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

Measurement of ^{36}Cl in ESF

Presented to:
Nuclear Waste Technical Review Board

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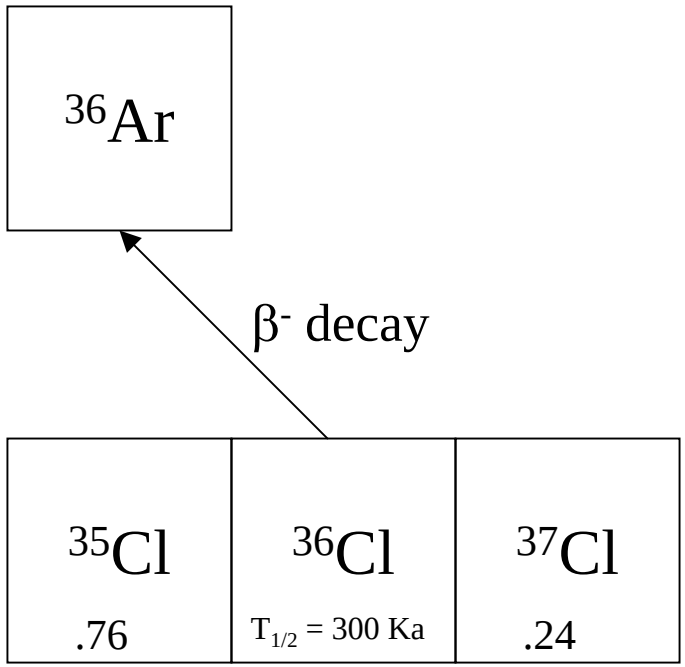
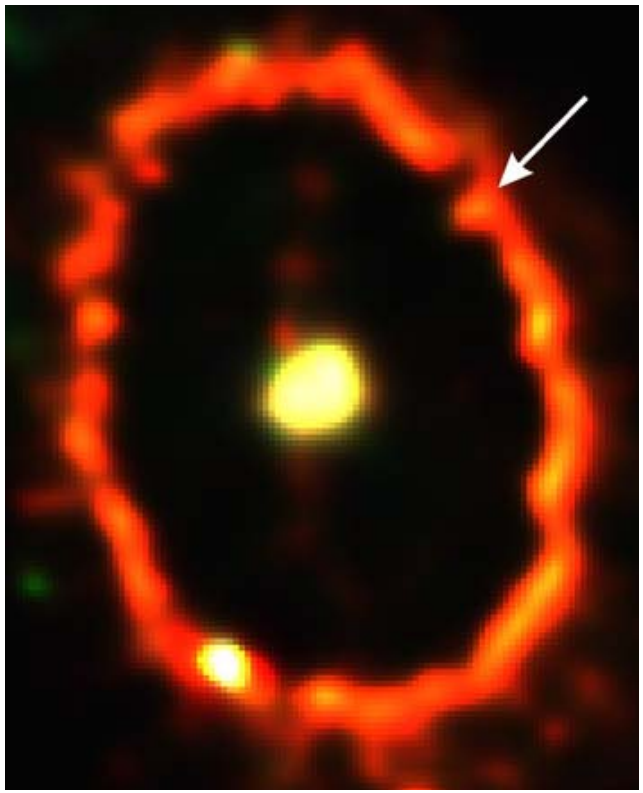
YUCCA MOUNTAIN PROJECT

