<u>Core</u>											
G1-3658											
Ba	room	air	21.000	120000.0					9.00-6.		38.
			21.000	190000.0					9.00-6.		38.
			21.000	8700.0	12000.0	42.000	3100.0	16000.0	9.00-6.		500.
			21.000	100000.0					9.00-6.	38.	106.
			21.000	90000.0					9.00-6.	38.	106.
			21.000	130000.0					9.00-6.	106.	500.
			21.000	140000.0					9.00-6.	106.	500.
			42.000	12000.0	9000.0	21.000	19000.0	2100.0	9.00-6.		500.
Ce	room	air	21.000	640.0	630.0	42.000	790.0	6800.0	2.00-7.		500.
			42.000	1500.0	1300.0	21.000	16000.0	14000.0	2.00-7.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G1-3658											
Cs	room	air	21.000	180000.0					7.00-9.		38.
			21.000	140000.0					8.00-9.		38.
			21.000	7800.0	8200.0	42.000	18000.0	10000.0	7.00-9.		500.
			21.000	61000.0					7.00-9.	38.	106.
			21.000	70000.0					7.00-9.	38.	106.
			21.000	49000.0					7.00-9.	106.	500.
			21.000	50000.0					7.00-9.	106.	500.
			42.000	8500.0	7700.0	21.000	10000.0	11000.0	7.00-9.		500.
Eu	room	air	21.000	150000.0					4.00-7.		38.
			21.000	160000.0					4.00-7.		38.
			21.000	510.0	490.0	42.000	700.0	6700.0	4.00-7.		500.
			21.000	4100.0					4.00-7.	38.	106.
			21.000	4800.0					4.00-7.	38.	106.
			21.000	4900.0					4.00-7.	106.	500.
			21.000	5700.0					4.00-7.	106.	500.
			42.000	1200.0	1000.0	21.000	15000.0	12000.0	4.00-7.		500.
Sr	room	air	21.000	98000.0					3.00-7.		38.
			21.000	160000.0					3.00-7.		38.
			21.000	10000.0	14000.0	42.000	3500.0	14000.0	3.00-7.		500.
			21.000	140000.0					3.00-7.	38.	106.
			21.000	120000.0					3.00-7.	38.	106.
			21.000	130000.0					3.00-7.	106.	500.
			21.000	130000.0					3.00-7.	106.	500.
			42.000	12000.0	11000.0	21.000	14000.0	17000.0	3.00-7.		500.
<u>Core</u>											
G2-0547											
Am	room	air	42.000	13000.0	13000.0	42.000	18500.0	16000.0	7.50-8.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
G2-0547											
Ba	room	air	42.000	3460.0	3520.0	42.000	3069.0	2740.0	7.30-8.		500.
Cs	room	air	42.000	11900.0	14800.0	42.000	9450.0	8360.0	4.80-9.		500.
Eu	room	air	42.000	360.0	414.0	42.000	1070.0	2330.0	5.90-8.		500.
Pu	room	air	42.000	1100.0	1300.0	42.000	1100.0	1300.0	4.80-8.	75.	500.
Se	room	air	42.000	3.0	1.0				1.00-10.	75.	500.
Sr	room	air	42.000	256.0	275.0	42.000	217.0	195.0	2.60-6.		500.
Tc	room	air	42.000	0.031	-0.056	42.000	0	0	1.90-11.		500.
U	room	air	42.000	9.4	9.5			5.00-6.		75.	500.
<u>Core</u>											
G2-0723											
Am	room	air	42.000	930000.0	840000.0	42.000	>999999.0	>999999.0	9.30-8.	75.	500.
Ba	room	air	42.000	3930.0	3080.0	42.000	4200.0	4217.0	7.00-8.		500.
Cs	room	air	42.000	4620.0	3530.0	42.000	4280.0	4276.0	5.00-9.		500.
Eu	room	air	42.000	10000.0	10000.0	42.000	10000.0	10000.0	3.00-8.		500.
Pu	room	air	42.000	4500.0	4500.0	42.000	4700.0	4700.0	7.00-9.	75.	500.
Se	room	air	42.000	20.0	17.0				1.00-10.	75.	500.
Sr	room	air	42.000	326.0	248.0	42.000	326.0	332.0	2.00-6.		500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G2-0723

Tc	room	air	42.000	0.020	-0.008	42.000	0	0	2.00-11.		500.
U	room	air	42.000	1.8	2.9				5.00-6.	75.	500.

Core

G2-1952

Am	room	air	42.000	1700.0	1500.0	42.000	7100.0	8100.0	1.40-7.	75.	500.
			42.000	1850.0	1700.0	42.000	4000.0	3800.0	1.40-7.	75.	500.
Ba	room	air	42.000	21500.0	28700.0	42.000	46050.0	34400.0	7.00-8.		500.
Cs	room	air	42.000	61300.0	63400.0	42.000	47070.0	44650.0	5.00-9.		500.
Eu	room	air	42.000	75.0	103.0	42.000	1770.0	1470.0	7.00-8.		500.
Np	room	air	42.000	2.8	2.6	42.000	17.0	13.0	7.10-9.	75.	500.
Pu	room	air	42.000	72.0	80.0	42.000	460.0	380.0	3.20-8.	75.	500.
			42.000	57.0	55.0	42.000	310.0	250.0	3.20-8.	75.	500.
Se	room	air	42.000	2.0	1.0				1.00-10.	75.	500.
Sr	room	air	42.000	1940.0	2560.0	42.000	4390.0	4080.0	2.00-6.		500.
Tc	room	air	42.000	-0.039	0.022				2.00-11.	75.	500.
U	room	air	42.000	-0.7	0.6				5.00-6.	75.	500.

Core

G2-2017

Se	room	air	42.00	1.42	1.12				1.90-9	75.	500.
		CO ₂	42.000	4.97	4.48				1.90-9	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G2-2017

Th	room	CO ₂	42.00	2000	4400				1.00-7	75.	500.
U	room	CO ₂	42.000	4.99	5.32				1.07-6	75.	500.

Core

G2-3933

Am	room	air	42.000	7000.0	6200.0	42.000	12000.0	11000.0	8.80-8.	75.	500.
Ba	room	air	42.000	1240.0	2220.0	42.000	905.0	1300.0	6.00-8.		500.
Cs	room	air	42.000	1580.0	3490.0	42.000	1105.0	1750.0	5.00-9.		500.
Eu	room	air	42.000	887.0	2230.0	42.000	1950.0	4060.0	6.00-8.		500.
Pu	room	air	42.000	1600.0	1600.0	42.000	650.0	330.0	4.10-8.	75.	500.
Sr	room	air	42	192.0	299.0	42.000	117.0	164.0	2.00-6.		500.
Tc	room	air	42	0.042	0.167	42.000	0	0		7.5	500.
U	room	air	42.000	-1.4	0.9					75.	500.

Core

G4-1502

Am	room	air	.042	470.0	510.0				1.30-8.	75.	500.
			.167	720.0	710.0				1.30-8.	75.	500.
			1.000	1000.0	1200.0				1.30-8.	75.	500.
			2.000	1200.0	1200.0				1.30-8.	75.	500.
			3.000	1500.0	1400.0				1.30-8.	75.	500.
			7.000	1800.0	2000.0				1.30-8.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

G4-1502

Np	room	air	42	4.6	4.8	42.000	13.0	10.0	1.00-10.	75.	500.
			91	5.2	3.6				1.00-10.	75.	500.
			182	5.2	5.2				1.00-10.	75.	500.
			273	5.7	5.5				1.00-10.	75.	500.
			368	5.8	5.8				1.00-10.	75.	500.
			460	5.8	5.8				1.00-10.	75.	500.
Pu	room	air	.042	19.0	20.0				3.10-8.	75.	500.
			.167	24.0	21.0				3.10-8.	75.	500.
			1.000	26.0	28.0				3.10-8.	75.	500.
			2.000	36.0	31.0				3.10-8.	75.	500.
			3.000	31.0	38.0				3.10-8.	75.	500.
			7.000	36.0	37.0				3.10-8.	75.	500.
			21.000	34.0	34.0				3.10-8.	75.	500.
			42.000	44.0	43.0				3.10-8.	75.	500.
Sn	room	air	42.000	159.0	271.0	42.000	503.0	492.0	3.00-8.	75.	500.
Tc	room	air	42.000	0.042	-0.003				8.00-10.	75.	500.
			91.000	0.06	-0.038				8.00-10.	75.	500.
			182.000	-0.085	-0.09				8.00-10.	75.	500.
			273.000	-0.06	-0.05				8.00-10.	75.	500.
			366.000	0.001	-0.015				8.00-10.	75.	500.
			480.000	-0.08	-0.03				8.00-10.	75.	500.

Core

G4-1608

Np	room	air	42	6.1	6.6				3.50-11.	75.	500.
		CO ₂	42	4.7					7.60-6.	75.	500.
			42	5.2	5.5				2.70-11.	75.	500.
			42	2.0	2.7				6.60-4.	75.	500.

	Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>												
G4-1608												
	Np	room	CO ₂	42	5.2	4.7				7.50-7.	75.	500.
				42	3.4	3.1				3.40-5.	75.	500.
				42	1.3	0.58				3.00-4.	75.	500.
				42	4.4	5.9				3.90-7.	75.	500.
				42	4.5	5.4				3.70-6.	75.	500.
				42	3.5	3.2				6.70-5.	75.	500.
				42	4.8					7.50-8.	75.	500.
				42	6.0	4.7				3.90-8.	75.	500.
				42	3.0	7.8				4.30-9.	75.	500
	Pa	room	CO ₂	42	5.3	10.1				5.00-13.	75.	500.
				42	3.8	4.1				1.00-12.	75.	500.
				42	3.3	4.1				5.00-14.	75.	500.
				42	5.0	5.0				5.00-12.	75.	500.
				42	3.4	5.3				1.00-11.	75.	500.
				42	8.4	8.0				1.00-13.	75.	500.
	Se	room	air	42	14.8	15.7				1.90-9	75.	500.
			CO ₂	42	3.46	3.16				1.90-9	75.	500.
	Th	room	CO ₂	42	17900	22700				1.50-7	75.	500.
	U	room	air	42	12.6	11.4				1.07-6	75.	500.
			CO ₂	42	20.5	22.2				1.07-6	75.	500.
<u>Core</u>												
GU3-0433												
	Am	room	air	42	3300.0	2900.0	42.000	9500.0	6000.0	2.10-7.	75.	500.
				42	3500.0	3800.0	42.000	7800.0	14000.0	2.10-7.	75.	500.
				85°.	air	42	2100.0	4200.0	42.000	6700.0	3500.0	2.10-7.

	Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>												
GU3-0433	Ba	room	air	42	392.0	290.0	42.000	508.0	413.0	3.00-8.	75.	500.
				42	708.0	912.0	42.000	450.0	486.0	3.00-8.	75.	500.
	Cs	room	air	42	613.0	651.0	42.000	482.0	576.0	3.00-9.	75.	500.
				42	436.0	370.0	42.000	531.0	499.0	3.00-9.	75.	500.
	Eu	room	air	42	55.0	82.0	42.000	166.0	138.0	9.00-8.	75.	500.
				42	86.0	113.0	42.000	103.0	144.0	9.00-8.	75.	500.
	Np	room	air	42	7.9	7.8	42.000	23.0	21.0	7.50-11.	75.	500.
				42	13.0	14.0				3.00-11.	75.	500.
			CO ₂	42	0.82	0.67				8.2-12.	75.	500.
				42	9.6	2.6				2.3-8	75.	500.
				42	6.2	6.1				4.4-8	75.	500.
				42	5.5	4.3				2.4-7	75.	500.
				42	5.3	5.1				5.0-7	75.	500.
				42	4.6	5.0				2.2-6	75.	500.
				42	3.4	4.9				4.3-6	75.	500.
				42	0.60	0.17				2.1-5	75.	500.
				42	2.6	1.6				4.8-5	75.	500.
	Pu	room	air	42	340.0	500.0	42	960.0	810.0	2.60-8.	75.	500.
				42	240.0	240.0	42	100.0	890.0	2.60-8.	75.	500.
		85°.	air	42	1700.0	1800.0	42	4500.0	7800.0	2.60-8.	75.	500.
	Sr	room	air	42	56.0	66.0	42	39.0	49.0	2.00-6.	75.	500.
				42	31.6	28.2	42	36.0	32.0	2.00-6.	75.	500.
	Tc	room	air	42	0.05	-0.004					75.	500.
	U	room	air	42	-0.7	-1.1					75.	500.

	Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>												
GU3-0855												
	Se	room	air	42	10 (4)						75.	500.
	U	room	air	42	10 (0.1)						75.	500.
<u>Core</u>												
GU3-0916												
	Np	room	air	42	4.8	4.9	42.000	35.0	32.0	6.00-11.	75.	500.
				91	5.1	5.4				6.00-11.	75.	500.
				182	5.6	5.2				6.00-11.	75.	500.
				273	5.1	5.1				6.00-11.	75.	500.
				366	6.8	6.8				6.00-11.	75.	500.
				457	7.2	9.6				6.00-11.	75.	500.
	Pu	room	air	42	280.0	230.0	42.000	720.0	640.0	1.00-7.	75.	500.
				42	190.0	180.0	42.000	280.0	240.0	9.50-8.	75.	500.
	Tc	room	air	42	0.50	0.94				6.00-10.	75.	500.
				91	0.33	1.3				6.00-10.	75.	500.
				183	0.81	0.44				6.00-10.	75.	500.
				273	0.14	0.11				6.00-10.	75.	500.
				366	0.13	0.32				6.00-10.	75.	500.
				480	0.08	0.17				6.00-10	75.	500.
<u>Core</u>												
GU3-1203												
	Am	room	air	42	1400.0	1200.0	42	900.0	1800.0	2.10-7.	75.	500.
				42	860.0	970.0	42	990.0	1400.0	2.10-7.	75.	500.
		85°.	air	42,	4200.0	4300.0	42	7200.0	10500.0	2.10-7.	75.	500.
	Ba	room	air	42	600.0	42		750.0	700.0	4.00-8.	75.	500.

	Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>												
GU3-1203												
	Cs	room	42	380.0	330.0	42		450.0	330.0	4.00-9.	75.	500.
	Eu	room	air	42.000	190.0	192.0	42.000	610.0	700.0	9.00-8.	75.	500.
	Np	room	air	42.000	2.8	2.6	42.000	42.0	57.0	7.70-11.	75.	500.
42.000				0.5	0.5				3.00-11.	75.	500.	
CO ₂				42.000	0.4	0.4			2.00-11.	75.	500.	
	Pu	room	air	42.000	330.0	480.0	42.000	920.0	880.0	2.40-8.	75.	500.
42.000				300.0	340.0	42.000	920.0	950.0	2.40-8.	75.	500.	
		85°.	air	42.000	440.0	940.0	42.000	620.0	830.0	2.40-8.	75.	500.
	Se	room	CO ₂	42.000	1.73	2.21				1.90-9	75.	500.
	Sr	room	air	42.000	43.0	42.0	42.000	48.0	46.0	1.00-6.	75.	500.
	Tc	room	air	42.000	0.02	-0.03				1.00-11.	75.	500.
	Th	room	CO ₂	42.000	2000	1700				9.70-8	75.	500.
	U	room	air	42.000	-3.3	-1.9					75.	500.
			CO ₂	42.000	2.98	5.35				1.07-6	75.	500.
<u>Core</u>												
GU3-1301												
	Am	room	air	42.000	1600.0	1400.0	42.000	3800.0	3200.0	2.40-7.	75.	500.
				42.000	2000.0	2050.0	42.000	1500.0	1500.0	2.40-7.	75.	500.
	Am	85°.	air	42.000	8600.0	11000.0	42.000	23000.0	19000.0	2.40-7.	75.	500.
	Ba	room	air	42.000	512.0	629.0	42.000	757.0	562.0	3.00-8.	75.	500.
				42.000	370.0	460.0	42.000	596.0	780.0	3.00-8.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
GU3-1301											
Cs	room	air	42.000	109.0	135.0	42.000	159.0	211.0	3.00-9.	75.	500.
			42.000	125.0	195.0	42.000	216.0	153.0	3.00-9.	75.	500.
Eu	room	air	42.000	64.0	87.0	42.000	147.0	75.0	1.00-7.	75.	500.
			42.000	31.0	44.0	42.000	51.0	131.0	1.00-7.	75.	500.
Np	room	air	42.000	5.2	4.9	42.000	41.0	37.0	7.10-11.	75.	500.
			42.000	1.8	1.7	42.000	18.0	18.0	2.30-11.	75.	500.
			91.000	2.1	1.9				6.00-11.	75.	500.
			91.000	2.3	2.1	42.000	23.0	26.0	6.00-11.	75.	500.
			188.000	2.2	2.3				6.00-11.	75.	500.
			288.000	1.9	1.8				6.00-11.	75.	500.
			369.000	2.1	2.0				6.00-11.	75.	500.
			476.000	2.4	2.4				6.00-11.	75.	500.
		CO ₂	42.000	2.1	2.1	42.000	31.0	26.0	2.50-11.	75.	500.
Pu	room	air	42.000	380.0	330.0	42.000	1800.0	2400.0	4.60-8.	75.	500.
			42.000	200.0	250.0	42.000	560.0	600.0	4.60-8.	75.	500.
	85°.	air	42.000	2500.0	7600.0	42.000	1300.0	1600.0	4.60-8.	75.	500.
Sn	room	air	42.000	160.0	175.0	42.000	1100.0	1460.0	2.00-8.	75.	500.
Sr	room	air	42.000	23.0	25.0	42.000	28.0	88.0	2.00-6.	75.	500.
			42.000	25.0	40.0	42.000	110.0	76.0	2.00-6.	75.	500.
Tc	room	air	42.000	0.058	0.022				7.00-10.	75.	500.
			91.000	0.065	0.002				7.00-10.	75.	500.
			182.000	-0.003	0.004				7.00-10.	75.	500.
			273.000	0.013	0.031				7.00-10.	75.	500.
			366.000	0.17	0.30				7.00-10.	75.	500.
			480.000	0.04	0.20				7.00-10.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
GU3-1301											
U	room	air	42.000	-1.7	-1.7					75.	500.
<u>Core</u>											
GU3-1436											
Se	room	air	42.000	3 (0)						75.	500.
U	room	air	42.000	20 (2)						75.	500.
<u>Core</u>											
GU3-1531											
Se	room	air	5 (1)							75.	500.
U	room	air	42.000	54 (9)						75.	500.
<u>Core</u>											
GU3-1937											
U	room	air	42.000	10.0	9.9	42.000	7.2	9.8	2.70-6.	75.	500.
<u>Core</u>											
JA-08											
Ba	room	air				21.000	560.0	520.0	1.00-9.	75.	500.
			21.000	400.0	420.0	84.000	520.0		1.00-9.	75.	500.
			42.000	470.0	450.0	42.000	270.0	580.0	1.00-9.	75.	500.
Cs	room	air				21.000	4400.0	4500.0	6.00-9.	75.	500.
			21.000	2400.0	2200.0	84.000	3600.0	6.00-9.		75.	500.
			42.000	2600.0	3800.0	42.000	6200.0	4600.0	6.00-9.	75.	500.
Eu	room	air				21.000	17000.0	17000.0	3.00-10.	75.	500.
			21.000	2100.0	1800.0	84.000	4000.0		3.00-10.	75.	500.
			42.000	2900.0	1700.0	42.000	5600.0	5600.0	3.00-10.	75.	500.
Sr	room	air				21.000	340.0	320.0	2.00-11.	75.	500.
			21.000	260.0	270.0	84.000	300.0		2.00-11.	75.	500.
			42.000	290.0	270.0	42.000	270.0	320.0	2.00-11.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-18											
Am	room	air	7.000	310.0		63.000	810.0		4.00-7.	106.	150.
			7.000	250.0					4.00-7.	106.	150.
			7.000	96.0					4.00-7.	106.	150.
			7.000	200.0		14.000	270.0		4.00-7.	106.	150.
			14.000	310.0		63.000	710.0		4.00-7.	106.	150.
			14.000	86.0		35.000	440.0		4.00-7.	106.	150.
			28.000	360.0		63.000	790.0		4.00-7.	106.	150.
			28.000	220.0					4.00-7.	106.	150.
			28.000	120.0					4.00-7.	106.	150.
			28.000	200.0		35.000	1200.0		4.00-7.	106.	150.
			56.000	100.0		35.000	2000.0		4.00-7.	106.	150.
			56.000	85.0		63.000	2300.0		4.00-7.	106.	150.
			56.000	85.0					4.00-7.	106.	150.
			56.000	57.0					4.00-7.	106.	150.
Ba	room	air				98.000	40000.0		2.00-7.	106.	150.
						98.000	34000.0		2.00-7.	355.	500.
			14.000	3100.0		21.000	24000.0		2.00-7.	106.	150.
			14.000	3100.0		21.000	24000.0		2.00-7.	106.	150.
			14.000	2300.0		21.000	8600.0		2.00-7.	355.	500.
			21.000	96000.0		84.000	240000.0		8.00-10.	75.	500.
			21.000	4500.0		35.000	38000.0		2.00-7.	106.	150.
			21.000	4500.0		35.000	38000.0		2.00-7.	106.	150.
			21.000	3300.0		35.000	23000.0		2.00-7.	355.	500.
			42.000	110000.0		63.000	220000.0		8.00-10.	75.	500.
			42.000	4700.0					2.00-7.	106.	150.
			42.000	7100.0					2.00-7.	355.	500.
			77.000	6600.0					2.00-7.	106.	150.
			77.000	7100.0					2.00-7.	355.	500.
			84.000	170000.0		21.000	370000.0		8.00-10.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

