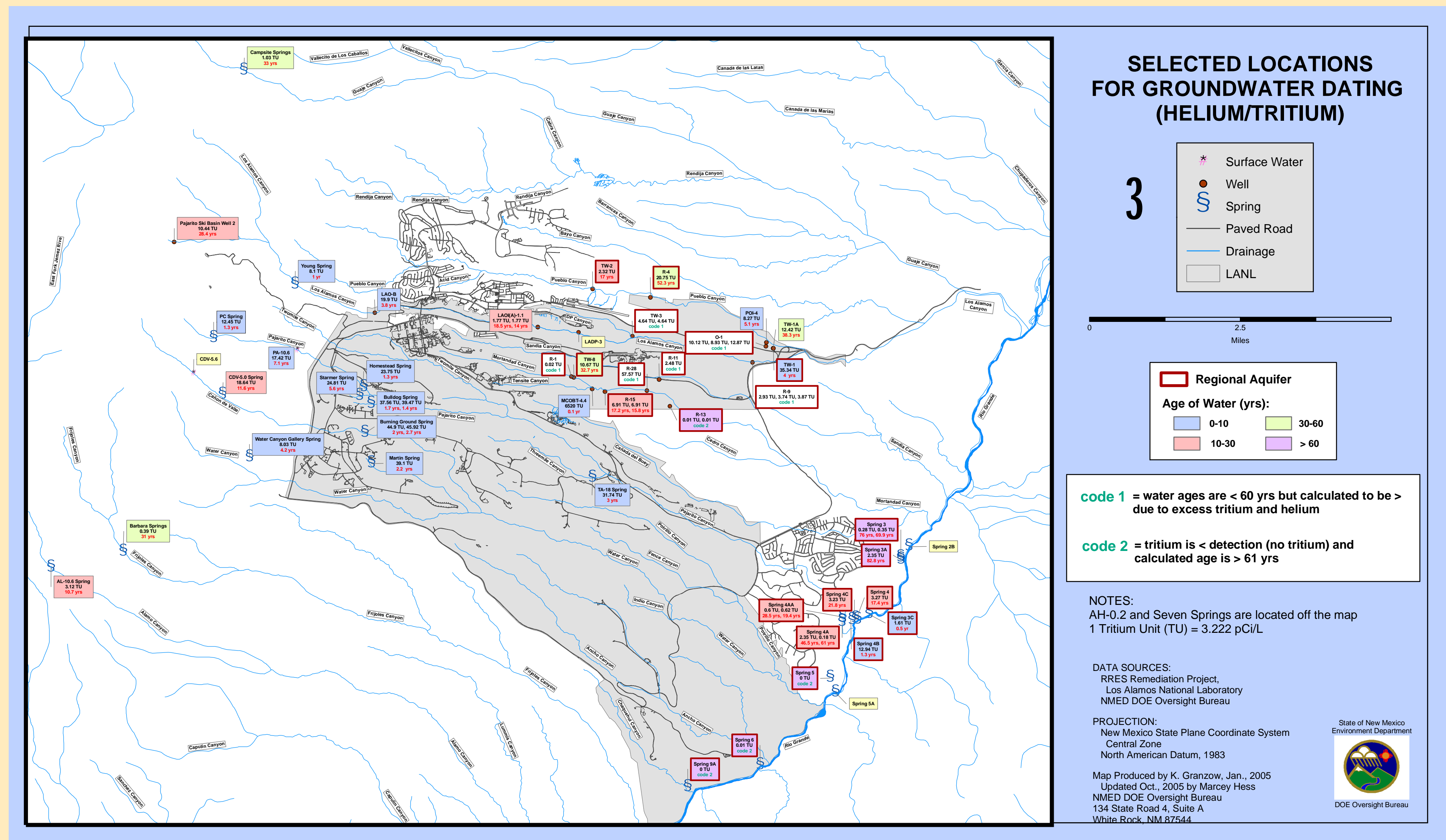


ABSTRACT

Helium-3 and tritium were used to date young fractions of groundwater and to evaluate groundwater flow paths beneath the Pajarito Plateau, New Mexico. Stable isotopes of hydrogen and oxygen were also used to determine the source(s) and recharge elevations of groundwater. Analytical methods include isotope ratio mass spectrometry for stable isotopes; mass spectrometry for helium and neon; and helium-3 ingrowth, electrolytic enrichment, and liquid scintillation for cosmogenic and anthropogenic tritium. Results of stable isotope analyses indicate that the Sierra de los Valles serves as a recharge zone