Nuclear Chemistry of ^{36}Cl

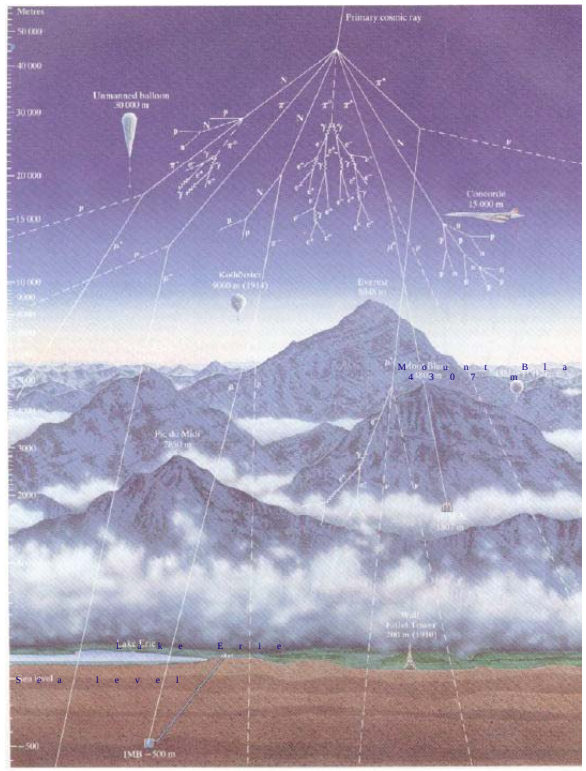


Production of ^{36}Cl

Sources of energetic particles



Sites of ^{36}Cl production



Production of *Bomb-Pulse* Radionuclides

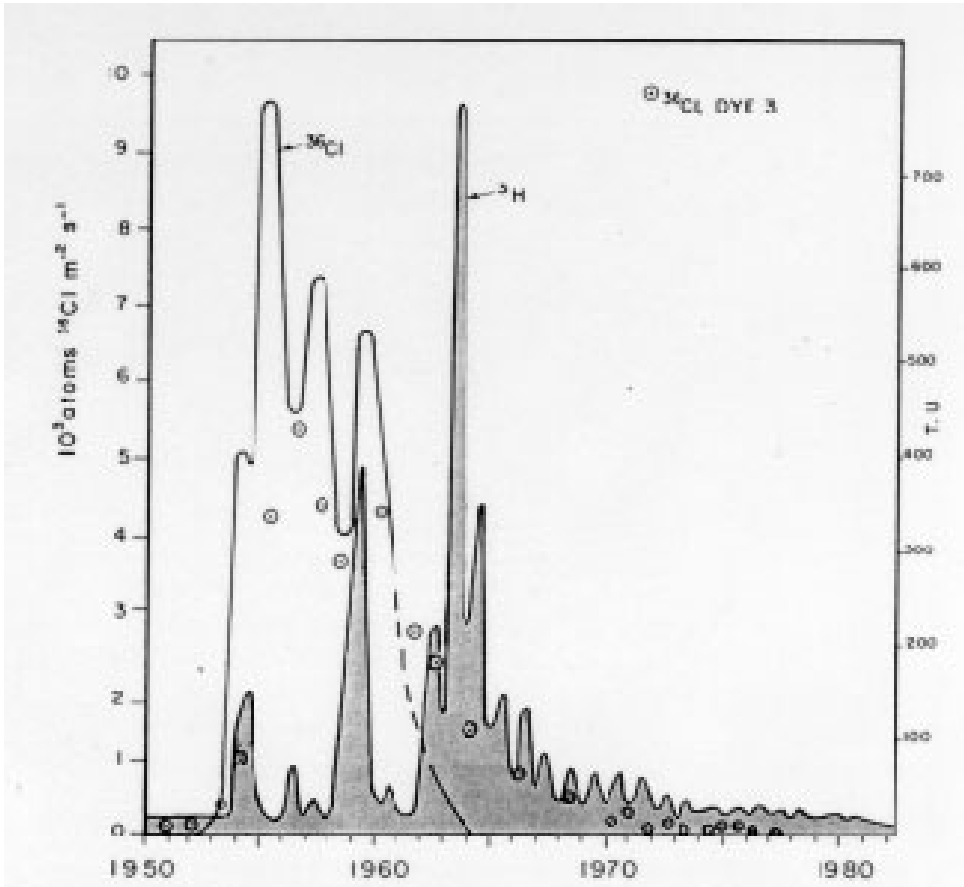


Figure from Phillips *et al*

Data from Elmore *et al*, Bentley *et al*, and IAEA

QuickTime™ and a Photo - JPEG decompressor are needed to see this picture

^{36}Cl Contributors

Pre-bomb
Meteoric ^{36}Cl
Modern ratio
~ 500 x 10^{-15}

^{36}Cl produced in
the subsurface resulting
from U and Th decay
Anticipated ratio ~ 20-50 x 10^{-15}

