

**U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**NUCLEAR WASTE TECHNICAL REVIEW BOARD
PANEL ON STRUCTURAL GEOLOGY & GEOENGINEERING**

**SUBJECT: COSMOGENIC HELIUM DATING
STUDIES**

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**ALEXIS PARK HOTEL
SEPTEMBER 14 - 16, 1992**

Outline

- **Conclusions from helium dates**
- **Background for cosmogenic ^3He dating**
- **Work in progress**
- **Observation, interpretation, and implication**

Conclusions from Helium Dates

- **QI₃, QI₄, and QI₅ lavas all erupted about 65 ka ago**
- **Within the current resolution of this technique (+/- 10ka) QI₃ and QI₅ are the same age**
- **Numerical age ranges for these lavas are 42 to 98 ka**
- **Most recent volcanism (cone) was >18 ka ago, but we cannot rule out that it is the same age as the lavas**

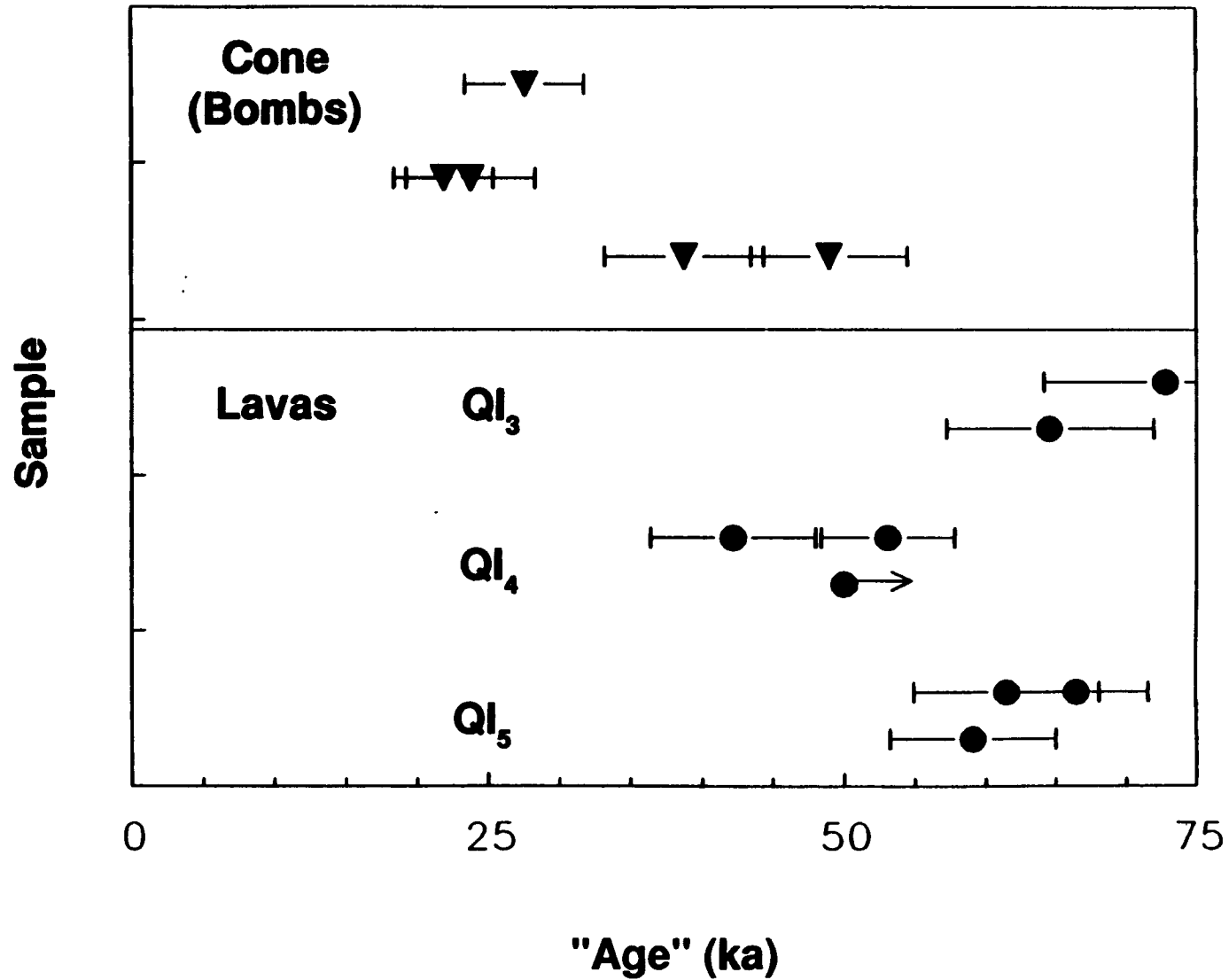
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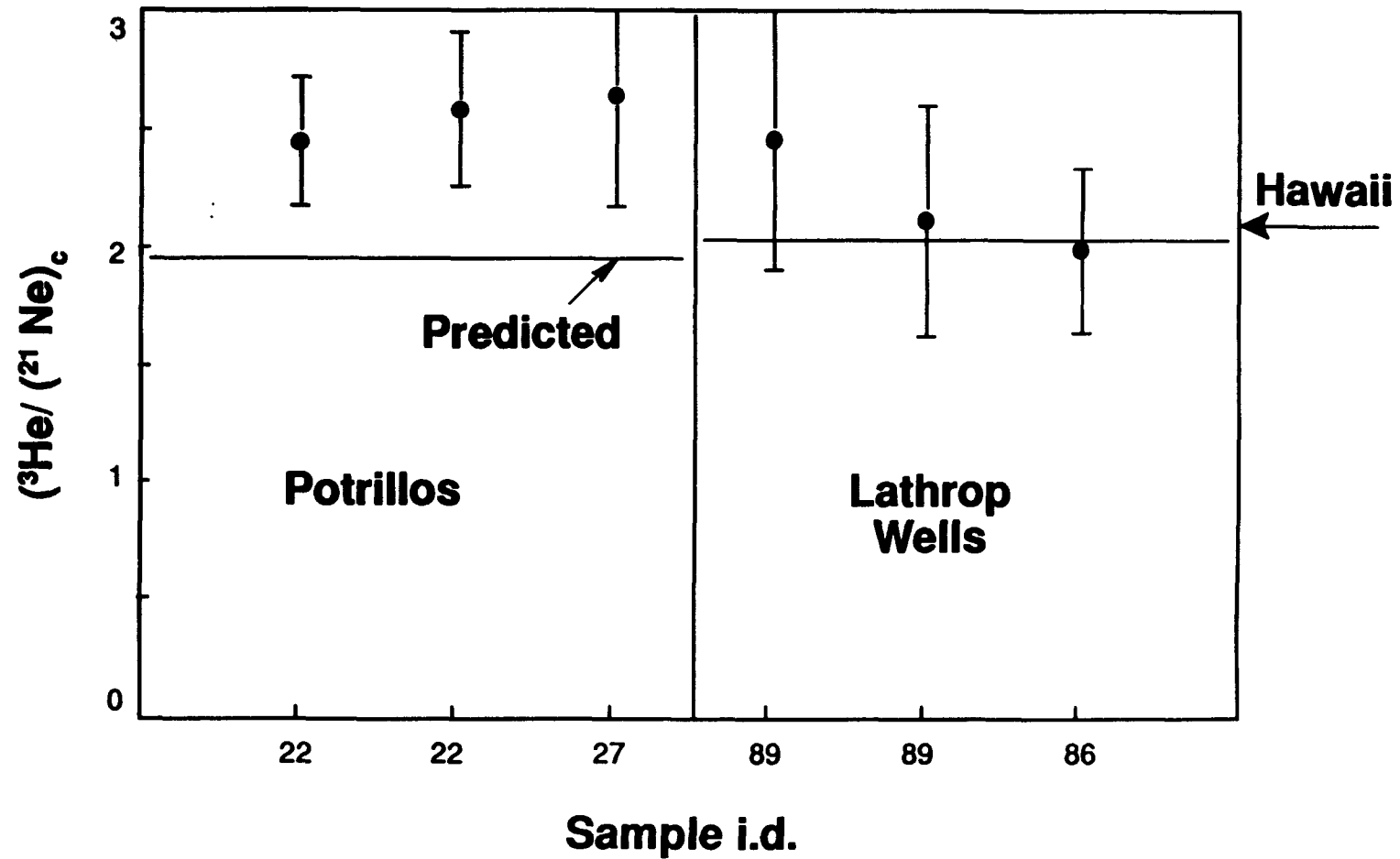
Background for Cosmogenic ^3He Dating

