COMMENTS CONCERNING THE USE OF URANIUM-BEARING MINERALS AND CHLORINE-36 TO RECONSTRUCT WATER MOVEMENT AT YUCCA MOUNTAIN

by

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Presentation to the United States
Nuclear Waste Technical Review Board

Denver, Colorado
July, 1996

1.

OUTLINE

- Introduction
  - Material to be covered
  - Water is not "dated"
  - History of nuclides
- Use of Uranium
  - Disequilibrium
  - Distance of movement not determined
- Use of Chlorine-36
  - Origin and distribution
  - Importance of bromide
  - Possible sources of anomalies
  - In situ production
  - Dissolution of surface rocks
  - Effects of microhydrology
- Conclusions

3.

PRODUCTION OF CHLORINE-36

(half-life = 301,000 yrs)

1. Ar-40 + p $\Rightarrow$ Cl-36 + α + n
2. Cl-35 + n $\Rightarrow$ Cl-36 + γ
3. Ca-40 + $\bar{\mu}$ $\Rightarrow$ Cl-36 + α
4. K-39 + n $\Rightarrow$ Cl-36 + α

Atmospheric origin:	reaction 1
Land surface:	reactions 2, 3, & 4
Deep subsurface:	reaction 2

4.

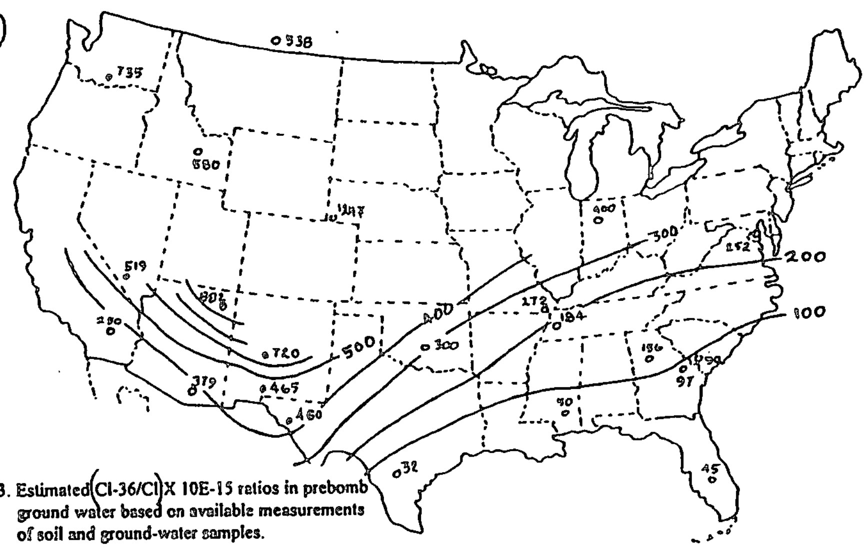
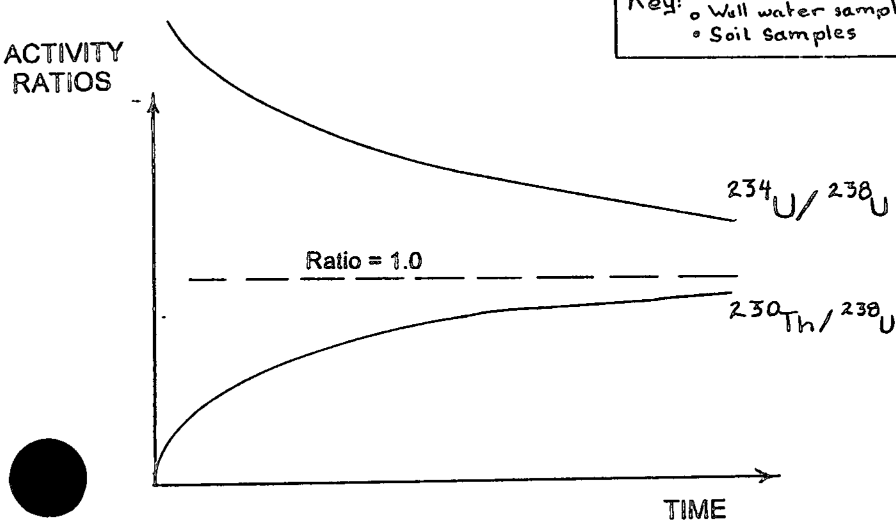


Figure 3. Estimated (Cl-36/Cl) X 10E-15 ratios in prebomb ground water based on available measurements of soil and ground-water samples.