Bomb-pulse ^{36}Cl
Ratio > 1000 x 10^{-15}

Σ

Measured ^{36}Cl in rock

Method of Validation Study

- **Study multiple bomb-pulse tracers from qualified samples taken from within ESF**
- **In addition to ^{36}Cl, ^{3}H is to be analyzed in all samples**
- **All samples were collected at regular intervals throughout the study zone**
- **Two inch cores were obtained from a depth of up to 4 m**
- **The samples, depth slices, were splits from cores obtained exclusively for this experiment**
- **All samples were cataloged at the SMF**

^{36}Cl Measurements

- **The goal of the ^{36}Cl measurements is to verify the presence of bomb-pulse ^{36}Cl in samples taken from ESF**
- **Accordingly, the sample preparation method was designed to detect the presence of bomb-pulse ^{36}Cl but not necessarily delineate the relative contributions of the other possible ^{36}Cl components**

Sample Preparation

- **The bomb-pulse ^{36}Cl is likely to be the most labile Cl constituent present in the sample**
- **To release this fraction of the Cl and minimize the release of sub-surface-produced-^{36}Cl the rock is crushed and leached with purified water**
- **Every sample has been prepared in the same manner**

Rock Preparation

Crush sample in hydraulic press

↓

Obtain 1-2 cm size fraction (1.5 - 3 kg; yield ~ .7)

