

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

by

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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

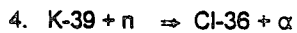
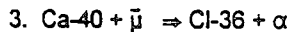
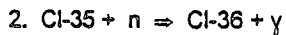
Effects of microhydrology

Conclusions

3.

PRODUCTION OF CHLORINE-36

(half-life = 301,000 yrs)



Atmospheric origin: reaction 1

Land surface: reactions 2, 3, & 4

Deep subsurface: reaction 2

4.

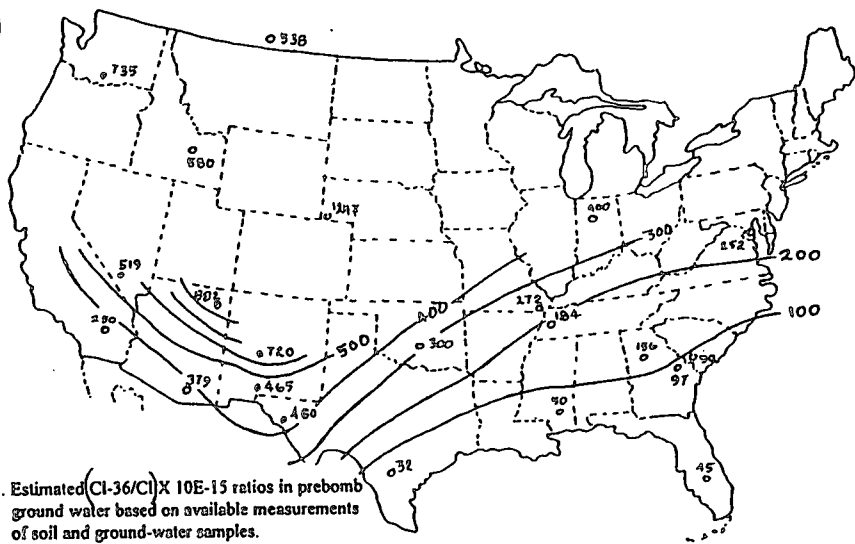
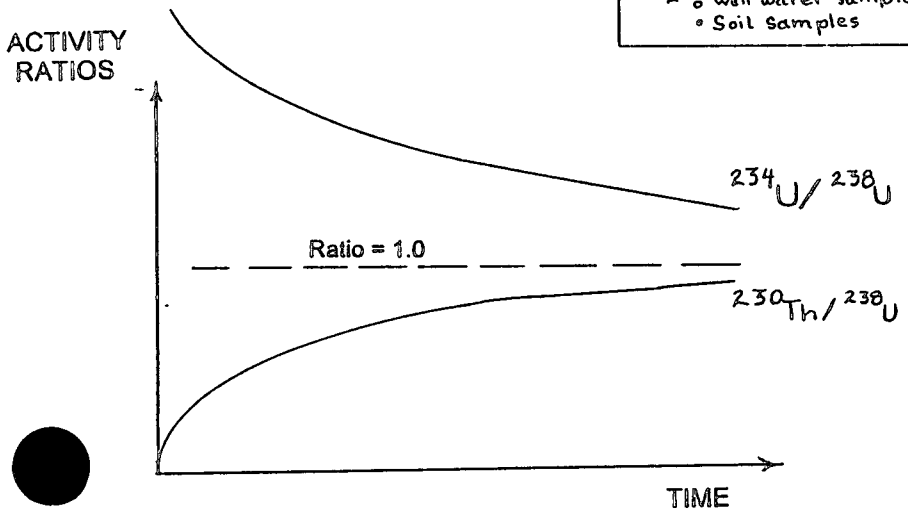


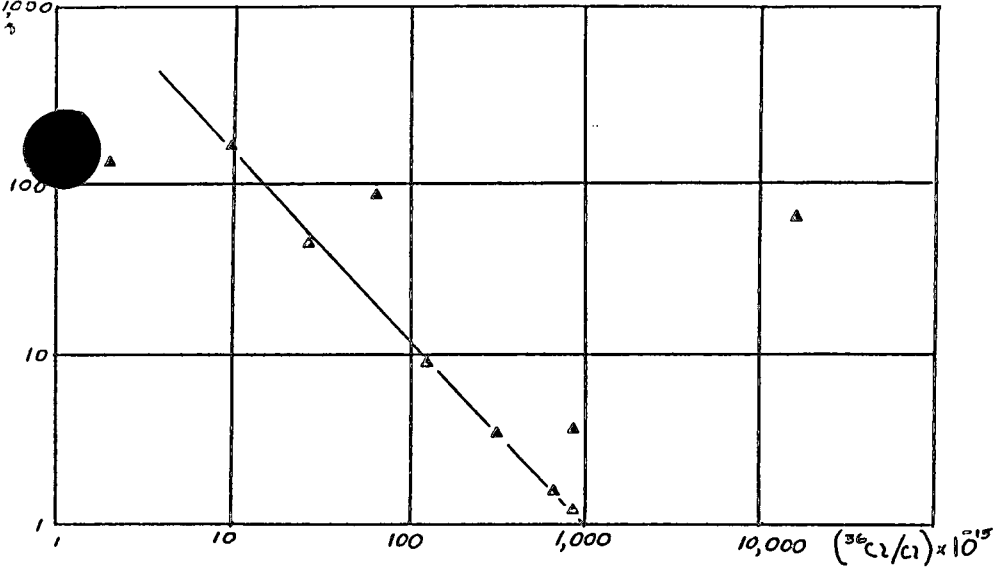
Figure 3. Estimated $(Cl-36/Cl) \times 10E-15$ ratios in prebomb ground water based on available measurements of soil and ground-water samples.