JA-18

Ba	70°.	air				98.000	110000.0		2.00-7.	106.	150.
						98.000	170000.0		2.00-7.	355.	500.
			14.000	23000.0		14.000	70000.0		2.00-7.	106.	150.
			14.000	35000.0		14.000	91000.0		2.00-7.	355.	500.
			21.000	29000.0		21.000	100000.0		2.00-7.	106.	150.
			21.000	40000.0		21.000	67000.0		2.00-7.	355.	500.
			35.000	64000.0		42.000	100000.0		2.00-7.	106.	150.
			35.000	75000.0		42.000	150000.0		2.00-7.	355.	500.
			63.000	64000.0					2.00-7.	106.	150.
			63.000	61000.0					2.00-7.	355.	500.
Ce	room	air				98.000	440.0		1.00-6.	106.	150.
						98.000	130.0		1.00-6.	355.	500.
			14.000	26.0		21.000	120.0		1.00-6.	106.	150.
			14.000	20.0		21.000	36.0		1.00-6.	355.	500.
			21.000	1400.0		84.000	2000.0		8.00-13.	75.	500.
			21.000	46.0		35.000	250.0		1.00-6.	106.	150.
			21.000	26.0		35.000	110.0		1.00-6.	355.	500.
			42.000	5700.0		63.000	1100.0		8.00-13.	75.	500.
			42.000	43.0					1.00-6.	106.	150.
			42.000	41.0					1.00-6.	355.	500.
			77.000	78.0					1.00-6.	106.	150.
			77.000	70.0					1.00-6.	355.	500.
			84.000	1300.0					8.00-13.	75.	500.
	70°.	air				98.000	550.0		9.00-7.	106.	150.
						98.000	300.0		9.00-7.	355.	500.
			14.000	40.0		14.000	160.0		9.00-7.	106.	150.
			14.000	40.0		14.000	240.0		9.00-7.	355.	500.
			21.000	36.0		21.000	350.0		9.00-7.	106.	150.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-18											
Ce	70°	air	21.000	45.0		21.000	120.0		9.00-7.	355.	500.
			34.000	46.0		42.000	230.0		9.00-7.	106.	150.
			35.000	40.0		42.000	220.0		9.00-7.	355.	500.
			63.000	51.0					9.00-7.	106.	150.
			63.000	42.0					9.00-7.	355.	500.
Cs	room	air				98.000	15000.0		1.00-8.	106.	150.
						98.000	15000.0		1.00-8.	355.	500.
			14.000	12000.0		21.000	22000.0		1.00-8.	106.	150.
			14.000	10000.0		21.000	16000.0		1.00-8.	355.	500.
			21.000	16000.0		84.000	19000.0		3.00-9.	75.	500.
			21.000	13000.0		35.000	18000.0		1.00-8.	106.	150.
			21.000	10000.0		35.000	17000.0		1.00-8.	355.	500.
			42.000	15000.0		63.000	17000.0		3.00-9.	75.	500.
			42.000	17000.0					1.00-8.	106.	150.
			42.000	19000.0					1.00-8.	355.	500.
			77.000	20000.0					1.00-8.	106.	150.
			77.000	19000.0					1.00-8.	355.	500.
			84.000	18000.0		21.000	19000.0		3.00-9.	75.	500.
	70°.	air				98.000	17000.0		1.00-8.	106.	150.
						98.000	26000.0		1.00-8.	355.	500.
			14.000	13000.0		14.000	14000.0		1.00-8.	106.	150.
			14.000	21000.0		14.000	22000.0		1.00-8.	355.	500.
			21.000	21000.0		21.000	17000.0		1.00-8.	106.	150.
			21.000	18000.0		21.000	21000.0		1.00-8.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-18											
Cs	70°	air	35.000	16000.0		42.000	17000.0		1.00-8.	106.	150.
			35.000	19000.0		42.000	21000.0		1.00-8.	355.	500.
			63.000	17000.0					1.00-8.	106.	150.
			63.000	19000.0					1.00-8.	355.	500.
Eu	room	air				98.000	350.0		6.00-7.	106.	150.
						98.000	140.0		6.00-7.	355.	500.
			14.000	14.0		21.000	120.0		6.00-7.	106.	150.
			14.000	14.0		21.000	30.0		6.00-7.	355.	500.
			21.000	1700.0		84.000	3000.0		1.00-10.	75.	500.
			21.000	1700.0		84.000	3000.0		1.00-10.	75.	500.
			21.000	30.0		35.000	210.0		6.00-7.	106.	150.
			21.000	18.0		35.000	74.0		6.00-7.	355.	500.
			42.000	1100.0		63.000	2300.0		1.00-10.	75.	500.
			42.000	32.0					6.00-7.	106.	150.
			42.000	26.0					6.00-7.	355.	500.
			77.000	66.0					6.00-7.	106.	150.
			77.000	37.0					6.00-7.	355.	500.
			84.000	1400.0		21.000	2100.0		1.00-10.	75.	500.
	70°	air				98.000	840.0		3.00-7.	355.	500.
			14.000	63.0		14.000	280.0		3.00-7.	106.	150.
			14.000	61.0		14.000	440.0		3.00-7.	355.	500.
			21.000	76.0		21.000	780.0		3.00-7.	106.	150.
			21.000	62.0		21.000	260.0		3.00-7.	355.	500.
			35.000	110.0		42.000	680.0		3.00-7.	106.	150.
			35.000	76.0		42.000	500.0		3.00-7.	355.	500.
			63.000	130.0					3.00-7.	106.	150.
			63.000	89.0					3.00-7.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-18											
I	room	air	21.000	-1.5					1.00-13.	355.	500.
			28.000	-0.5					1.00-13.	355.	500.
Mo	room	air	21.000	4.3					1.00-14.	355.	500.
Pu	room	air	7.000	170.0	70.0	14.000	160.0		4.00-7.	106.	150.
			14.000	110.0		14.000	710.0		1.00-13.	106.	150.
			28.000	81.0					4.00-7.	106.	150.
			28.000	120.0		14.000	450.0		1.00-13.	106.	150.
			56.000	68.0					4.00-7.	106.	150.
			56.000	220.0		21.000	97.0		1.00-13.	106.	150.
Ru	room	air	21.000	67.0					3.00-12.	355.	500.
			28.000	32.0					3.00-12.	355.	500.
Sb	room	air	21.000	-0.9					6.00-12.	355.	500.
			28.000	0.2					6.00-12.	355.	500.
Sr	room	air				98.000	13000.0		1.00-6.	106.	150.
						98.000	16000.0		1.00-6.	355.	500.
			14.000	11000.0		21.000	21000.0		1.00-6.	106.	150.
			14.000	8900.0		21.000	13000.0		1.00-6.	355.	500.
			21.000	16000.0		84.000	17000.0		8.00-11.	75.	500.
			21.000	13000.0		35.000	5800.0		1.00-6.	106.	150.
			21.000	6500.0		35.000	5500.0		1.00-6.	355.	500.
			42.000	45000.0		63.000	16000.0		8.00-11.	75.	500.
			42.000	18000.0					1.00-6.	106.	150.
			42.000	5800.0					1.00-6.	355.	500.
			77.000	22000.0					1.00-6.	106.	150.
			77.000	16000.0					1.00-6.	355.	500.
			84.000	20000.0		21.000	26000.0		8.00-11.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

JA-18

Sr	70°.	air				98.000	17000.0		1.00-6.	106.	150.
						98.000	19000.0		1.00-6.	355.	500.
			14.000	13000.0		14.000	22000.0		1.00-6.	106.	150.
			14.000	19000.0		14.000	22000.0		1.00-6.	355.	500.
			21.000	22000.0		21.000	30000.0		1.00-6.	106.	150.
			21.000	15000.0		21.000	24000.0		1.00-6.	355.	500.
			35.000	15000.0		42.000	18000.0		1.00-6.	106.	150.
			35.000	22000.0		42.000	17000.0		1.00-6.	355.	500.
			63.000	4700.0					1.00-6.	106.	150.
			63.000	4300.0					1.00-6.	355.	500.
U	room	air	7.000	4.9		21.000	13.0		1.00-7.	106.	150.
			7.000	1.6		21.000	9.7		1.00-7.	355.	500.
			14.000	3.5		14.000	12.0		1.00-7.	106.	150.
			14.000	1.4		14.000	6.4		1.00-7.	355.	500.
			21.000	12.0		7.000	4.4		1.00-7.	106.	150.
			21.000	1.3		7.000	6.3		1.00-7.	355.	500.
	70°.	air	7.000	4.2		21.000	13.0		1.00-7.	355.	500.
			14.000	3.6		14.000	9.5		1.00-7.	355.	500.
			21.000	4.3		7.000	18.0		1.00-7.	355.	500.

Core

JA-26

Ba	room	air				21.000	490.0	480.0	1.00-9.	75.	500.
			21.000	210.0	270.0	84.000	460.0	400.0	1.00-9.	75.	500.
			42.000	1200.0	1400.0	42.000	430.0	450.0	1.00-9.	75.	500.
Cs	room	air				21.000	1700.0	1700.0	6.00-9.	75.	500.
			21.000	420.0	720.0	84.000	1200.0	1500.0	6.00-9.	75.	500.
			42.000	2900.0	1900.0	42.000	1600.0	1800.0	6.00-9.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax	
<u>Core</u>												
JA-26	Eu	room	air			21.000	2400.0	3100.0	3.00-10.	75.	500.	
				21.000	220.0	47.0	84.000	3700.0	3300.0	3.00-10.	75.	500.
				42.000	15000.0	1200.0	42.000	2100.0	3100.0	3.00-10.	75.	500.
	Sr	room	air			21.000	46.0	46.0	2.00-11.	75.	500.	
				21.000	36.0	40.0	84.000	32.0	30.0	2.00-11.	75.	500.
				42.000	130.0	170.0	42.000	38.0	43.0	2.00-11.	75.	500.
	<u>Core</u>											
	JA-28	Ba	room	air			21.000	1100.0	1100.0	1.00-9.	75.	500.
21.000					900.0	760.0	84.000	1200.0	1200.0	1.00-9.	75.	500.
42.000					720.0	900.0	42.000	1200.0	1200.0	1.00-9.	75.	500.
Cs		room	air			21.000	2300.0	2700.0	6.00-9.	75.	500.	
				21.000	1700.0	1200.0	84.000	3100.0	2500.0	6.00-9.	75.	500.
				42.000	2200.0	1500.0	42.000	2400.0	2200.0	6.00-9.	75.	500.
Eu		room	air			21.000	11000.0	14000.0	1.00-10.	75.	500.	
				21.000	1500.0	1200.0	84.000	13000.0	13000.0	1.00-10.	75.	500.
				42.000	5200.0	600.0	42.000	11000.0	12000.0	1.00-10.	75.	500.
Sr		room	air			21.000	110.0	110.0	2.00-11.	75.	500.	
				21.000	140.0	110.0	84.000	120.0	120.0	2.00-11.	75.	500.
				42.000	69.0	54.0	42.000	110.0	110.0	2.00-11.	75.	500.
<u>Core</u>												
JA-32		Am	room	air	7.000	110.0		35.000	2800.0		1.00-6.	106.
	14.000				110.0					1.00-6.	106.	150.
	28.000				140.0					1.00-6.	106.	150.
	28.000				230.0		35.000	1500.0		1.00-6.	106.	150.
	56.000				79.0					1.00-6.	106.	150.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-32											
Am	70°.	air	7.000	120.0					1.00-6.	106.	150.
			14.000	160.0					1.00-6.	106.	150.
			28.000	130.0					1.00-6.	106.	150.
			56.000	46.0					1.00-6.	106.	150.
Ba	room	air	7.000	370.0		7.000	420.0		1.00-6.	106.	150.
			7.000	270.0		14.000	360.0		1.00-6.	355.	500.
			21.000	370.0		21.000	430.0		1.00-6.	106.	150.
			21.000	310.0		28.000	390.0		1.00-6.	355.	500.
			35.000	420.0		35.000	560.0		1.00-6.	106.	150.
			35.000	370.0		42.000	560.0		1.00-6.	355.	500.
			56.000	440.0		77.000	510.0		1.00-6.	106.	150.
			56.000	520.0		84.000	700.0		1.00-6.	355.	500.
	70°.	air				21.000	970.0		1.00-6.	106.	150.
						21.000	1600.0		1.00-6.	355.	500.
			7.000	560.0		14.000	710.0		1.00-6.	106.	150.
			7.000	900.0		14.000	1100.0		1.00-6.	355.	500.
			14.000	660.0		21.000	940.0		1.00-6.	106.	150.
			14.000	1000.0		21.000	950.0		1.00-6.	355.	500.
			28.000	940.0		42.000	1300.0		1.00-6.	106.	150.
			28.000	1100.0		42.000	1800.0		1.00-6.	355.	500.
			56.000	1300.0		14.000	1100.0		1.00-6.	106.	150.
			56.000	1600.0		14.000	1200.0		1.00-6.	355.	500.
Ce	room	air	7.000	43.0		7.000	1300.0		8.00-7.	106.	150.
			7.000	66.0		14.000	670.0		8.00-7.	355.	500.
			21.000	53.0		21.000	340.0		8.00-7.	106.	150.
			21.000	90.0		28.000	490.0		8.00-7.	355.	500.
			35.000	48.0		35.000	310.0		8.00-7.	106.	150.
			35.000	90.0		42.000	240.0		8.00-7.	355.	500.
			56.000	160.0		77.000	240.0		8.00-7.	106.	150.
			56.000	110.0		84.000	640.0		8.00-7.	355.	500.