↓

Agitate in presence of ultrapure water for 7 hours

↓

Filter solution to .45μ

TIPS CL89, 92, 93, 95, 97, 100, 103, 109, 110

Sample Chemistry

Remove IC analysis aliquots, add Cl carrier, archive more aliquots

↓

Pump leachate through anion resin

↓

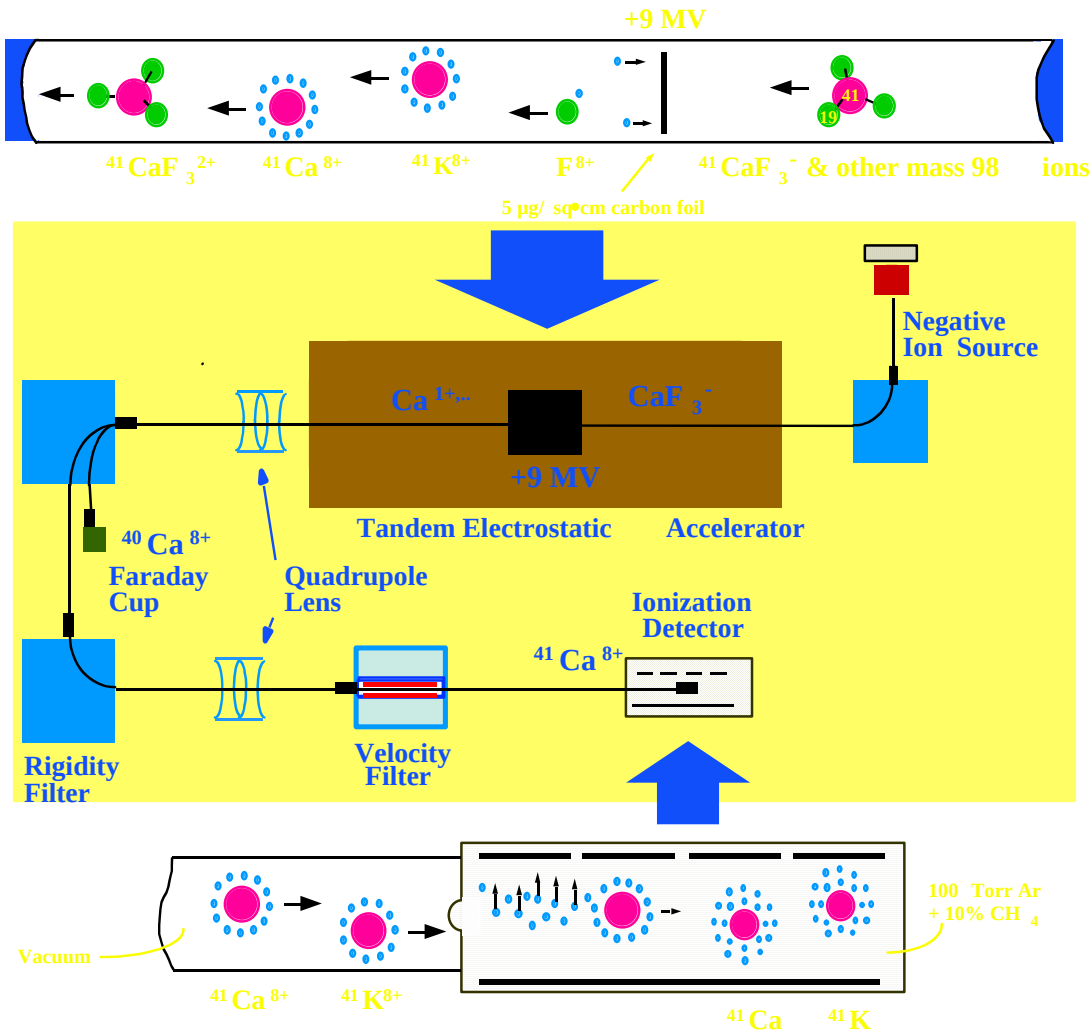
Elute fractions containing Cl

↓

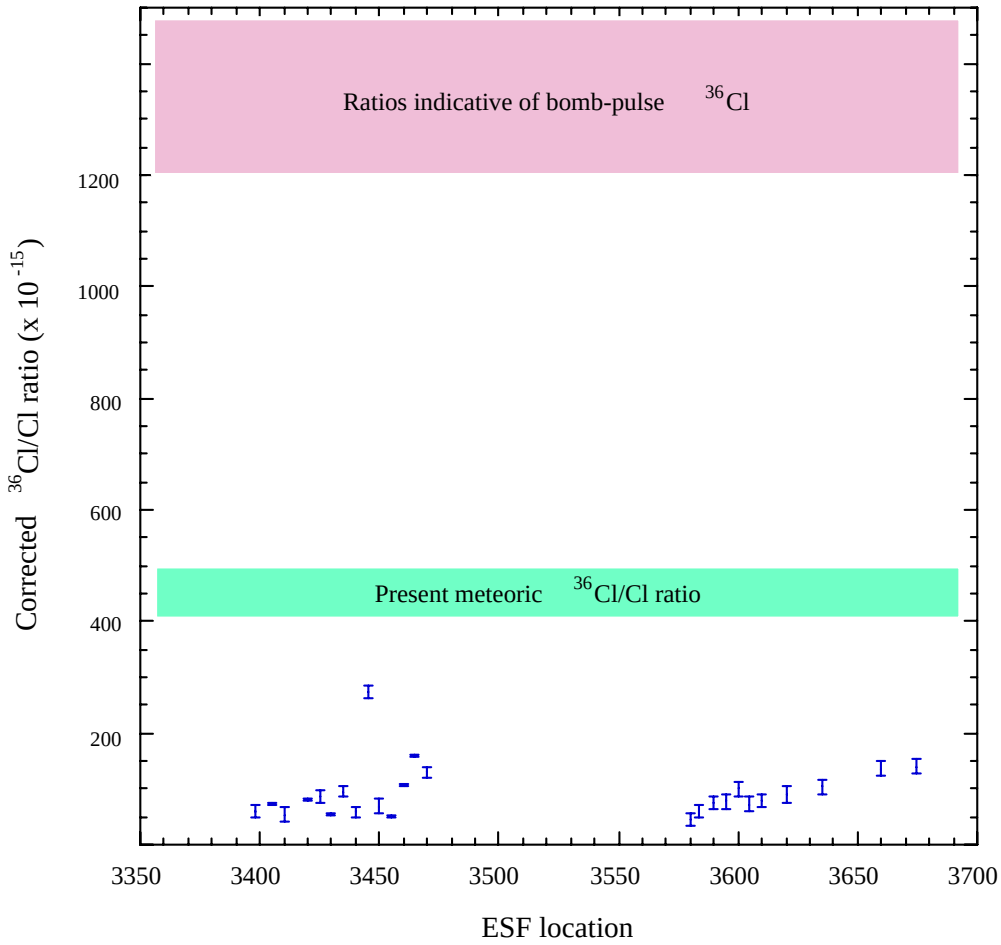
Precipitate Cl as AgCl

TIPS CL89, 92, 93, 95, 97, 100, 103, 109, 110

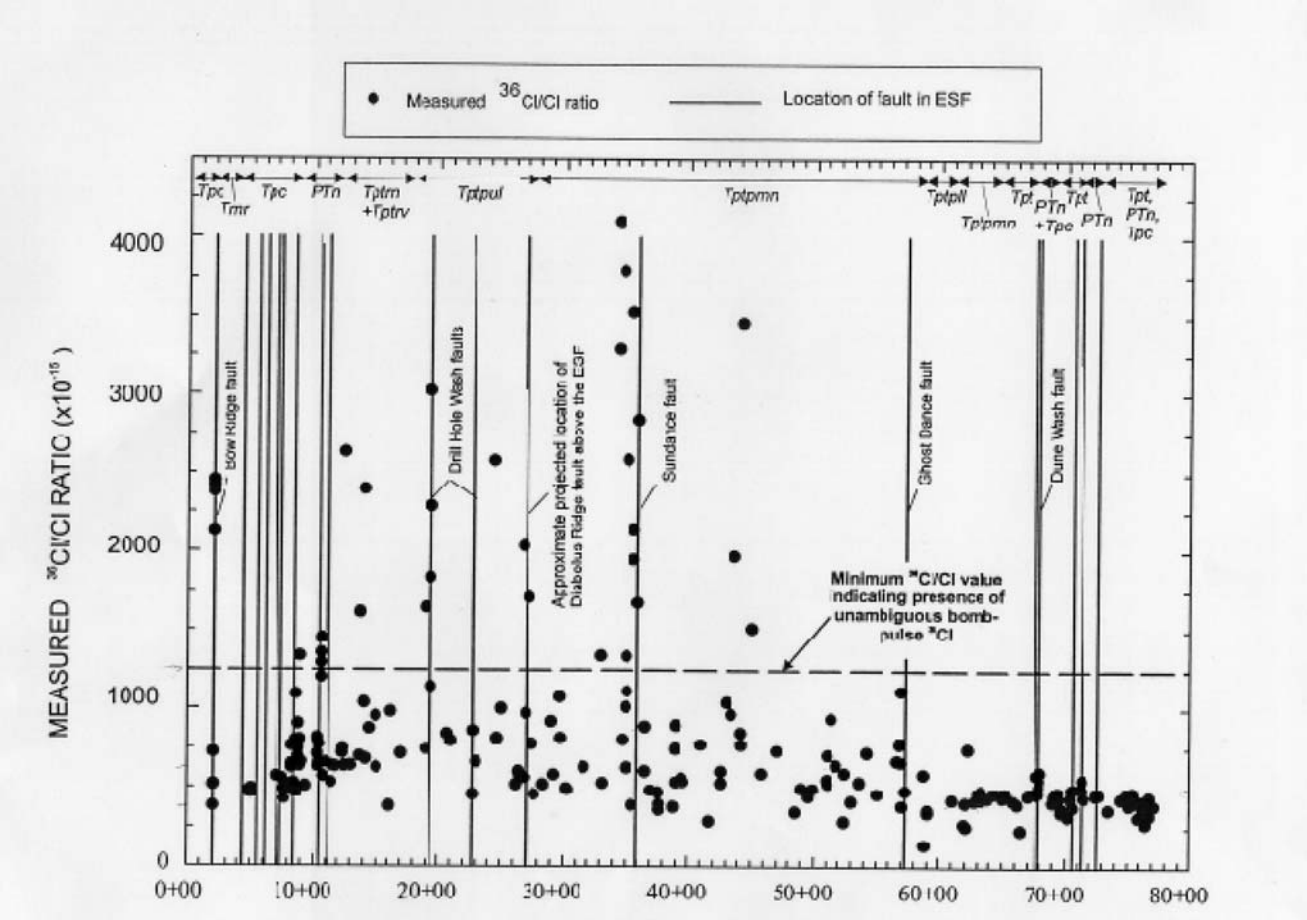
LLNL Accelerator Mass Spectrometry