for perched intermediate groundwater and the regional aquifer west of Los Alamos, New Mexico. Additional recharge to the regional aquifer occurs along wet canyon bottoms on the Pajarito Plateau. Age of the young fraction of groundwater within the Sierra de los Valles ranges from 1 to 33 years based on activities of tritium and helium-3. Springs discharging in White Rock Canyon have stable isotope ratios very similar to regional aquifer wells sampled on the Pajarito Plateau. This indicates that the springs contain a component of groundwater originating on the Pajarito Plateau. Age of the young fraction of groundwater within the regional aquifer beneath the Pajarito Plateau ranges from 16 to greater than 62 years. Age of the young fraction of regional aquifer groundwater, discharging as springs in White Rock Canyon, ranges from 1.3 to greater than 62 years. Distributions of groundwater ages suggest that recharge continuously occurs along the Pajarito Plateau and local recharge to the White Rock Canyon springs also takes place. These results suggest that there are multiple groundwater flow paths, with varying residence times, within the vadose zone and regional aquifer.

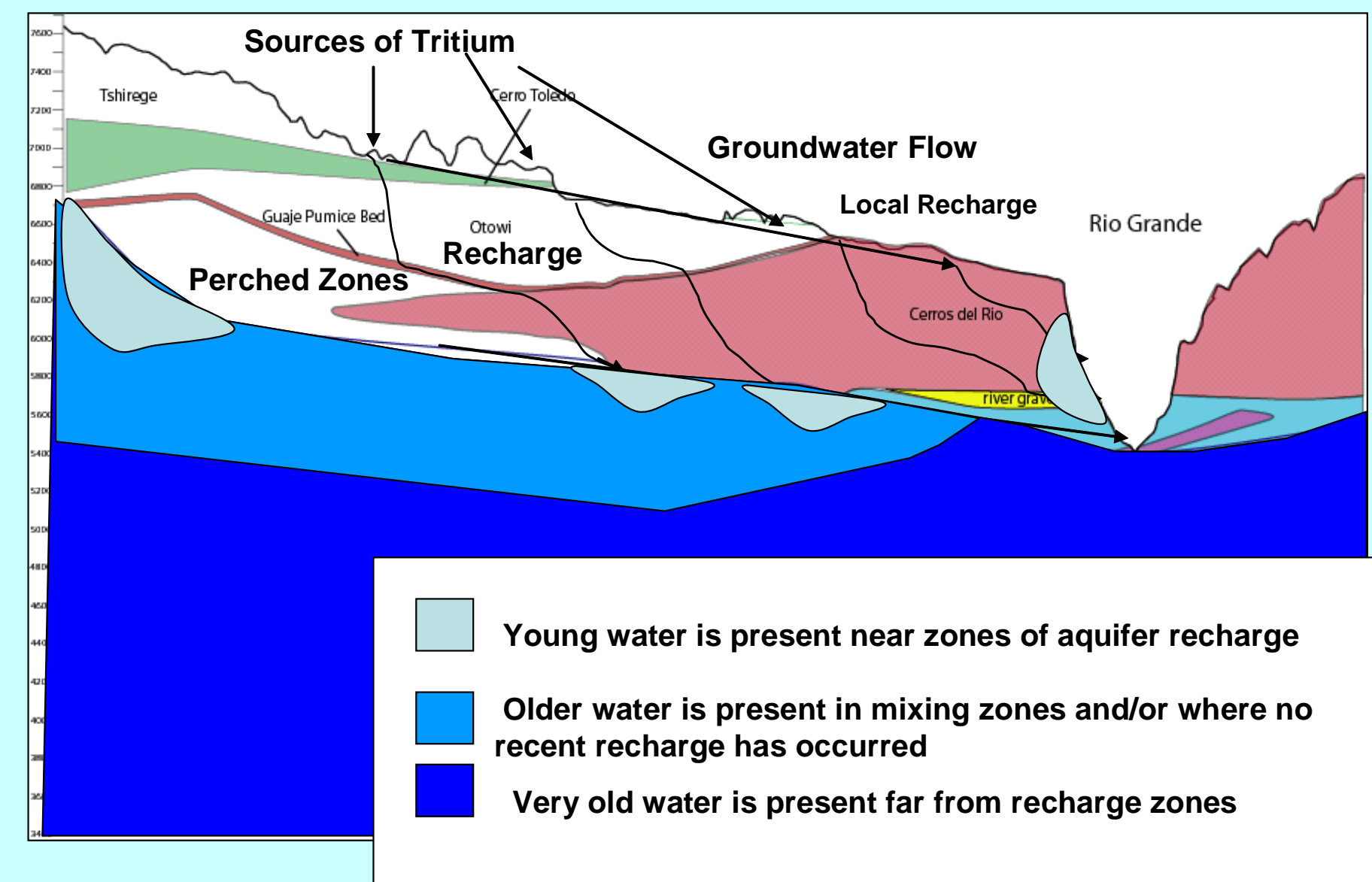
PRESENT DAY TRITIUM ACTIVITY IN GROUNDWATER AND GROUNDWATER AGE, LOS ALAMOS, NEW MEXICO