Element	Temp	Atm	Stime	srđ1	srđ2	dtime	drđ1	drđ2	Conc	pmin	pmax
<u>Core</u>											
JA-32											
Ce	70°	air				21.000	710.0		1.00-6.	106.	150.
						21.000	1100.0		1.00-6.	355.	500.
			7.000	53.0		14.000	360.0		1.00-6.	106.	150.
			7.000	51.0		14.000	750.0		1.00-6.	355.	500.
			14.000	64.0		21.000	600.0		1.00-6.	106.	150.
			14.000	61.0		21.000	310.0		1.00-6.	355.	500.
			56.000	67.0		14.000	460.0		1.00-6.	106.	150.
			56.000	170.0		14.000	800.0		1.00-6.	355.	500.
Cs	room	air	7.000	120.0		7.000	170.0		1.00-9.	106.	150.
			7.000	110.0		14.000	200.0		1.00-9.	355.	500.
			21.000	120.0		21.000	230.0		1.00-9.	106.	150.
			21.000	120.0		28.000	150.0		1.00-9.	355.	500.
			35.000	130.0		35.000	130.0		1.00-9.	106.	150.
			35.000	140.0		42.000	200.0		1.00-9.	355.	500.
			56.000	140.0		77.000	150.0		1.00-9.	106.	150.
			56.000	120.0		84.000	180.0		1.00-9.	355.	500.
	70°	air				21.000	130.0		2.00-9.	106.	150.
						21.000	99.0		2.00-9.	355.	500.
			7.000	82.0		14.000	80.0		2.00-9.	106.	150.
			7.000	82.0		14.000	89.0		2.00-9.	355.	500.
			14.000	87.0		21.000	110.0		2.00-9.	106.	150.
			14.000	85.0		21.000	96.0		2.00-9.	355.	500.
			28.000	120.0		42.000	130.0		2.00-9.	106.	150.
			28.000	100.0		42.000	110.0		2.00-9.	355.	500.
			56.000	120.0		14.000	120.0		2.00-9.	106.	150.
			56.000	100.0		14.000	100.0		2.00-9.	355.	500.
Eu	room	air	7.000	51.0		7.000	1600.0		6.00-7.	106.	150.
			7.000	48.0		14.000	610.0		6.00-7.	355.	500.
			21.000	69.0		21.000	600.0		6.00-7.	106.	150.
			21.000	92.0		28.000	600.0		6.00-7.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-32											
Eu	room	air	35.000	73.0		35.000	740.0		6.00-7.	106.	150.
			35.000	88.0		42.000	570.0		6.00-7.	355.	500.
			56.000	190.0		77.000	1300.0		6.00-7.	106.	150.
			56.000	120.0		84.000	780.0		6.00-7.	355.	500.
	70°.	air				21.000	1300.0		6.00-7.	106.	150.
						21.000	1100.0		6.00-7.	355.	500.
			7.000	120.0		14.000	880.0		6.00-7.	106.	150.
			7.000	93.0		14.000	1700.0		6.00-7.	355.	500.
			14.000	180.0		21.000	1500.0		6.00-7.	106.	150.
			14.000	130.0		21.000	890.0		6.00-7.	355.	500.
			28.000	220.0		42.000	1600.0		6.00-7.	106.	150.
			28.000	380.0		42.000	3200.0		6.00-7.	355.	500.
			56.000	240.0		14.000	2000.0		6.00-7.	106.	150.
			56.000	130.0		14.000	4000.0		6.00-7.	355.	500.
I	room	air	21.000	0.35					1.00-13.	355.	500.
			28.000	-0.2					1.00-13.	355.	500.
Mo	room	air	21.000	8.2					1.00-14.	355.	500.
Pu	room	air	14.000	110.0					1.00-6.	106.	150.
Ru	room	air	21.000	88.0					3.00-12.	355.	500.
			28.000	44.0					3.00-12.	355.	500.
Sb	room	air	21.000	0.12					6.00-12.	355.	500.
			28.000	-0.88					6.00-12.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax	
<u>Core</u>												
JA-32												
Sr	room	air	7.000	48.0		7.000	48.0		2.00-6.	106.	150.	
			7.000	50.0		14.000	55.0		2.00-6.	355.	500.	
			21.000	50.0		21.000	41.0		2.00-6.	106.	150.	
			21.000	52.0		28.000	52.0		2.00-6.	355.	500.	
			35.000	72.0		35.000	50.0		2.00-6.	106.	150.	
			35.000	56.0		42.000	58.0		2.00-6.	355.	500.	
			56.000	55.0		77.000	50.0		2.00-6.	106.	150.	
			56.000	71.0		84.000	72.0		2.00-6.	355.	500.	
			70°. air	21.000		120.0		2.00-6.	106.	150.		
					21.000	110.0		2.00-6.	355.	500.		
				7.000	82.0		14.000	80.0		2.00-6.	106.	150.
				7.000	93.0		14.000	80.0		2.00-6.	355.	500.
				14.000	92.0		21.000	110.0		2.00-6.	106.	150.
				14.000	110.0		21.000	80.0		2.00-6.	355.	500.
				28.000	120.0		42.000	140.0		2.00-6.	106.	150.
				28.000	110.0		42.000	120.0		2.00-6.	355.	500.
				56.000	160.0		14.000	93.0		2.00-6.	106.	150.
				56.000	140.0		14.000	70.0		2.00-6.	355.	500.
	U	room	air	7.000	3.5		21.000	15.0		1.00-7.	106.	150.
				7.000	1.4		21.000	0.2		1.00-7.	355.	500.
				14.000	2.9		14.000	12.0		1.00-7.	106.	150.
				14.000	1.3		14.000	5.4		1.00-7.	355.	500.
				21.000	2.5		7.000	9.6		1.00-7.	106.	150.
				21.000	1.3		7.000	5.2		1.00-7.	355.	500.
70°. air				7.000	10.0		21.000	23.0		1.00-7.	355.	500.
				14.000	11.0		14.000	19.0		1.00-7.	355.	500.
				21.000	15.0		7.000	20.0		1.00-7.	355.	500.
<u>Core</u>												
JA-37												
Am	room	air	7.000	430.0		35.00	14000.0		1.00-6.	106.	150.	
			14.000	370.0		35.000	14000.0		1.00-6.	106.	150.	
			21.000	18000.0		84.000	54000.0		1.00-7.	106.	250.	
			28.000	430.0					1.00-6.	106.	150.	
			28.000	1500.0		35.000	21000.0		1.00-6.	106.	150.	