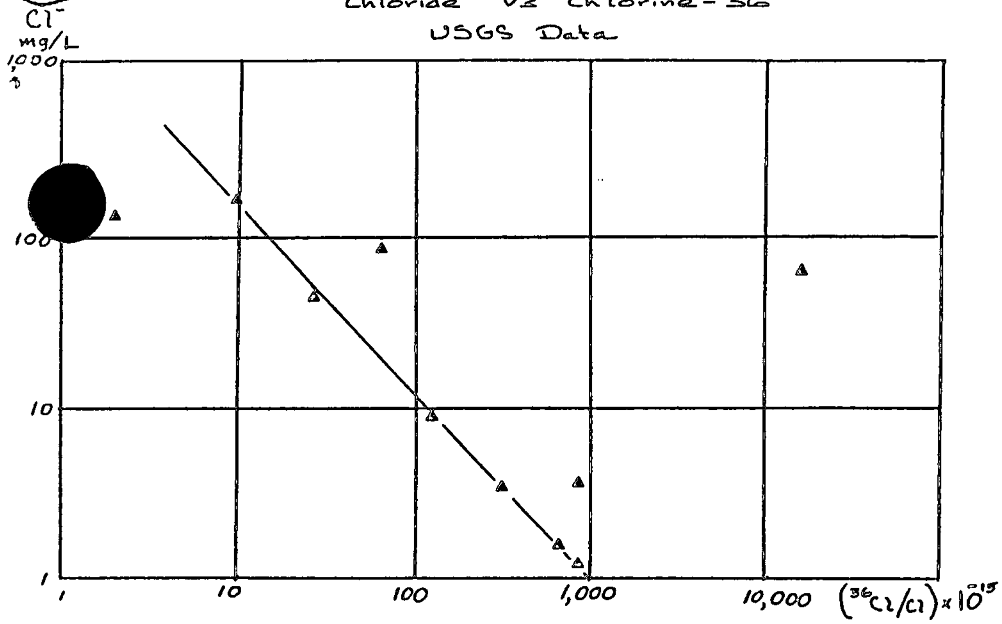
Key: ○ Well water samples
• Soil samples

2.



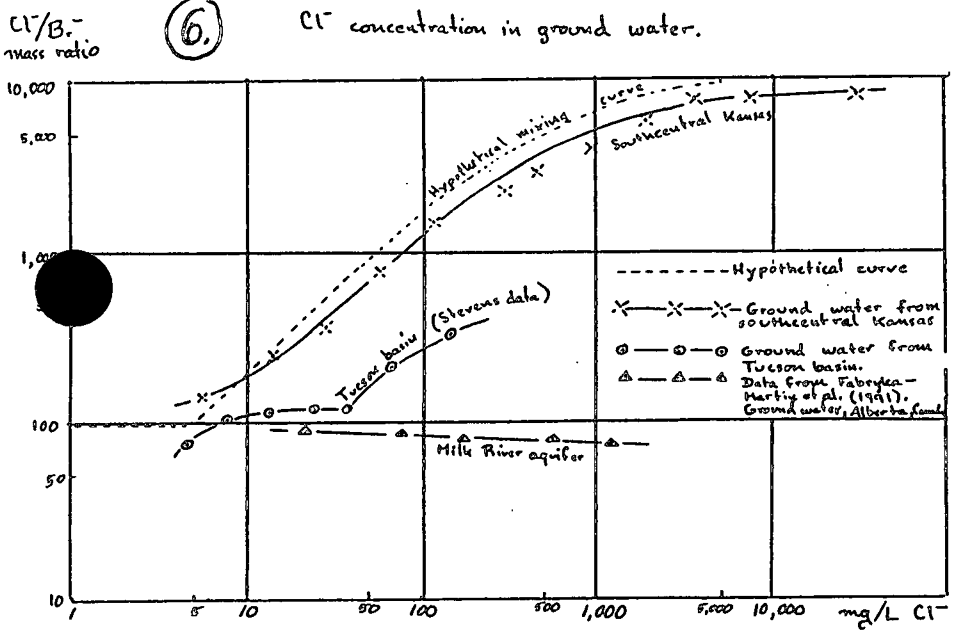
5.