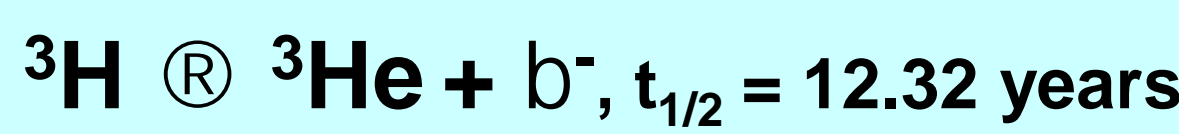
PURPOSE AND SCOPE

- Conceptual Models of Groundwater Flow
- Analytical Methods
- Helium and Tritium Systematics
- Stable Isotopes of Hydrogen and Oxygen
- Tritium Results
- Summary and Conclusions

Generalized Expected Trends in Groundwater Age for Conceptual Model of Groundwater Flow



HELIUM AND TRITIUM SYSTEMATICS



$${}^3\text{He}_t = {}^3\text{H}_t - {}^3\text{H}_t e^{-\lambda t}$$

where,

${}^3\text{He}_t$ = helium concentration at time t ,

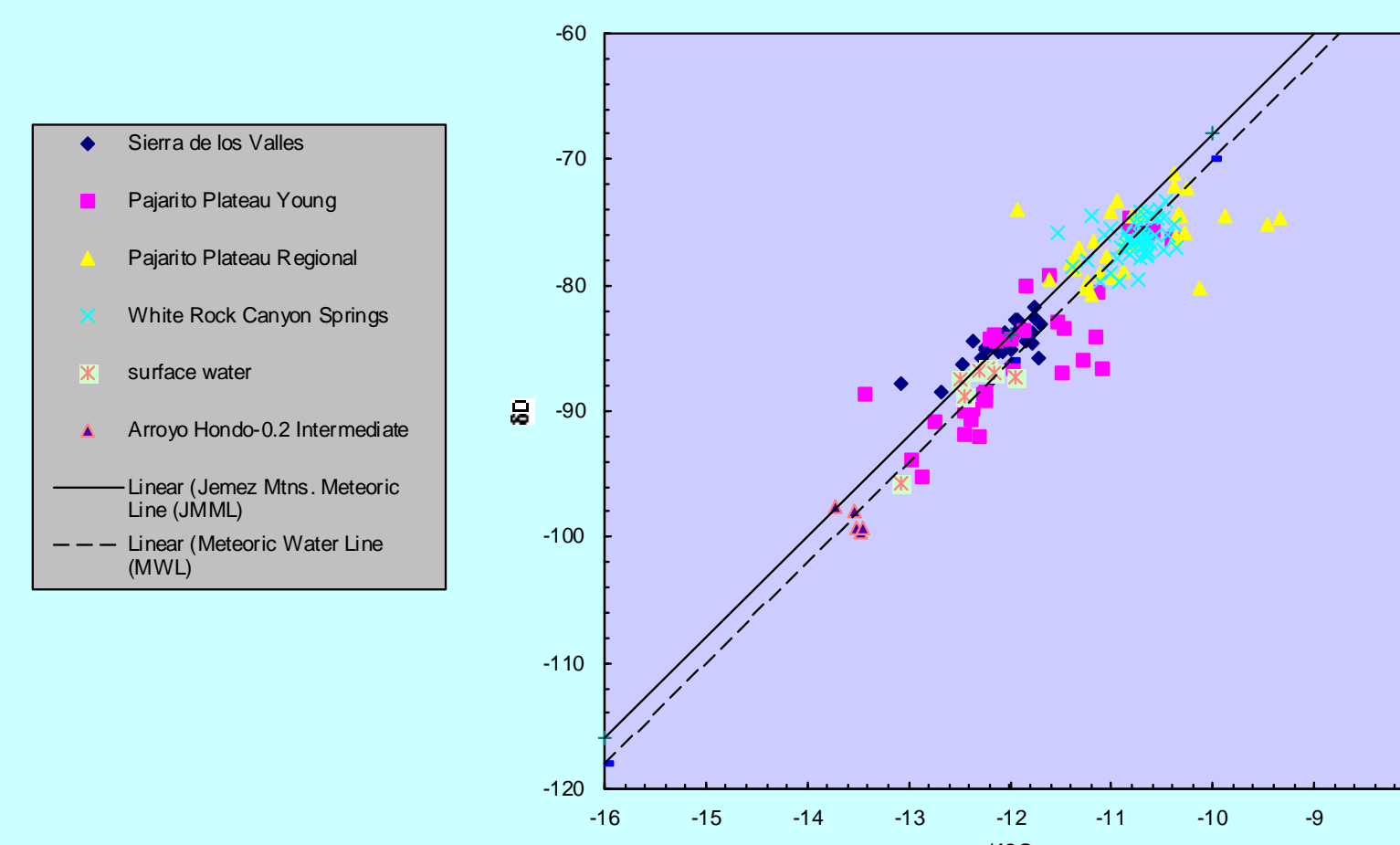
${}^3\text{He}_t$ is in tritium units [TU] [one ${}^3\text{He}$ atom per 10^{18} H atoms]],