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-37											
Am	room	air	42.000	37000.0		63.000	59000.0		1.00-7.	106.	250.
			56.000	640.0					1.00-6.	106.	150.
			84.000	46000.0		21.000	43000.0		1.00-7.	106.	250.
	70°.	air	7.000	520.0					1.00-6.	106.	150.
			14.000	2100.0					1.00-6.	106.	150.
			14.000	680.0					1.00-6.	106.	150.
			28.000	960.0					1.00-6.	106.	150.
			56.000	730.0					1.00-6.	106.	150.
			56.000	800.0					1.00-6.	106.	150.
Ba	room	air				84.000	1100.0		2.00-6.	106.	150.
						28.000	750.0		2.00-6.	106.	150.
						28.000	950.0		2.00-6.	355.	500.
						84.000	990.0		2.00-6.	355.	500.
			14.000	700.0		14.000	810.0		2.00-6.	106.	150.
			14.000	600.0		14.000	840.0		2.00-6.	355.	500.
			21.000	750.0		21.000	1000.0		2.00-6.	106.	150.
			21.000	660.0		21.000	860.0		2.00-6.	355.	500.
			35.000	710.0		42.000	900.0		2.00-6.	106.	150.
			35.000	830.0		42.000	1100.0		2.00-6.	355.	500.
			70.000	1000.0					2.00-6.	106.	150.
			70.000	760.0					2.00-6.	355.	500.
	70°.	air				91.000	12000.0		2.00-6.	106.	150.
						21.000	3500.0		2.00-6.	106.	150.
						91.000	9900.0		1.00-6.	355.	500.
						21.000	3000.0		1.00-6.	355.	500.
			7.000	2000.0		14.000	3300.0		2.00-6.	106.	150.
Ba	70°	air	7.000	1700.0		14.000	2500.0		1.00-6.	355.	500.
			14.000	2500.0		21.000	4800.0		2.00-6.	106.	150.
			14.000	2400.0		21.000	4400.0		1.00-6.	355.	500.
			21.000	4200.0		42.000	7600.0		2.00-6.	106.	150.
			21.000	3400.0		42.000	6300.0		1.00-6.	355.	500.
			49.000	6600.0		21.000	7500.0		2.00-6.	106.	150.
			49.000	6600.0		21.000	5900.0		1.00-6.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-37											
Cs	room	air				28.000	600.0		1.00-7.	106.	150.
						84.000	1000.0		1.00-7.	106.	150.
						28.000	950.0		1.00-7.	355.	500.
						84.000	1100.0		1.00-7.	355.	500.
			14.000	530.0		14.000	640.0		1.00-7.	106.	150.
			14.000	700.0		14.000	880.0		1.00-7.	355.	500.
			21.000	490.0		21.000	800.0		1.00-7.	106.	150.
			21.000	480.0		21.000	800.0		1.00-7.	355.	500.
			35.000	510.0		42.000	720.0		1.00-7.	106.	150.
			35.000	650.0		42.000	970.0		1.00-7.	355.	500.
			70.000	780.0					1.00-7.	106.	150.
			70.000	750.0					1.00-7.	355.	500.
	70°	air				21.000	1600.0		4.00-8.	106.	150.
						91.000	5800.0		4.00-8.	106.	150.
						21.000	1500.0		4.00-8.	355.	500.
						91.000	4400.0		4.00-8.	355.	500.
			7.000	1100.0		14.000	1200.0		4.00-8.	106.	150.
			7.000	1100.0		14.000	1300.0		4.00-8.	355.	500.
			14.000	1300.0		21.000	4600.0		4.00-8.	106.	150.
			14.000	1300.0		21.000	4700.0		4.00-8.	355.	500.
			21.000	1400.0		42.000	1500.0		4.00-8.	106.	150.
			21.000	1400.0		42.000	1800.0		4.00-8.	355.	500.
			49.000	1800.0		21.000	1400.0		4.00-8.	106.	150.
			49.000	1600.0		21.000	1800.0		4.00-8.	355.	500.
Eu	room	air				84.000	24000.0		3.00-7.	106.	150.
						84.000	18000.0		3.00-7.	355.	500.
						28.000	6700.0		3.00-7.	355.	500.
			14.000	2100.0		14.000	3900.0		3.00-7.	106.	150.
			14.000	4100.0		14.000	6000.0		3.00-7.	355.	500.
			21.000	7600.0		21.000	7700.0		3.00-7.	106.	150.
			21.000	4000.0		21.000	14000.0		3.00-7.	355.	500.
			28.000	13000.0					3.00-8.	250.	355.
			35.000	7300.0		42.000	17000.0		3.00-7.	106.	150.
			35.000	6400.0		42.000	18000.0		3.00-7.	355.	500.
			63.000	51000.0					3.00-8.	250.	355.
			63.000	>26000.0					8.00-9.	250.	355.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-37											
Eu	room	air	70.000	9500.0					3.00-7.	106.	150.
			70.000	6900.0					3.00-7.	355.	500.
	70°.	air				91.000	24000.0		1.00-7.	106.	150.
						21.000	19000.0		1.00-7.	106.	150.
						21.000	11000.0		1.00-7.	355.	500.
						91.000	13000.0		1.00-7.	355.	500.
			7.000	4000.0		14.000	9700.0		1.00-7.	106.	150.
			7.000	2100.0		14.000	7600.0		1.00-7.	355.	500.
			14.000	4100.0		21.000	7700.0		1.00-7.	106.	150.
			14.000	4400.0		21.000	12000.0		1.00-7.	355.	500.
	70°.	air	21.000	4000.0		42.000	17000.0		1.00-7.	106.	150.
			21.000	4500.0		42.000	19000.0		1.00-7.	355.	500.
			49.000	5200.0		21.000	13000.0		1.00-7.	106.	150.
			49.000	5500.0		21.000	18000.0		1.00-7.	355.	500.
	room	air	21.000	-0.9					1.00-13.	355.	500.
			28.000	-0.2					1.00-13.	355.	500.
Mo	room	air	21.000	10.0					1.00-14.	355.	500.
Np	room	air	21.000	20.0		84.000	230.0		8.00-11.	106.	250.
			42.000	22.0		63.000	65.0		8.00-11.	106.	250.
			91.000	42.0		21.000	210.0		8.00-11.	106.	250.
Pu	room	air	7.000	390.0					1.00-6.	106.	150.
			21.000	300.0		84.000	870.0		4.00-12.	106.	250.
			28.000	180.0					1.00-6.	106.	150.
			42.000	420.0	560.0	56.000	890.0	1700.0	4.00-12.	106.	250.
			91.000	760.0	1900.0	21.000	1300.0	2400.0	4.00-12.	106.	250.
	70°.	air	7.000	240.0					1.00-6.	106.	150.
Ru	room	air	21.000	67.0					3.00-12.	355.	500.
			28.000	65.0					3.00-12.	355.	500.
Sb	room	air	21.000	0.5					6.00-12.	355.	500.
			28.000	0.1					6.00-12.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
JA-37											
Sr	room	air				84.000	320.0		3.00-6.	106.	150.
						28.000	290.0		3.00-6.	106.	150.
						28.000	280.0		3.00-6.	355.	500.
						84.000	320.0		3.00-6.	355.	500.
			14.000	300.0		14.000	320.0		3.00-6.	106.	150.
			14.000	260.0		14.000	300.0		3.00-6.	355.	500.
			21.000	280.0		21.000	350.0		3.00-6.	106.	150.
			21.000	250.0		21.000	320.0		3.00-6.	355.	500.
			35.000	280.0		42.000	260.0		3.00-6.	106.	150.
			35.000	340.0		42.000	350.0		3.00-6.	355.	500.
	70°.	air	70.000	350.0					3.00-6.	106.	150.
			70.000	280.0					3.00-6.	355.	500.
						91.000	1900.0		2.00-6.	106.	150.
						21.000	950.0		2.00-6.	106.	150.
						21.000	820.0		2.00-6.	355.	500.
						91.000	1800.0		2.00-6.	355.	500.
			7.000	770.0		14.000	1000.0		2.00-6.	106.	150.
			7.000	660.0		14.000	900.0		2.00-6.	355.	500.
			14.000	820.0		21.000	1200.0		2.00-6.	106.	150.
			14.000	790.0		21.000	1100.0		2.00-6.	355.	500.
			21.000	1200.0		42.000	1900.0		2.00-6.	106.	150.
U	room	air	21.000	1000.0		42.000	1500.0		2.00-6.	355.	500.
			49.000	1600.0		21.000	1400.0		2.00-6.	106.	150.
			49.000	1500.0		21.000	1500.0		2.00-6.	355.	500.
			7.000	4.0		21.000	6.1		1.00-7.	106.	150.
			7.000	2.6		21.000	2.2		1.00-7.	355.	500.
			7.000	0.5	6.0	7.000	13.0	13.0	2.00-6.	355.	500.
			7.000	5.0		7.000	13.0		2.00-6.	355.	500.
			14.000	4.8		14.000	9.6		1.00-7.	106.	150.
			14.000	4.2		14.000	9.2		1.00-7.	355.	500.
			21.000	5.1		7.000	11.0		1.00-7.	106.	150.
	70°.	air	21.000	4.7		7.000	12.0		1.00-7.	355.	500.
			7.000	13.0		7.000	58.0		1.00-3.	355.	500.
			14.000	17.0		14.000	42.0		1.00-6.	355.	500.
			21.000	19.0		7.000	40.0		1.00-6.	355.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-22											
Am	room	air	21.000	6500.0		84.000	6700.0		1.00-7.		75.
			21.000	1500.0		84.000	2400.0		1.00-7.	75.	500.
			42.000	6800.0		63.000	6500.0		1.00-7.		75.
			42.000	6800.0		63.000	6500.0		1.00-7.		75.
			42.000	1100.0		63.000	1900.0		1.00-7.	75.	500.
			84.000	6900.0		21.000	7300.0		1.00-7.		75.
			84.000	1100.0		21.000	3100.0		1.00-7.	75.	500.
			ca	21.000	1400.0		84.000	2500.0		3.00-8.	75.
	ca		21.000	750.0		84.000	2300.0		3.00-8.	75.	500.
			42.000	2100.0		63.000	3100.0		3.00-8.		75.
			42.000	960.0		63.000	2300.0		3.00-8.	75.	500.
			84.000	1800.0		21.000	7500.0		3.00-8.		75.
			84.000	1200.0		21.000	4300.0		3.00-8.	75.	500.
Ba	room	air	21.000	1200.0					4.00-7.		75.
			21.000	1300.0					3.00-7.		75.
			21.000	1000.0					3.00-7.		75.
			21.000	760.0					1.00-5.		75.
			21.000	400.0					1.00-4.		75.
			21.000	600.0					3.00-7.	75.	500.
			21.000	210.0					1.00-4.	75.	500.
			21.000	470.0					1.00-5.	75.	500.
			21.000	670.0					3.00-7.	75.	500.
			21.000	790.0					4.00-7.	75.	500.
			21.000	910.0		42.000	650.0		3.00-7.	106.	500.
			21.000	850.0					3.00-7.	106.	500.
			42.000	1300.0		21.000	1600.0		3.00-7.		106.
			42.000	980.0	850.0	21.000	990.0	830.0	3.00-7.	106.	500.
	ca		21.000	660.0		42.000	1100.0		3.00-7.		75.
			21.000	200.0		42.000	470.0		3.00-7.	75.	500.
			42.000	900.0		21.000	1300.0		3.00-7.		75.
			42.000	300.0		21.000	460.0		3.00-7.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-22											
				84.000	1000.0				3.00-7.		75.
				84.000	300.0				3.00-7.	75.	500.
Ce	room	air	21.000	1200.0					7.00-7.	106.	500.
			21.000	1400.0		42.000	6100.0		7.00-7.	106.	500.
			42.000	1600.0		21.000	4900.0		7.00-7.		106.
			42.000	1300.0	1200.0	21.000	8100.0	5400.0	7.00-7.	106.	500.
		ca				21.000	2100.0		2.00-8.	75.	500.
			21.000	630.0		42.000	2400.0		2.00-8.		75.
			21.000	760.0		42.000	2700.0		2.00-8.	75.	500.
			42.000	860.0		21.000	2100.0		2.00-8.		75.
			84.000	760.0					2.00-8.		75.
			84.000	1600.0					2.00-8.	75.	500.
Cs	room	air	21.000	610.0					2.00-7.		75.
			21.000	12.0					2.00-3.		75.
			21.000	380.0					3.00-9.		75.
			21.000	130.0					2.00-5.		75.
			21.000	260.0					2.00-7.	75.	500.
			21.000	550.0					3.00-10.	75.	500.
			21.000	10.0					2.00-3.	75.	500.
			21.000	110.0					2.00-5.	75.	500.
			21.000	660.0					3.00-9.	75.	500.
			21.000	260.0		42.000	360.0		1.00-9.	106.	500.
			21.000	380.0					1.00-9.	106.	500.
			42.000	540.0		21.000	500.0		1.00-9.		106.
			42.000	270.0	240.0	21.000	380.0	360.0	1.00-9.	106.	500.
		ca	21.000	380.0		42.000	550.0		2.00-9.		75.
			21.000	200.0		42.000	340.0		2.00-9.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-22											
Cs	room	ca	42.000	440.0		21.000	490.0		2.00-9.		75.
			42.000	210.0		21.000	280.0		2.00-9.	75.	500.
			84.000	480.0					2.00-9.		75.
			84.000	250.0					2.00-9.	75.	500.
Eu	room	air	21.000	1900.0					1.00-8.		75.
			21.000	1900.0					4.00-8.		75.
			21.000	5800.0					9.00-6.		75.
			21.000	690.0					3.00-6.		75.
			21.000	2100.0					3.00-9.	75.	500.
			21.000	1900.0					1.00-8.	75.	500.
			21.000	1900.0					4.00-8.	75.	500.
			21.000	1100.0					9.00-6.	75.	500.
			21.000	1200.0					3.00-6.	75.	500.
			21.000	1200.0					5.00-8.	106.	500.
			21.000	1300.0		42.000	3300.0		5.00-8.	106.	500.
			42.000	1500.0		21.000	4000.0		5.00-8.		106.
			42.000	1700.0	1400.0	21.000	3900.0	3100.0	5.00-8.	106.	500.
	ca					42.000	3100.0		2.00-8.	75.	500.
			21.000	800.0		42.000	2200.0		2.00-8.		75.
	ca		21.000	710.0		42.000	2500.0		2.00-8.	75.	500.
			42.000	990.0		21.000	1900.0		2.00-8.		75.
			84.000	1000.0					2.00-8.		75.
			84.000	1300.0					2.00-8.	75.	500.
Np	room	air	21.000	5.1		84.000	26.0		1.00-10.	75.	500.
			42.000	5.8		63.000	30.0		1.00-10.	75.	500.
			84.000	7.0		21.000	42.0		1.00-10.	75.	500.
	ca		28.000	6.1	7.0	84.000	18.0	18.0	3.00-11.	75.	500.
			56.000	9.5	9.5	49.000	19.0	17.0	3.00-11.	75.	500.
			84.000	9.5	10.0	21.000	34.0	34.0	3.00-11.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-22											
Pu	room	air	21.000	54.0		21.000	990.0		2.00-10.		75.
			21.000	66.0		21.000	1100.0		2.00- 9.		75.
			21.000	63.0		21.000	1200.0		3.00-11.		75.
			21.000	34.0		21.000	280.0		1.00-8.		75.
			21.000	60.0		21.000	1100.0		8.00-12.		75.
			21.000	130.0		84.000	1400.0		4.00-12.		75.
			21.000	41.0		21.000	920.0		2.00-9.	75.	500.
			21.000	54.0		21.000	470.0		2.00-10.	75.	500.
			21.000	16.0		21.000	910.0		1.00-8.	75.	500.
			21.000	47.0		21.000	1800.0		2.00-11.	75.	500.
			21.000	37.0		84.000	1300.0		4.00-12.	75.	500.
			21.000	65.0		21.000	960.0		8.00-12.	75.	500.
			21.000	70.0		21.000	1900.0		6.00-10.	75.	500.
			21.000	120.0		21.000	2800.0		6.00-13.	75.	500.
			21.000	62.0		21.000	580.0		3.00-11.	75.	500.
			21.000	79.0		21.000	1400.0		1.00-10.	75.	500.
			21.000	17.0		21.000	730.0		1.00-8.	75.	500.
			42.000	210.0		63.000	1300.0		4.00-12.		75.
			42.000	64.0		63.000	1300.0		4.00-12.	75.	500.
			84.000	280.0		21.000	1900.0		4.00-12.		75.
			84.000	100.0		21.000	1400.0		4.00-12.	75.	500.
		ca	21.000	85.0		84.000	1000.0		4.00-13.		75.
			21.000	120.0		84.000	970.0		4.00-13.	75.	500.
			42.000	260.0		63.000	1500.0		4.00-13.		75.
			42.000	400.0		63.000	1800.0		4.00-13.	75.	500.
			84.000	190.0		21.000	3100.0		4.00-13.		75.
			84.000	250.0		21.000	1200.0		4.00-13.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax	
<u>Core</u>												
YM-22												
Sr	room	air	21.000	70.0					6.00-7.		75.	
			21.000	20.0					3.00-3.		75.	
			21.000	81.0					5.00-7.		75.	
			21.000	54.0					3.00-5.		75.	
			21.000	65.0					6.00-7.		75.	
			21.000	95.0					6.00-7.	75.	500.	
			21.000	65.0					6.00-7.	75.	500.	
			21.000	71.0					5.00-7.	75.	500.	
			21.000	9.4					3.00-3.	75.	500.	
			21.000	55.0					3.00-5.	75.	500.	
			21.000	48.0		42.000	59.0		7.00-7.	106.	500.	
			21.000	48.0					7.00-7.	106.	500.	
			42.000	66.0		21.000	74.0		7.00-7.		106.	
			42.000	55.0	62.0	21.000	63.0	57.0	7.00-7.	106.	500.	
			ca	21.000	73.0		42.000	120.0		7.00-7.		75.
				21.000	48.0		42.000	120.0		7.00-7.	75.	500.
				42.000	75.0		21.000	100.0		7.00-7.	75.	
				42.000	53.0		21.000	70.0		7.00-7.	75.	500.
				84.000	81.0					7.00-7.		75.
				84.000	46.0					7.00-7.	75.	500.
Tc	room	air		42.000	0.13		63.000	0.47		1.00-3.	106.	500.
				42.000	0.17		63.000	1.2		1.00-6.	106.	500.
			42.000	0.72		63.000	1.2		1.00-12.	106.	500.	
			42.000	0.16		63.000	1.9		1.00-9.	106.	500.	
		ca	21.000	3.8		84.000	37.0		1.00-12.		75.	
			21.000	0.4		84.000	12.0		1.00-12.	75.	500.	
		ca	42.000	6.5		63.000	14.0		1.00-12.		75.	
			42.000	0.3		63.000	9.5		1.00-12.	75.	500.	
			84.000	3.2		21.000	32.0		1.00-12.		75.	
			84.000	1.5		21.000	5.3		1.00-12.	75.	500.	