Key:
○ Well water samples
● Soil samples

2.



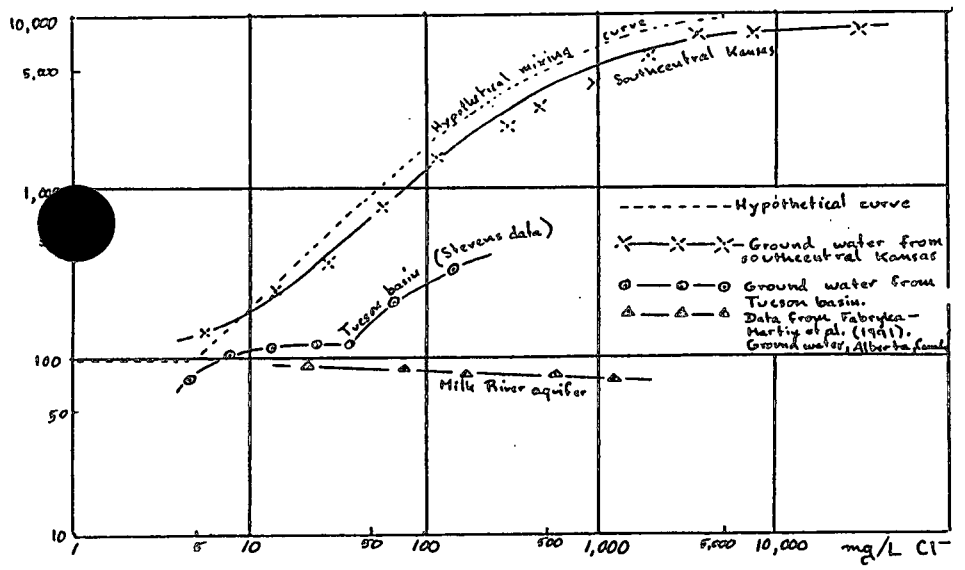
5. NORTHEASTERN ARIZONA
Chloride vs chlorine-36
USGS Data



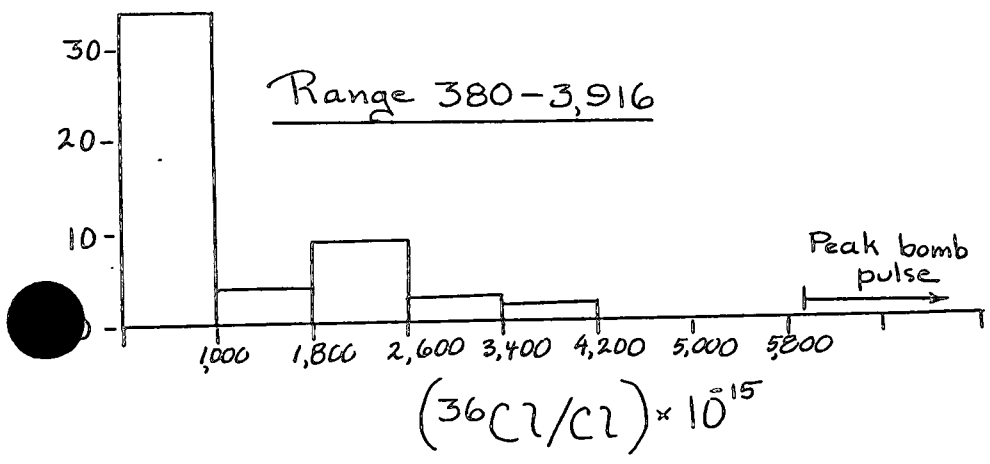
7. SOME ³⁶Cl/total Cl RATIOS

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	$8,500 \times 10^{-15}$

6. Median values of Cl⁻/Br⁻ ratios related to the Cl⁻ concentration in ground water.



8. Number



Pluralites non est ponenda sine necessitate.

"Multiplicity ought not to be posited without necessity."

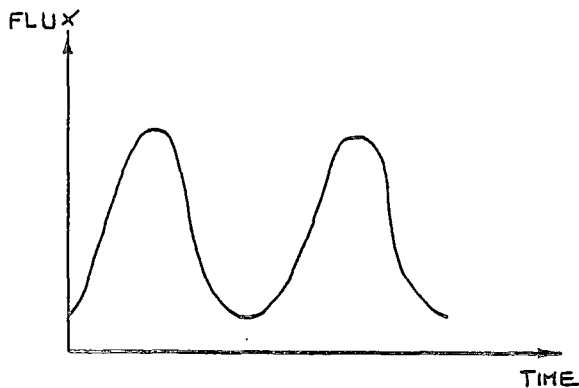
— William Ockham (1280-1349)

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

12.



11.

CHLORINE-36 FROM DISSOLUTION OF SURFACE ROCKS

Assume

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

Result

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