${}^3\text{H}_t$ = tritium concentration at time t ,

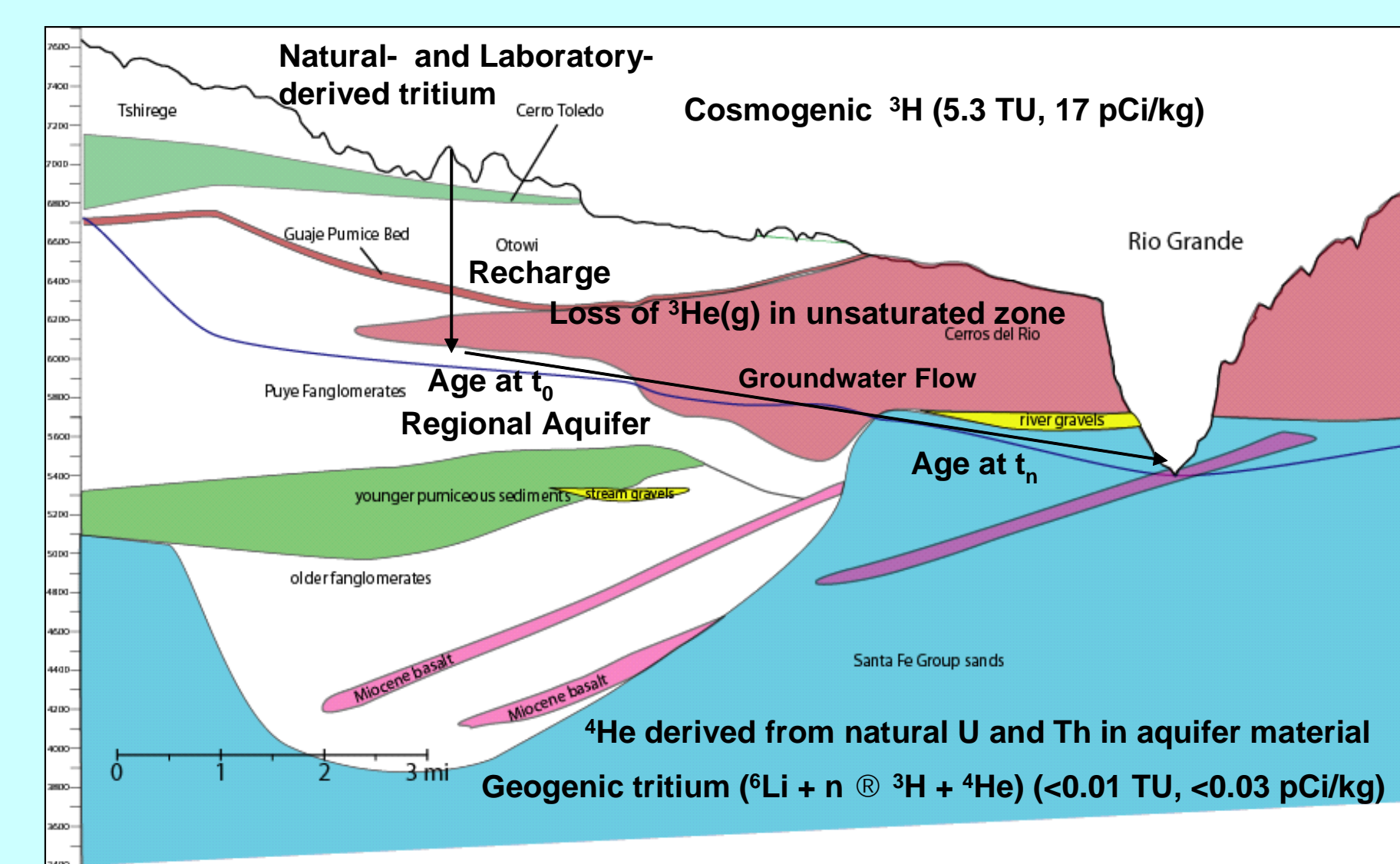
λ = decay constant ($\ln 2/t_{1/2}$), and

t = time.

Results of stable isotope analyses suggest recharge occurs within the Sierra de los Valles and along wet canyon bottoms.