- **Ideally, the buildup of cosmogenic ^3He in a surface sample provides an estimate for the age of eruption**
- **Due to effects such as erosion, in practice a surface exposure age is always less than or equal to the eruption age**
- **Due to uncertainty in the production rate for cosmogenic ^3He , uncertainty in the ^3He ages of $\pm 30\%$ must be assumed when comparing to ages from other techniques**
- **Olivine retains cosmogenic ^3He quantitatively**

^3He Surface Exposure Ages for Lathrop Wells



Retention of Cosmogenic ^3He in Olivine



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Work in Progress

At Lathrop Wells

- **Multiple surfaces of Ql_3 , Ql_4 , Ql_5 have been collected to look at reproducibility/reliability of He ages**
- **In-place bombs from the side of the cone, unlikely to have had significant cover over their lifetime**
- **Will collect and analyze Ql_6 and spatter mound**

Work in Progress

(Continued)

Cross calibration to other chronometers

- We are searching for well-dated lavas in the Western U.S.

Zuni-Bandera flow near Grants, NM

- ^{14}C ages on charcoal: $9.1 \pm .08\text{ka}$ and $9.8 \pm .06\text{ka}$.
Cosmogenic He: $13.0 \pm 1.3\text{ka}$ (analytical precision)

Bluewater flow near Grants, NM

- Uranium series disequilibrium age of $80 (+20/-15)\text{ka}$
- 2 Ma K-Ar age

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Observation:

- Isotopic composition of Ar released by crushing olivine:

$^{40}\text{Ar}/^{36}\text{Ar}$

$\text{QI}_3: 328 \pm 7$

$\text{QI}_5: 371 \pm 8$

Air Ar: 295.5

Interpretation:

- These lavas contain excess ^{40}Ar that is not due to in situ decay of ^{40}K

Concentrations released by crushing olivine:

$Ql_3: 5 \pm 1 \times 10^{-9} \text{ cm}^3\text{STP/g}$ of excess ^{40}Ar

$Ql_5: 7.3 \pm 0.6 \times 10^{-9} \text{ cm}^3\text{STP/g}$ of excess ^{40}Ar

Expect $10 \times 10^{-9} \text{ cm}^3\text{STP/g}$ of excess ^{40}Ar from decay of K in bulk rock (1.8% K) in 130ka. Note, however, that olivine makes up only 2% of the rock as microphenocrysts. May be more important in groundmass. Glass phase unknown

Implication:

- **Need to know more about the distribution of this excess (mantle) Ar component between minerals before we can believe (or disbelieve) the K-Ar and $^{40}\text{Ar}/^{39}\text{Ar}$ ages**