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

YM-22

U	room	air	7.000	2.0		14.000	15.0		1.00-6.		106.
			7.000	1.0		14.000	0		1.00- 6.	106.	500.
			14.000	2.0		7.000	8.0		1.00-6.		106.
			14.000	2.0		7.000	8.0		1.00-6.	106.	500.
			21.000	2.0					1.00-6.		106.
			21.000	2.0					1.00-6.	106.	500.
	ca		7.000	0					1.00-6.		75.
			14.000	0.9					1.00-6.		75.
			14.000	0					1.00-6.	75.	500.
			21.000	1.2					1.00-6.		75.
			21.000	0.8					1.00-6.	75.	500.

Core

YM-30

Ba	room	air	21.000	2000.0		84.000	4200.0		8.00-10.	75.	500.
			42.000	1800.0		63.000	2000.0		8.00-10.	75.	500.
			84.000	6400.0		21.000	3100.0		8.00-10.	75.	500.
Ce	room	air	21.000	130000		84.000	200000		8.00-13.	75.	500.
			42.000	1100000		63.000	160000		8.00-13.	75.	500.
			84.000	330000		21.000	150000		8.00-13.	75.	500.
cs	room	air	21.000	850.0		84.000	1600.0		3.00- 9.	75.	500.
			42.000	860.0		63.000	1700.0		3.00-9.	75.	500.
			84.000	2000.0		21.000	1300.0		3.00-9.	75.	500.
Eu	room	air	21.000	94000.0		84.000	10000.0		1.00-10.	75.	500.
			42.000	120000.0		63.000	10000.0		1.00-10.	75.	500.
			84.000	260000.0		21.000	12000.0		1.00-10.	75.	500.
Sr	room	air	21.000	100.0		84.000	210.0		8.00-11.	75.	500.
			42.000	320.0		63.000	260.0		8.00-11.	75.	500.
			84.000	360.0		21.000	160.0		8.00-11.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-38											
Am	room	air	21.000	9500.0		84.000	9900.0		1.00-7.		75.
			21.000	6100.0		84.000	5900.0		1.00-7.	75.	500.
			42.000	7300.0		63.000	14000.0		1.00-7.		75.
			42.000	5200.0		63.000	9600.0		1.00-7.	75.	500.
			84.000	2600.0		28.000	12000.0		1.00-7.		75.
			84.000	2500.0		28.000	5800.0		1.00-7.	75.	500.
	ca		21.000	4600.0		84.000	18000.0		3.00-8.		75.
			21.000	3400.0		84.000	18000.0		3.00-8.	75.	500.
			42.000	8800.0		63.000	10000.0		3.00-8.		75.
			42.000	3600.0		63.000	8400.0		3.00-8.	75.	500.
	ca		84.000	8200.0		21.000	19000.0		3.00-8.		75.
			84.000	5000.0		21.000	9100.0		3.00-8.	75.	500.
Ba	room	air	21.000	69000.0					4.00-7.		38.
			21.000	190000.0					4.00-7.		38.
			21.000	93000.0					1.00-5.		75.
			21.000	72000.0					4.00-7.		75.
			21.000	100000.0					1.00-4.		75.
			21.000	97000.0					2.00-6.		75.
			21.000	81000.0					6.00-7.		75.
			21.000	100000.0					4.00-7.	38.	106.
			21.000	120000.0					4.00-7.	38.	106.
			21.000	33000.0					4.00-7.	75.	500.
			21.000	79000.0					1.00-4.	75.	500.
			21.000	36000.0					2.00-6.	75.	500.
			21.000	68000.0					6.00-7.	75.	500.
			21.000	75000.0					1.00-5.	75.	500.
			21.000	77000.0					4.00-7.	106.	500.
			21.000	57000.0					4.00-7.	106.	500.
			21.000	100000.0					4.00-7.	106.	500.
			42.000	40000.0		21.000	110000.0	4.00-7.	106.		
			42.000	81000.0		21.000	260000.0		4.00-7.	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

YM-38

Ba	room	ca	21.000	57000.0		42.000	63000.0		4.00-7.		75.
			21.000	34000.0		42.000	58000.0		4.00-7.	75.	500.
			42.000	>210000.0		21.000	46000.0		4.00-7.		75.
			42.000	41000.0		21.000	89000.0		4.00-7.	75.	500.
			84.000	22000.0					4.00-7.		75.
			84.000	11000.0					4.00-7.	75.	500.
Ce	room	air	21.000	900.0					1.00-6.	106.	500.
			42.000	950.0		21.000	4900.0		1.00-6.		106.
			42.000	620.0		21.000	2600.0		1.00-6.	106.	500.
			21.000	650.0		42.000	21000.0		7.00-8.		75.
			21.000	560.0		42.000	1300.0		7.00-8.	75.	500.
			42.000	320.0		21.000	660.0		7.00-8.		75.
			42.000	850.0		21.000	3200.0		7.00-8.	75.	500.
			84.000	740.0					7.00-8.		75.
			84.000	320.0					7.00-8.	75.	500.
Cs	room	air	21.000	11000.0					4.00-9.		38.
			21.000	20000.0					4.00-9.		38.
			21.000	3500.0					3.00-3.		75.
			21.000	3700.0					3.00-5.		75.
			21.000	6300.0					3.00-7.		75.
			21.000	3200.0					2.00-10.		75.
			21.000	2700.0					2.00-9.		75.
			21.000	17000.0					4.00-9.	38.	106.
			21.000	15000.0					4.00-9.	38.	106.
			21.000	3400.0					3.00-3.	75.	500.
			21.000	6000.0					3.00-5.	75.	500.
			21.000	4000.0					2.00-9.	75.	500.
			21.000	4200.0					3.00-7.	75.	500.
			21.000	3500.0					2.00-10.	75.	500.
			21.000	14000.0					4.00-9.	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-38											
Cs	room	air	21.000	12000.0					1.00-9.	106.	500.
			21.000	14000.0					4.00-9.	106.	500.
			42.000	5900.0	21.000	13000.0			1.00-9.		106.
			42.000	8200.0	21.000	13000.0			1.00-9.	106.	500.
	ca		21.000	9500.0	42.000	12000.0			3.00-9.		75.
			21.000	7900.0	42.000	15000.0			3.00-9.	75.	500.
			42.000	14000.0	21.000	8000.0			3.00-9.	75.	
			42.000	10000.0	21.000	15000.0			3.00-9.	75.	500.
			84.000	9000.0					3.00-9.		75.
			84.000	5400.0					3.00-9.	75.	500.
Eu	room	air	21.000	2200.0					7.00-8.		38.
			21.000	3000.0					7.00-8.		38.
			21.000	3700.0					6.00-8.		75.
			21.000	5000.0					6.00-9.		75.
			21.000	7100.0					6.00-6.		75.
			21.000	2600.0					3.00-6.		75.
			21.000	3100.0					4.00-8.		75.
			21.000	1300.0					7.00-8.	38.	106.
			21.000	1300.0					7.00-8.	38.	106.
			21.000	3700.0					6.00-9.	75.	500.
			21.000	4600.0					6.00-6.	75.	500.
			21.000	1700.0					4.00-6.	75.	500.
			21.000	1700.0					6.00-8.	75.	500.
			21.000	2700.0					4.00-8.	75.	500.
			21.000	1300.0					7.00-8.	106.	500.
			21.000	1500.0	42.000	21000.0			7.00-8.	106.	500.
			21.000	2600.0					7.00-8.	106.	500.
			42.000	4900.0	21.000	10000.0			7.00-8.		106.
			42.000	1500.0	21.000	7300.0			7.00-8.	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-38											
		ca	21.000	1100.0		42.000	21000.0		9.00-8.		75.
			21.000	840.0		42.000	1300.0		9.00-8.	75.	500.
			42.000	560.0		21.000	820.0		9.00-8.		75.
			42.000	1000.0		21.000	4300.0		9.00-8.	75.	500.
			84.000	1000.0					9.00-8.		75.
			84.000	470.0					9.00-8.	75.	500.
Np	room	air	28.000	9.3		84.000	17.0		4.00-11.	75.	500.
			28.000	9.4		84.000	22.0		4.00-11.	75.	500.
			42.000	11.0	11.0	63.000	23.0	24.0	4.00-11.	75.	500.
	ca		84.000	12.0	14.0	21.000	28.0	33.0	4.00-11.	75.	500.
			28.000	14.0	19.0	84.000	22.0	250.0	2.00-11.	75.	500.
			56.000	120.0	160.0	49.000	310.0	500.0	2.00-11.	75.	500.
			84.000	190.0	77.0	21.000	2100.0	250.0	2.00-11.	75.	500.
Pu	room	air	21.000	130.0		91.000	1700.0		4.00-12.		75.
			21.000	53.0		91.000	1100.0		4.00-12.	75.	500.
			42.000	320.0		63.000	2200.0		4.00-12.		75.
			42.000	120.0		63.000	1000.0		4.00-12.	75.	500.
			84.000	650.0		21.000	4300.0		4.00-12.		75.
			84.000	240.0		21.000	1800.0		4.00-12.	75.	500.
	ca		21.000	500.0		84.000	2200.0		2.00-13.		75.
			21.000	620.0		91.000	2400.0		2.00-13.	75.	500.
			49.000	930.0		56.000	2000.0		2.00-13.		75.
			49.000	830.0		56.000	2200.0		2.00-13.	75.	500.
			84.000	1100.0		21.000	2600.0		2.00-13.		75.
			84.000	830.0		21.000	2300.0		2.00-13.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