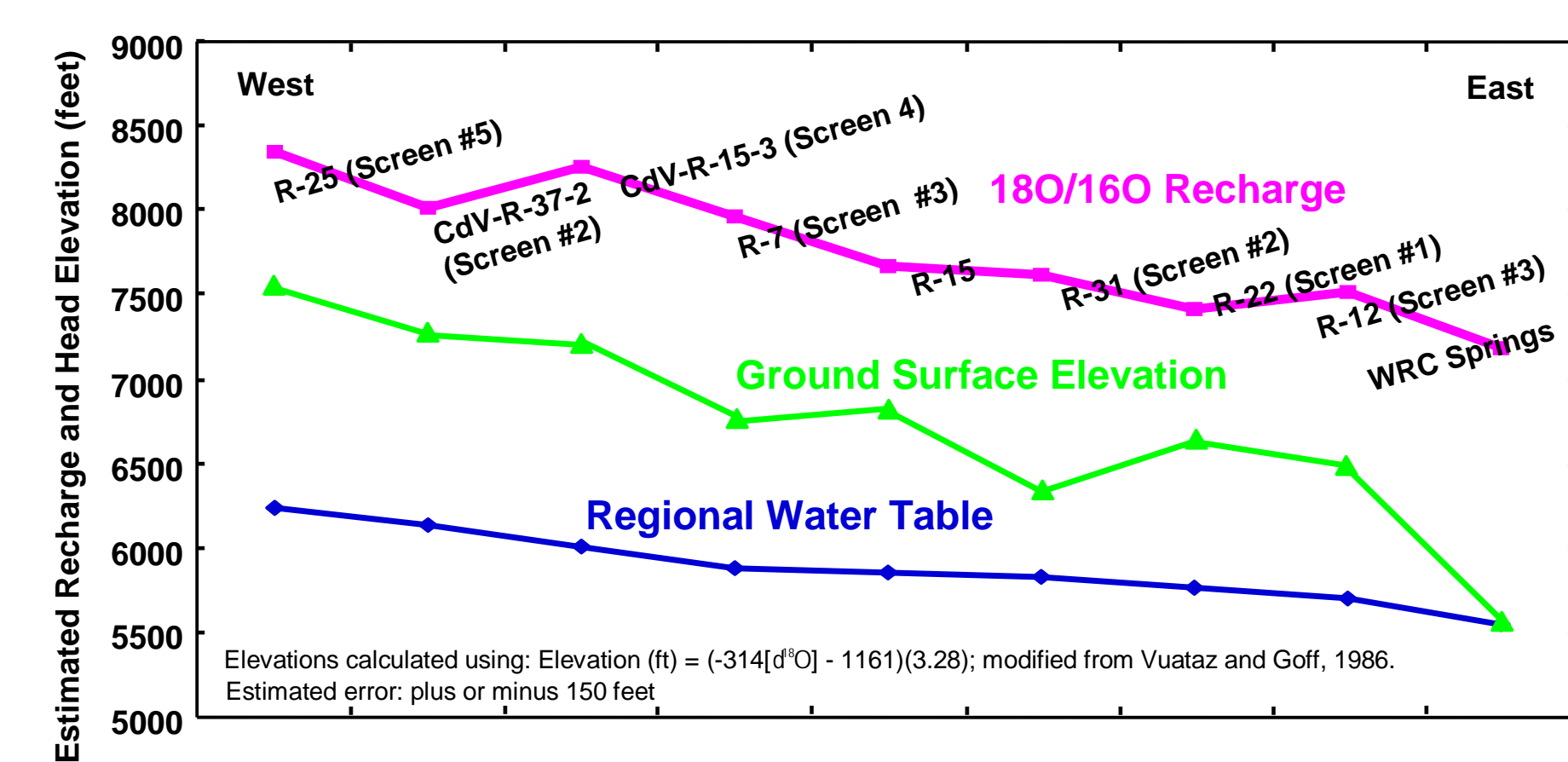
CONCEPTUAL MODEL FOR TRITIUM AND HELIUM



ANALYTICAL METHODS

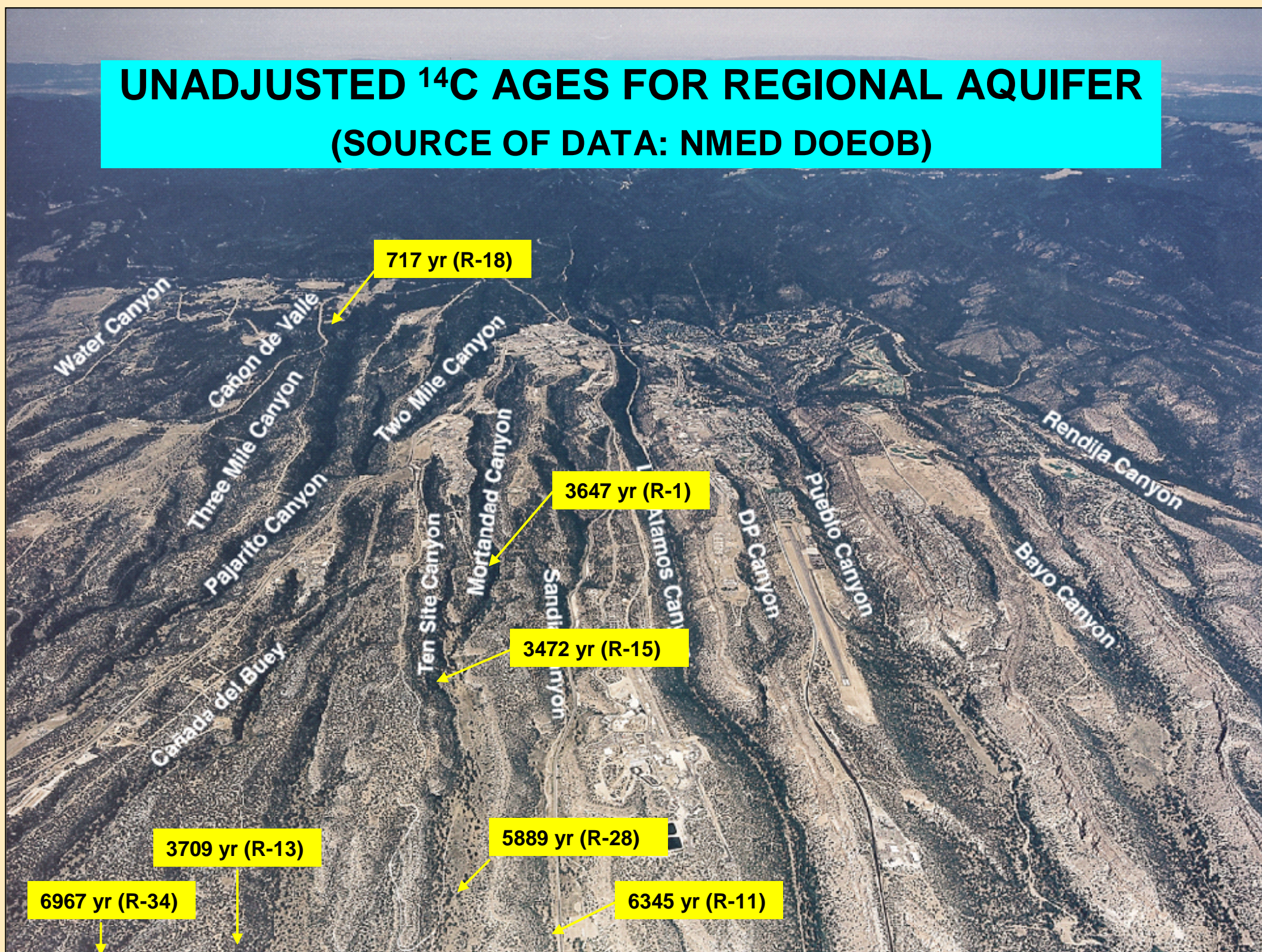
- Isotope ratio mass spectrometry (δD and $\delta^{18}\text{O}$)
- Mass spectrometry (helium and neon)
- Ingrowth from He-3, electrolytic enrichment, and liquid scintillation (tritium)

Estimated Recharge Elevations as Determined by Stable Isotope Analyses for the Regional Aquifer (Water Table)

