

YUCCA
MOUNTAIN
PROJECT

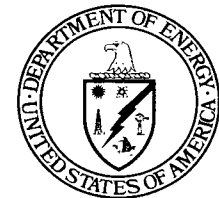
Studies

Inferences from Saturated Zone Water Chemistry and Implications for Transport Parameters

Presented to:
Nuclear Waste Technical Review Board

Presented by:
Arend Meijer
LANL/GCX

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U.S. Department of Energy
Office of Civilian Radioactive
Waste Management

Important Water/Rock Reactions

- Precipitation/Dissolution Reactions



- Ion Exchange Reactions



- Hydrolysis Reactions



Inferences and Implications from Data on Major Constituents in Waters from Volcanic Aquifers (Rock and Alluvium)

DATA: Major constituent concentrations show only limited variability in waters along flowlines from Pahute Mesa/Rainier Mesa through Yucca Mountain and into Amargosa Valley.

INFERENCE: Major constituent concentrations largely buffered by water/rock reactions.

Na⁺/H⁺ reaction continues along flowline.

IMPLICATION: Variations in concentrations of major constituents in saturated zone waters are unlikely to have a major influence on transport parameter values.

Inferences and Implications from Data on Major Constituents in Waters from Volcanic Aquifers (Rock and Alluvium)

(Continued)

DATA: The ages of waters along flowpath along flowlines are up to 20,000 yr BP.

INFERENCE: Time of infiltration is not a major factor in control of concentrations of major constituents in waters along flowlines. Water/rock interactions buffer these concentrations.

IMPLICATION: Climatic variations are not a major influence on concentrations of major constituents in saturated zone waters.

Major Constituents in Saturated Zone Waters Along Flowlines from Pahute Mesa To Amargosa Valley

	Pahute Mesa" TW-8 Tv	"Yucca Mountain" J-13 Tv	Lathrop Wells "Airport Well" Qa1	Yucca Mountain Ue25p#1 Ds
Ca	8.8	13	5.6	100
Mg	0.9	2.1	0.2	39
Na	30	44	70	150
K	3.3	5.0	1.5	12
HCO ₃ /CO ₃	78/0	124/0	110/7	694/0
Cl	7.8	7.2	10	28
SO ₄	16	20	46	160
NO ₃	3.6	10.1	6.2	0
SiO ₂	45	64	40	64
pH	6.8	7.3	9.0	6.6
Eh	?	?	?	

Inferences and Implications From Data on Major Constituents in Waters from Volcanic Aquifers (Rock and Alluvium)

- DATA:** Well J-13 is in middle portion of flowline and samples volcanic aquifer.
- INFERENCE:** J-13 water is representative of major constituents in saturated zone waters in volcanic aquifers.
- IMPLICATION:** J-13 water can be used to represent saturated zone water in laboratory experiments carried out to obtain transport parameters.
- DATA:** pH in saturated zone waters shows substantial variation from 6.5-9.0.
- INFERENCE:** The partial pressure of CO₂ varies substantially along flowpath.
- IMPLICATION:** Laboratory experiments should be carried out over a range of pH values.

Inferences and Implications from Data on Major Constituents in Waters from Volcanic Aquifers (Rock and Alluvium)

(Continued)

- DATA:** Oxidation/reduction potential (Eh) in saturated zone waters at Yucca Mountain shows a range from -143 to 365 mv but data are very limited. Methane found in some wells.
- INFERENCE:** Eh of waters in saturated zone downgradient of potential repository may be sufficiently low to stabilize lower oxidation states of redox sensitive radionuclides.
- IMPLICATION:** If lower oxidation states were stable, the transport of Tc and Np would be greatly retarded. Need more data on Eh in saturated zone waters.

Redox Potential Measurements in Yucca Mountain Waters to Date

- **Ogard and Kerrisk (1984)**
 - Los Alamos Report LA-10188-MS
 - Platinum Electrode in Pumped Water
 - Metal pump and tubing
- **Results**
 - Range -143 to + 395 mv (H-3 and H-6 respectively)
 - Average 225 mv
 - Lower values obtained in “thief” samples (Average = 110 mv)

Important Redox-Sensitive Radionuclides

- **Neptunium-237**

- $\text{Np}^{4+} \leftrightarrow \text{Np}^{5+} + \text{e}^-$
- $\text{Np}(\text{OH})_4^0 \leftrightarrow \text{NpO}_2^+$
- At pH = 7.0, Eh = 100-200 mv

- **Technetium-99**

- $\text{Tc}^{4+} \leftrightarrow \text{Tc}^{7+}$
- $\text{Tc}(\text{OH})_4 \leftrightarrow \text{TcO}_4^-$
- At pH = 7.0, Eh = 200-300 mv

New Measurements Planned

- **Measurements to be made on redox state of saturated zone waters**
- **Measurements to be carried out on pumped water**
- **Pumping system to be almost completely non-metallic**
- **Wells will be cleaned out and purged**
- **Pumped water will be monitored for redox parameters**

Parameters To Be Measured

- **Platinum and/or gold electrode potential (Eh)**
- **Redox couples including $\text{Fe}_{\text{total}}/\text{Fe}^{2+}$, $\text{SO}_4^{2-}/\text{HS}^-$, $\text{NO}_3^-/\text{NO}_2^-$ and others**
- **DO, pH, TDS, turbidity**
- **Major constituents (USGS)**
- **Environmental isotopes (USGS)**