YM-38

Sr	room	air	21.000	14000.0					4.00-7.		38.
			21.000	20000.0					4.00-7.		38.
			21.000	10000.0					7.00-8.		75.
			21.000	13000.0					2.00-5.		75.
			21.000	1500.0					2.00-3.		75.
			21.000	10000.0					2.00-7.		75.
			21.000	3300.0					5.00-8.		75.
			21.000	20000.0					4.00-7.	38.	106.
			21.000	20000.0					4.00-7.	38.	106.
			21.000	5700.0					2.00-5.	75.	500.
			21.000	1500.0					6.00-8.	75.	500.
			21.000	9000.0					2.00-7.	75.	500.
			21.000	1200.0					2.00-3.	75.	500.
			21.000	4100.0					7.00-8.	75.	500.
			21.000	17000.0					4.00-7.	106.	500.
			21.000	18000.0					4.00-7.	106.	500.
			21.000	18000.0					6.00-8.	106.	500.
			42.000	7400.0		21.000	18000.0		3.00-8.		106.
			42.000	10000.0		21.000	22000.0		6.00-8.	106.	500.
	ca		21.000	9100.0		42.000	23000.0		1.00-7.		75.
			21.000	7200.0		42.000	13000.0		1.00-7.	75.	500.
			42.000	23000.0		21.000	18000.0		1.00-7.		75.
			42.000	8500.0		21.000	14000.0		1.00-7.	75.	500.
			84.000	8000.0					1.00-7.		75.
			84.000	7500.0					1.00-7.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

YM-38

Tc	room	ca	21.000	3.0		84.000	160.0		1.00-12.		75.
			21.000	2.6		84.000	180.0		1.00-12.	75.	500.
			42.000	17.0		63.000	160.0		1.00-12.		75.
			42.000	7.3		63.000	87.0		1.00-12.	75.	500.
			84.000	29.0		21.000	46.0		1.00-12.		75.
			84.000	21.0		21.000	73.0		1.00-12.	75.	500.
U	room	air	7.000	5.0		7.000	16.0		1.00-6.		106.
			7.000	5.0		7.000	16.0		1.00-6.	106.	500.
			14.000	6.0		14.000	15.0		1.00-6.		106.
			14.000	5.0		14.000	12.0		1.00-6.	106.	500.
			21.000	6.0					1.00-6.		106.
			21.000	5.0					1.00-6.	106.	500.
		ca	7.000	17.0					1.00-6.		75.
			7.000	11.0					1.00-6.	75.	500.
			14.000	20.0					1.00-6.		75.
			14.000	14.0					1.00-6.	75.	500.
			21.000	14.0					1.00-6.		75.
			21.000	15.0					1.00-6.	75.	500.

Core

YM-42

Ba	room	air	21.000	72000.0		84.000	42000.0		8.00-10.	75.	500.
			42.000	90000.0		63.000	83000.0		8.00-10.	75.	500.
			84.000	120000.0		21.000	150000.0		8.00-10.	75.	500.
Ce	room	air	21.000	35000.0		84.000	46000.0		8.00-13.	75.	500.
			42.000	47000.0		63.000	35000.0		8.00-13.	75.	500.
			84.000	29000.0		21.000	52000.0		8.00-13.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
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Core

YM-42

Cs	room	air	21.000	16000.0		84.000	19000.0		3.00-9.	75.	500.
			42.000	17000.0		63.000	19000.0		3.00-9.	75.	500.
			84.000	19000.0		21.000	25000.0		3.00-9.	75.	500.
Eu	room	air	21.000	45000.0		84.000	64000.0		1.00-10.	75.	500.
			42.000	58000.0		63.000	59000.0		1.00-10.	75.	500.
			84.000	53000.0		21.000	70000.0		1.00-10.	75.	500.
Sr	room	air	21.000	2900.0		84.000	3300.0		8.00-11.	75.	500.
			42.000	3900.0		63.000	3000.0		8.00-11.	75.	500.
			84.000	5000.0		21.000	6000.0		8.00-11.	75.	500.

Core

YM-45

Ba	room	air	21.000	970.0		42.000	1200.0		3.00-7.		106.
			21.000	1200.0		42.000	1500.0		3.00-7.	106.	500.
			42.000	1200.0		21.000	1300.0		3.00-7.		106.
			42.000	1400.0		21.000	1200.0		3.00-7.	106.	500.
Ce	room	air	21.000	540.0		42.000	4100.0		9.00-7.		106.
			21.000	1000.0		42.000	7400.0		9.00-7.	106.	500.
			42.000	670.0		21.000	6800.0		9.00-7.		106.
			42.000	710.0		21.000	4700.0		9.00-7.	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
Cs	room	air	21.000	740.0		42.000	780.0		1.00-9.		106.
			21.000	480.0		42.000	450.0		1.00-9.	106.	500.
			42.000	550.0		21.000	840.0		1.00-9.		106.
			42.000	320.0		21.000	430.0		1.00-9.	106.	500.
Eu	room	air	21.000	990.0		42.000	5800.0		1.00-7.		106.
			21.000	2100.0		42.000	7100.0		1.00-7.	106.	500.
			42.000	1700.0		21.000	9700.0		1.00-7.		106.
			42.000	1600.0		21.000	6400.0		1.00-7.	106.	500.
Sr	room	air	21.000	220.0		42.000	240.0		6.00-7.		106.
			21.000	170.0		42.000	190.0		6.00-7.	106.	500.
			42.000	220.0		21.000	230.0		6.00-7.		106.
			42.000	170.0		21.000	180.0		6.00-7.	106.	500.

Core

YM-46

Ba	room	air	21.000	6500.0		84.000	23000.0		8.00-10.	75.	500.
			42.000	11000.0		63.000	25000.0		8.00-10.	75.	500.
			84.000	25000.0		21.000	16000.0		8.00-10.	75.	500.
Ce	room	air	21.000	97000.0		84.000	370000.0		8.00-13.	75.	500.
			42.000	360000.0		63.000	400000.0		8.00-13.	75.	500.
			84.000	470000.0		21.000	230000.0		8.00-13.	75.	500.
Cs	room	air	21.000	500.0		84.000	1800.0		3.00-9.	75.	500.
			42.000	320.0		63.000	2200.0		3.00-9.	75.	500.
			84.000	1700.0		21.000	1300.0		3.00-9.	75.	500.
Eu	air		21.000	110000.0		84.000	27000.0			1.00-10.	75. 500.
			42.000	320000.0		63.000	35000.0		1.00-10.	75.	500.
			84.000	490000.0		21.000	310000.0		1.00-10.	75.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax	
Core YM-48	Sr	room	air	21.000	90.0		84.000	280.0		8.00-11.	75.	500.
				42.000	170.0		63.000	290.0		8.00-11.	75.	500.
				84.000	300.0		21.000	220.0		8.00-11.	75.	500.
	Ba	air	21.000	12000.0						4.00-7.	106.	500.
				42.000	10000.0		21.000	27000.0		4.00-7.		106.
				42.000	23000.0		21.000	41000.0		4.00-7.	106.	500.
	Ce	room	air	21.000	870.0					7.00-7.	106.	500.
				42.000	2900.0		21.000	13000.0		7.00-7.		106.
				42.000	1900.0		21.000	12000.0		7.00-7.	106.	500.
Cs	room	air	21.000	15000.0					1.00-9.	106.	500.	
			42.000	6900.0		21.000	23000.0		1.00-9.		106.	
			42.000	22000.0		21.000	30000.0		1.00-9.	106.	500.	
Eu	room	air	21.000	1700.0					5.00-8.	106.	500.	
			42.000	3100.0		21.000	6800.0		5.00-8.		106.	
			42.000	2700.0		21.000	9300.0		5.00-8.	106.	500.	
Sr	room	air	21.000	15000.0					7.00-8.	106.	500.	
			42.000	1200.0		21.000	4200.0		7.00-8.		106.	
			42.000	2500.0		21.000	2900.0		7.00-8.	106.	500.	
Tc	room	air	42.000	0.11		63.000	2.3		1.00-9.	106.	500.	
			42.000	0.14		63.000	1.2		1.00-6.	106.	500.	
			42.000	0.16		63.000		1.5	1.00-3.	106.	500.	
			42.000	0.2		63.000	1.6		1.00-12.	106.	500.	