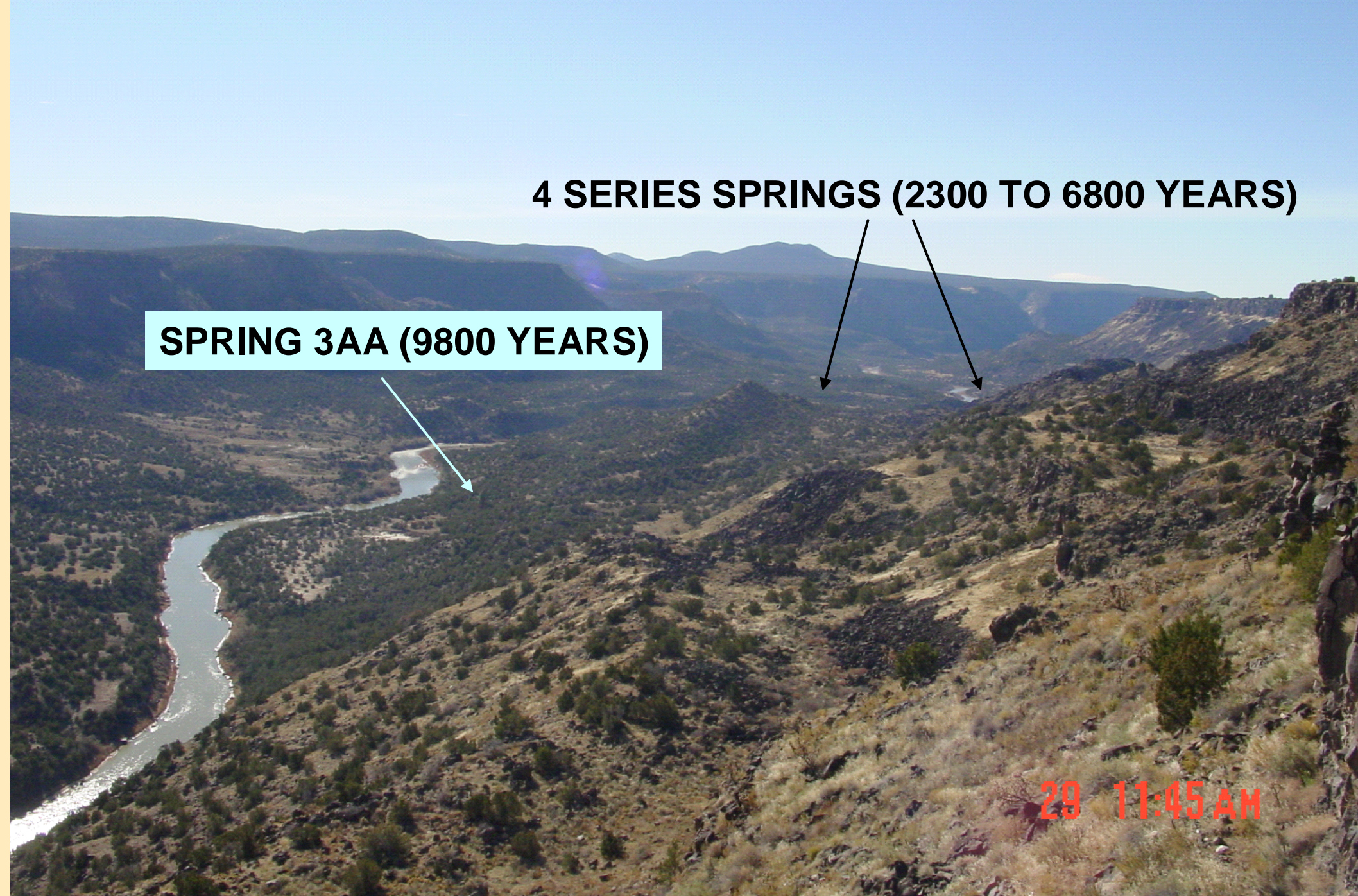


QUALITATIVE INTERPRETATION OF TRITIUM ACTIVITY IN THE REGIONAL AQUIFER AT LOS ALAMOS, NEW MEXICO

<0.01 TU (0.03 pCi/kg)	Submodern - recharge prior to 1943
0.01 to ~5 TU (0.03 - 17 pCi/kg)	Mixture between submodern and recent recharge
>5 TU (>17 pCi/kg)	Presence of Laboratory-derived tritium, water post-dates 1943



WHITE ROCK CANYON (VIEW TO THE SOUTH)



SUMMARY AND CONCLUSIONS

- Tritium and helium-3 must be isolated from the unsaturated zone to accurately date groundwater.
- Age of the young fraction of groundwater within recharge zone (Sierra de los Valles) ranges from 1 to 33 years. Very young ages represent short residence times in groundwater.
- Age of the young fraction of groundwater within the regional aquifer ranges from 16 to greater than 62 years (pre-1943) beneath the Pajarito Plateau.

SUMMARY AND CONCLUSIONS

- Cosmogenic activities of tritium are less than 0.3 TU (1.0 pCi/kg) within the regional aquifer. The vast majority of groundwater near the regional water table ranges from 700 to 10,000 years.
- Age of the young fraction of groundwater discharging from the regional aquifer springs (White Rock Canyon) ranges from 1.3 to greater than 62 years.
- Analytical results for tritium and helium suggest that there are multiple flow paths with local recharge (short residence time) occurring between the Sierra de los Valles and White Rock Canyon.