NORTHEASTERN ARIZONA
Chloride vs chlorine-36
USGS Data



6.

Median values of Cl^-/Br^- ratios related to the Cl^- concentration in ground water.

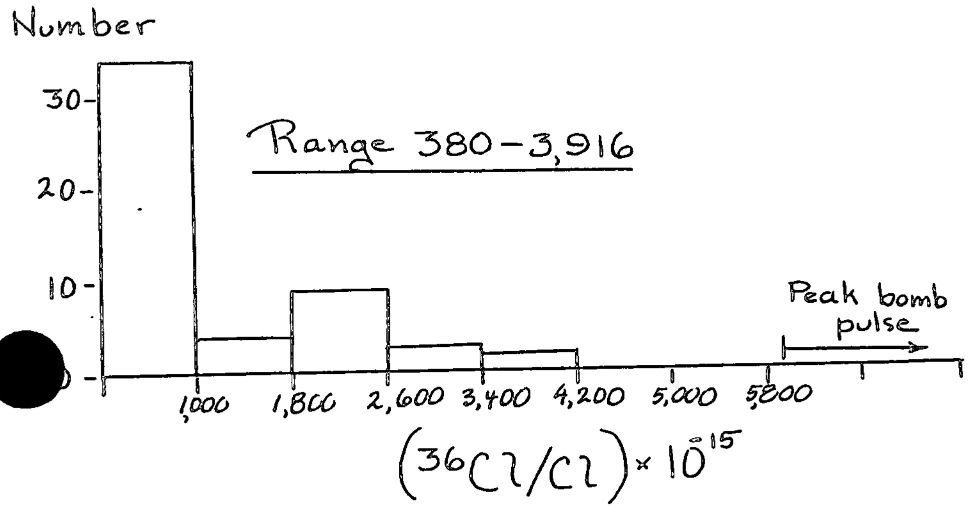


7.

SOME ^{36}Cl/total Cl RATIOS

Bomb fallout	
Yucca Mountain, NV	$3{,}821 \times 10^{-15}$
West Texas	$6{,}560 \times 10^{-15}$
New Mexico	$7{,}040 \times 10^{-15}$
New Mexico	$9{,}700 \times 10^{-15}$
New Mexico	$6{,}000 \times 10^{-15}$
Atmospheric constituents	
Stratospheric HCl	$3{,}260 \times 10^{-15}$
Uranium ore	
Koongarra, Australia	$128{,}500 \times 10^{-15}$
Cigar Lake, Canada	$47{,}800 \times 10^{-15}$
Surface rocks	
Meteor Crater	$1{,}400 \times 10^{-15}$
Boulder Bishop Creek	$8{,}500 \times 10^{-15}$

8)



9.

Pluralites non est ponenda sine necessitate.

"Multiplicity ought not to be posited without essity."

— William Ockham (1280-1349)

10.

POSSIBLE SOURCES OF CHLORINE-36 ANOMALIES

1. Testing nuclear explosives
2. Fluctuations of cosmic-ray production
3. In situ natural production
4. Dissolution of surface rocks
5. Variations in total chloride deposition
6. Variations of ^{36}Cl in troposphere related to annual recharge
7. Atomic reactor sources
8. Contamination of sample (Lucas Heights)
9. Analytical problems
10. Gas-phase transport
11. Prehistoric supernovas

11.

CHLORINE-36 FROM DISSOLUTION OF SURFACE ROCKS

<u>Assume</u>

Rock with 100 mg/kg chloride
Chloride with $^{36}Cl/Cl$ ratio of 10^{-11}
Available water per 1.0 cm^2 = 200 ml
Inwash cancels erosion
TDS from rock dissolution = 100 mg/L
Precipitation has 0.5 mg/L Cl^- and $^{36}Cl/Cl$ ratio of 5×10^{-13}

<u>Result</u>

3.39×10^5 atoms $^{36}Cl/cm^2$ yr from rock
8.48×10^5 atoms $^{36}Cl/cm^2$ yr from rain
Expected average from atmosphere, about 10^5 atoms $^{36}Cl/cm^2$ yr

12.