YUCCA MOUNTAIN PROJECT

Studies

Inferences from Saturated Zone Water Chemistry and Implications for Transport Parameters

Presented to:
Nuclear Waste Technical Review Board

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Important Water/Rock Reactions

- Precipitation/Dissolution Reactions

  $Ca^{2+} + CO_3^{2-} \longleftrightarrow CaCo_3$ (Calcite)

  Volcanic Glass $\longrightarrow Na^+ + Ca^{2+} + H_4SiO_4 +$

- Ion Exchange Reactions

  $Ca^{2+} + Na_2Zeol \longleftrightarrow CaZeol + 2Na^+$

  H^+ + NaGlass $\longleftrightarrow$ Hglass + Na^+

  H^+ + NaFeldspar $\longleftrightarrow$ Hfeldspar + Na^+

- Hydrolysis Reactions

  $H_2O + CO_2 \longleftrightarrow H_2CO_3 \longleftrightarrow H^+ + HCO_3$

  -Si-O-Si + $H_2O \longrightarrow$ -Si-OH OH-SI-

  -Al-O-Al- + $H_2O \longrightarrow$ -Al-OH OH-Al-

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" Qal	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 CO_2 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
  - $Np^{4+} \Leftrightarrow Np^{5+} + e^-$
  - $Np(OH)_4^o \Leftrightarrow NpO_2^+$
  - At pH = 7.0, Eh = 100-200 mv
- Technetium-99
  - $Tc^{4+} \Leftrightarrow Tc^{7+}$
  - $Tc(OH)_4 \Leftrightarrow TcO_4^-$
  - 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 $Fe_{total}/Fe^{2}+$, SO_4^{2-}/HS^-, NO_3^-/NO_2^- and others
- DO, pH, TDS, turbidity
- Major constituents (USGS)
- Environmental isotopes (USGS)