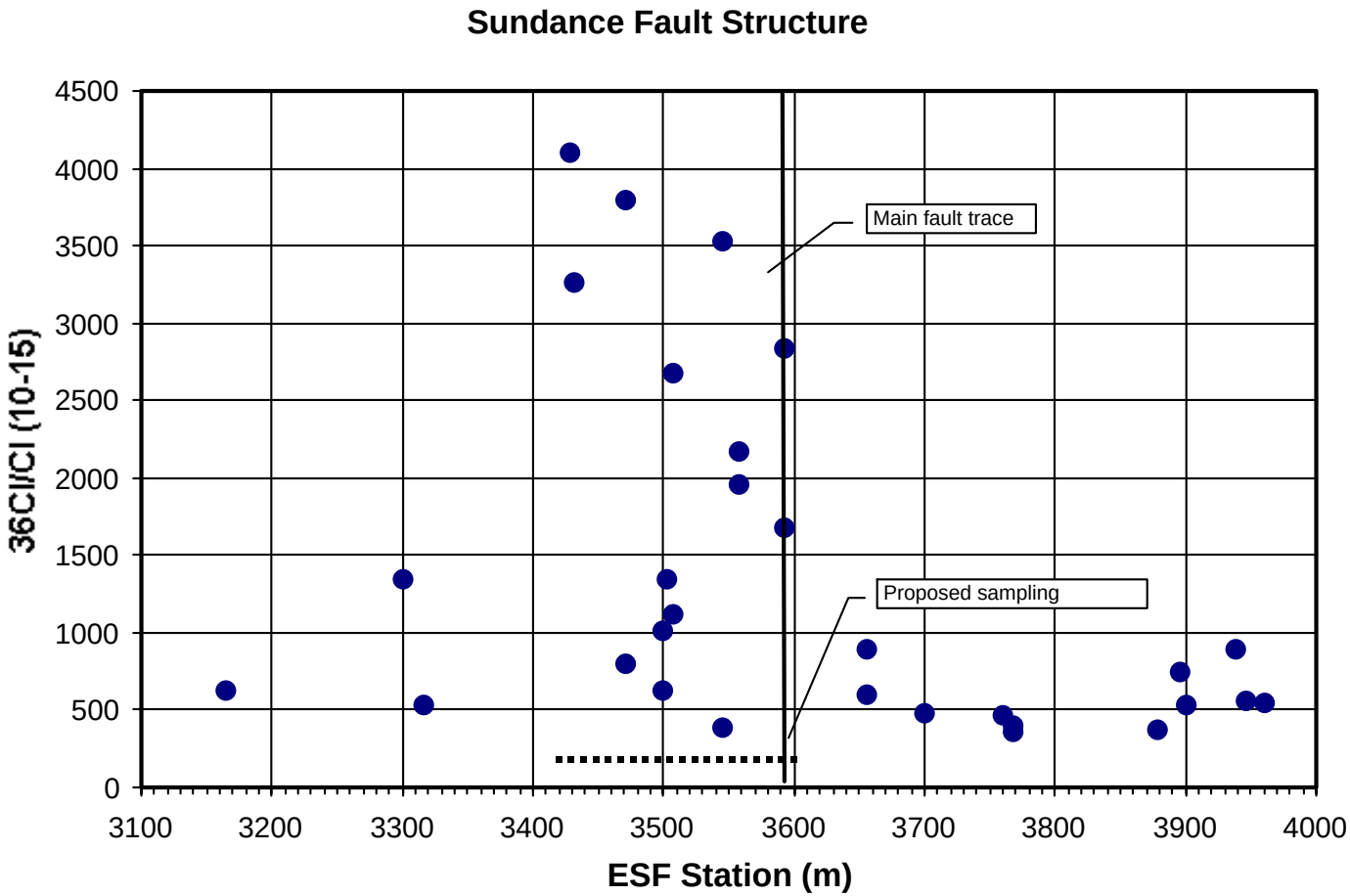
LLNL ^{36}Cl/Cl Results



Previous LANL $^{36}Cl/Cl$ Results



Previous LANL $^{36}Cl/Cl$ Results

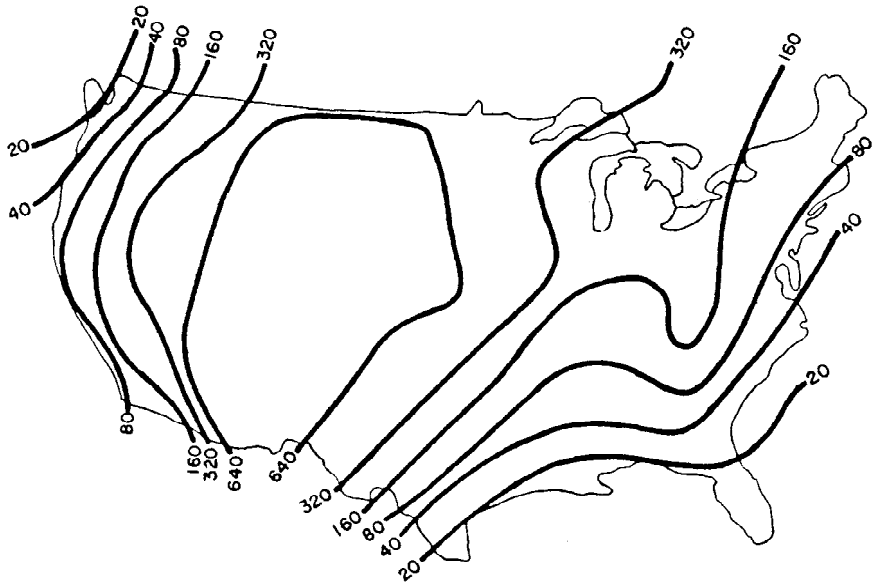


Salient Differences in Results

- **To date, the LLNL measurements have detected no evidence of bomb-pulse ^{36}Cl**
- **We do not observe evidence for increased ^{36}Cl production rates during the Pleistocene**

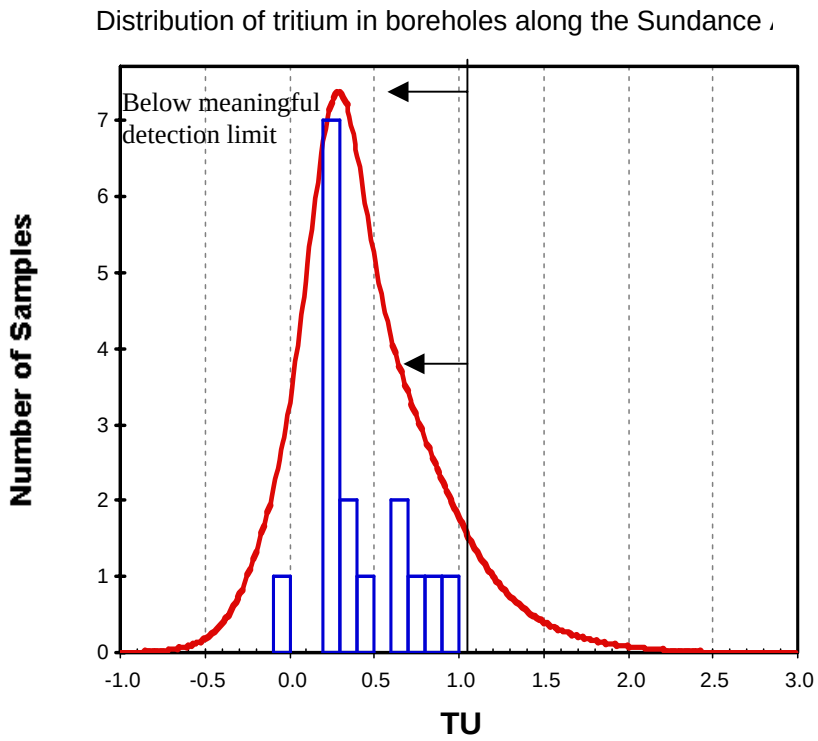
Based on the recent data alone, the Cl in ESF appears old

Meteoric Cl Input



Taken from Bentley et al.

How Robust are these Data?



All tritium measurements from the Sundance fault indicate no bomb-pulse tritium

How Robust are these Data?

(Continued)

- **Blank corrections do not greatly influence the final ratio**
- **All corrections tend to lower, rather than raise, the final ratios**
- **These samples were run in conjunction with many other samples, all of which have yielded results consistent with their geologic setting**

What Factors Could Account for the Differences Observed

- **We may yet see bomb-pulse ^{36}Cl**
  - **Our work has not demonstrated its absence**
- **Our sample processing procedure may have selected phases that do not contain bomb-pulse ^{36}Cl**
- **Our samples may not have bomb-pulse ^{36}Cl in them**

What do we do next?

- **Extract remaining ^{36}Cl from our samples**
  - **We have yet to measure the ^{36}Cl in the fine**
  - **We should completely dissolve the leached fractions to extract the remaining ^{36}Cl**
- **Obtain and process an ESF ^{36}Cl standard reference material**