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-49											
Am	room	air	21.000	2900.0		84.000	19000.0		1.00-7.	106.	250.
			42.000	2800.0		63.000	3800.0		1.00-7.	106.	250.
			84.000	7100.0		21.000	3000.0		1.00-7.	106.	250.
Ba	room	air	21.000	17000.0		42.000	28000.0		4.00-7.		106.
			21.000	26000.0		42.000	51000.0		4.00-7.	106.	500.
			21.000	30000.0					4.00-7.	106.	500.
			42.000	9200.0					4.00-7.		106.
			42.000	59000.0	54000.0	21.000	69000.0	76000.0	4.00-7.	106.	500.
Ce	room	air	21.000	570.0		42.000	1400.0		3.00-7.		106.
			21.000	560.0		42.000	1000.0		3.00-7.	106.	500.
			21.000	490.0					3.00-7.	106.	500.
			42.000	530.0					3.00-7.		106.
			42.000	810.0	350.0	21.000	1100.0	970.0	3.00-7.	106.	500.
Cs	room	air	21.000	22000.0		42.000	15000.0		1.00-9.		106.
			21.000	29000.0		42.000	38000.0		1.00-9.	106.	500.
			21.000	37000.0					1.00-9.	106.	500.
			42.000	8700.0					1.00-9.		106.
			42.000	36000.0	43000.0	21.000	40000.0	40000.0	1.00-9.	106.	500.
Eu	room	air	21.000	1400.0		42.000	2200.0		1.00-7.	106.	
			21.000	1200.0					1.00-7.	106.	500.
			21.000	1000.0		42.000	1600.0		1.00-7.	106.	500.
			42.000	1300.0					1.00-7.		106.
			42.000	1500.0	1000.0	21.000	3100.0	1600.0	1.00-7.	106.	500.
Np	room	air	21.000	15.0		84.000	6.7		7.00-11.	106.	250.
			42.000	5.3		63.000	9.2		7.00-11.	106.	250.
			84.000	6.3		21.000	20.0		7.00-11.	106.	250.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
Pu	room	air	21.000	270.0		21.000	690.0		3.00- 8.	75.	
			21.000	170.0		21.000	700.0		2.00-12.		75.
			21.000	180.0		21.000	490.0		4.00-10.		75.
			21.000	130.0		21.000	780.0		1.00-10.		75.
			21.000	160.0		21.000	840.0		8.00-12.		75.
			21.000	140.0		21.000	590.0		1.00-10.	75.	500.
			21.000	390.0		21.000	1300.0		1.00-10.	75.	500.
			21.000	150.0		21.000	670.0		2.00-12.	75.	500.
			21.000	220.0		21.000	620.0		4.00-10.	75.	500.
			21.000	89.0		21.000	790.0		8.00-12.	75.	500.
			21.000	2000.0		21.000	1700.0		8.00-10.	75.	500.
			21.000	130.0		21.000	720.0		3.00-12.	75.	500.
			21.000	120.0		21.000	560.0		1.00-8.	75.	500.
			21.000	240.0		21.000	700.0		2.00-11.	75.	500.
			21.000	240.0		21.000	340.0		3.00-8.	75.	500.
			21.000	140.0		84.000	390.0		3.00-12.	106.	250.
			42.000	160.0	200.0	63.000	410.0	440.0	3.00-12.	106.	250.
			84.000	210.0	820.0	21.000	660.0	930.0	3.00-12.	106.	250.
Sr	room	air	21.000	1500.0		42.000	2400.0		6.00-8.		106.
			21.000	2700.0		42.000	4400.0		6.00-8.	106.	500.
			21.000	2600.0					6.00-8.	106.	500.
			42.000	2400.0					6.00-8.		106.
			42.000	3800.0	3800.0	21.000	4400.0	4300.0	6.00-8.	106.	500.
Tc	room	air	42.000	0.23		63.000	2.3		1.00-12.	106.	500.
			42.000	0.25		63.000	2.7		1.00-9.	106.	500.
			42.000	0.2		63.000	1.5		1.00-6.	106.	500.
			42.000	0.16		63.000	1.3		1.00-3.	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax	
<u>Core</u>												
YM-54												
Am	room	air	21.000	900.0		84.000	690.0		1.00-7.		75.	
			21.000	150.0		84.000	400.0		1.00-7.	75.	500.	
			42.000	1300.0		63.000	670.0		1.00-7.		75.	
			42.000	150.0		63.000	680.0		1.00-7.	75.	500.	
			84.000	900.0		21.000	560.0		1.00-7.		75.	
			84.000	160.0		21.000	570.0		1.00-7.	75.	500.	
		ca	21.000	1000.0		84.000	2400.0		1.00-7.		75.	
			21.000	650.0		84.000	1400.0		1.00-7.	75.	500.	
			42.000	1400.0		63.000	3200.0		1.00-7.		75.	
			42.000	620.0		63.000	1600.0		1.00-7.	75.	500.	
			84.000	1900.0		21.000	3800.0		1.00-7.		75.	
			84.000	660.0		21.000	2900.0		1.00-7.	75.	500.	
	Ba	room	air	21.000	1700.0					3.00-7.		38.
				21.000	1600.0					3.00-7.		38.
				21.000	520.0		42.000	690.0		3.00-7.		106.
				21.000	480.0					3.00-7.	38.	106.
21.000				470.0					3.00-7.	38.	106.	
21.000				130.0					3.00-7.	106.	500.	
21.000				150.0					3.00-7.	106.	500.	
21.000				720.0		42.000	620.0		3.00-7.	106.	500.	
ca	42.000		650.0		21.000	680.0		3.00-7.		106.		
	42.000		590.0		21.000	640.0		3.00-7.	106.	500.		
	21.000		610.0		42.000	630.0		1.00-7.		75.		
	21.000		870.0		42.000	470.0		1.00-7.	75.	500.		
	42.000		740.0		21.000	660.0		1.00-7.		75.		
	42.000		620.0		21.000	640.0		1.00-7.	75.	500.		
	84.000		660.0					1.00-7.		75.		
	84.000		350.0					1.00-7.	75.	500.		
Ce	room	air	21.000	110.0		42.000	1000.0		9.00-7.		106.	
			21.000	180.0		42.000	1500.0		9.00-7.	106.	500.	

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-54											
Ce	room	air	42.000	170.0		21.000	690.0		9.00-7.		106.
			42.000	110.0		21.000	720.0		9.00-7.	106.	500.
	ca		21.000	150.0		42.000	840.0		1.00-7.		75.
			21.000	110.0		42.000	680.0		1.00-7.	75.	500.
			42.000	860.0		21.000	2400.0		1.00-7.		75.
			42.000	540.0		21.000	2100.0		1.00-7.	75.	500.
			84.000	970.0					1.00-7.		75.
			84.000	490.0					1.00-7.	75.	500.
Cs	room	air	21.000	890.0					3.00-9.		38.
			21.000	940.0					3.00-9.		38.
			21.000	270.0		42.000	270.0		2.00-9.		106.
			21.000	190.0					3.00-9.	38.	106.
			21.000	190.0					3.00-9.	38.	106.
			21.000	130.0					3.00-9.	106.	500.
			21.000	290.0		42.000	290.0		2.00-9.	106.	500.
			21.000	110.0					3.00-9.	106.	500.
	ca		42.000	230.0		21.000	320.0		2.00-9.		106.
			42.000	200.0		21.000	350.0		2.00-9.	106.	500.
			21.000	360.0		42.000	460.0		3.00-9.		75.
			21.000	210.0		42.000	260.0		3.00-9.	75.	500.
			42.000	370.0		21.000	420.0		3.00-9.		75.
			42.000	260.0		21.000	310.0		3.00-9.	75.	500.
			84.000	390.0					3.00-9.		75.
			84.000	240.0					3.00-9.	75.	500.
	room	air	21.000	1600.0					4.00-8.		38.
			21.000	1600.0					4.00-8.		38.
			21.000	390.0		42.000	1900.0		1.00-7.		106.
			21.000	420.0					4.00-8.	38.	106.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-54											
Eu	room	air	21.000	260.0					4.00-8.	38.	106.
			21.000	440.0					4.00-8.	106.	500.
			21.000	580.0		42.000	2100.0		1.00-7.	106.	500.
			21.000	490.0					4.00-8.	106.	500.
			42.000	700.0		21.000	1700.0		1.00-7.		106.
			42.000	370.0		21.000	1700.0		1.00-7.	106.	500.
	ca		21.000	530.0		42.000	1700.0		2.00-7.		75.
			21.000	330.0		42.000	1500.0		2.00-7.	75.	500.
			42.000	1400.0		21.000	2600.0		2.00-7.		75.
			42.000	850.0		21.000	2100.0		2.00-7.	75.	500.
			84.000	1500.0					2.00-7.		75.
			84.000	770.0					2.00-7.	75.	500.
	room	air	21.000	66.0		84.000	830.0		5.00-12.		75.
			21.000	52.0		84.000	660.0		5.00-12.	75.	500.
			42.000	64.0		63.000	590.0		5.00-12.		75.
			42.000	81.0		63.000	600.0		5.00-12.	75.	500.
			84.000	76.0		21.000	670.0		5.00-12.		75.
			84.000	160.0		21.000	660.0		5.00-12.	75.	500.
		ca	21.000	65.0		84.000	1000.0		3.00-13.		75.
			21.000	110.0		84.000	850.0		3.00-13.	75.	500.
			42.000	100.0		63.000	780.0		3.00-13.		75.
			49.000	205.0		56.000	1600.0		3.00-13.	75.	500.
			84.000	120.0		21.000	1900.0		3.00-13.		75.
Sr	room	air	21.000	280.0					6.00-7.		38.
			21.000	270.0					6.00-7.		38.
			21.000	95.0		42.000	120.0		6.00-7.		106.
			21.000	56.0					6.00-7.	38.	106.
			21.000	57.0					6.00-7.	38.	106.
			21.000	42.0					6.00-7.	106.	500.

Element	Temp	Atm	Stime	srd1	srd2	dtime	drd1	drd2	Conc	pmin	pmax
<u>Core</u>											
YM-54											
Sr	room	air	21.000	88.0		42.000	80.0		6.00-7.	106.	500.
			21.000	37.0					6.00-7.	106.	500.
			42.000	97.0		21.000	110.0		6.00-7.		106.
			42.000	80.0		21.000	84.0		6.00-7.	106.	500.
			42.000	150.0		21.000	120.0		8.00-8.		75.
			42.000	130.0		21.000	120.0		8.00-8.	75.	500.
			84.000	130.0					8.00-8.		75.
			84.000	70.0					8.00-8.	75.	500.
		ca	21.000	100.0		42.000	150.0		8.00-8.		75.
			21.000	76.0		42.000	110.0		8.00-8.	75.	500.
Tc	room	ca	21.000	0.7		84.000	37.0		1.00-12.		75.
			21.000	4.7		84.000	140.0		1.00-12.	75.	500.
			42.000	0.8		63.000	13.0		1.00-12.		75.
			42.000	3.8		63.000	38.0		1.00-12.	75.	500.
			84.000	3.4		21.000	5.0		1.00-12.		75.
			84.000	33.0		21.000	240.0		1.00-12.	75.	500.
U	room	air	7.000	2.0		14.000	14.0		1.00-6.		106.
			7.000	1.0		14.000	4.0		1.00-6.	106.	500.
			14.000	2.0		7.000	15.0		1.00-6.		106.
			14.000	2.0		7.000	19.0		1.00-6.	106.	500.
			21.000	2.0					1.00-6.		106.
			21.000	1.0					1.00-6.	106.	500.
		ca	7.000	1.0					1.00-6.		75.
			7.000	.8					1.00-6.	75.	500.
			14.000	1.8					1.00-6.		75.
			14.000	1.4					1.00-6.	75.	500.
			21.000	2.3					1.00-6.		75.
			21.000	1.7					1.00-6.	75.	500.