

Strontium and Uranium Isotopes in Unsaturated Zone Fracture Fillings and UZ-14 Water

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Strontium and Uranium Isotopes in Unsaturated Zone Fracture Fillings and UZ-14 Water

- **UZ-14**
 - ▶ **Pumping History**
 - ▶ **On-site Chemistry**
 - ▶ **Strontium**
 - ▶ **Comparison with J-13**
 - ▶ **Uranium Isotopes**
- **Unsaturated Zone Fracture Fillings**
 - ▶ **Similarity of Fracture Filling Calcite to Pedogenic Calcite**
 - ▶ **Unsaturated Zone Fracture Fillings and UZ-14 Water**



UZ-14 History

- water encountered at 1259 feet
- advanced to 1262 feet
- bailed sample "A"
- advanced to 1272 feet in two steps
- bailed samples "B" and "C"
- reamed to 1282 feet
- four pump tests



Importance of Saturated Zone Intersected by UZ-14

- Perched or water table?
- Natural or lost drilling fluid from other holes?
- If natural then zone will be intersected by ESF
and we will need to know...
 - Thickness of zone, if perched
 - Lateral extent of zone



Principle

Different rock masses evolve strontium isotope compositions dependent on time and composition according to:

$$\left({}^{87}\text{Sr} / {}^{86}\text{Sr} \right)_{\text{today}} = \left({}^{87}\text{Sr} / {}^{86}\text{Sr} \right)_o + {}^{87}\text{Rb} / {}^{86}\text{Sr} \cdot \left(e^{\lambda t} - 1 \right)$$

Strontium isotope compositions can be measured to better than 50 ppm and are reported as:

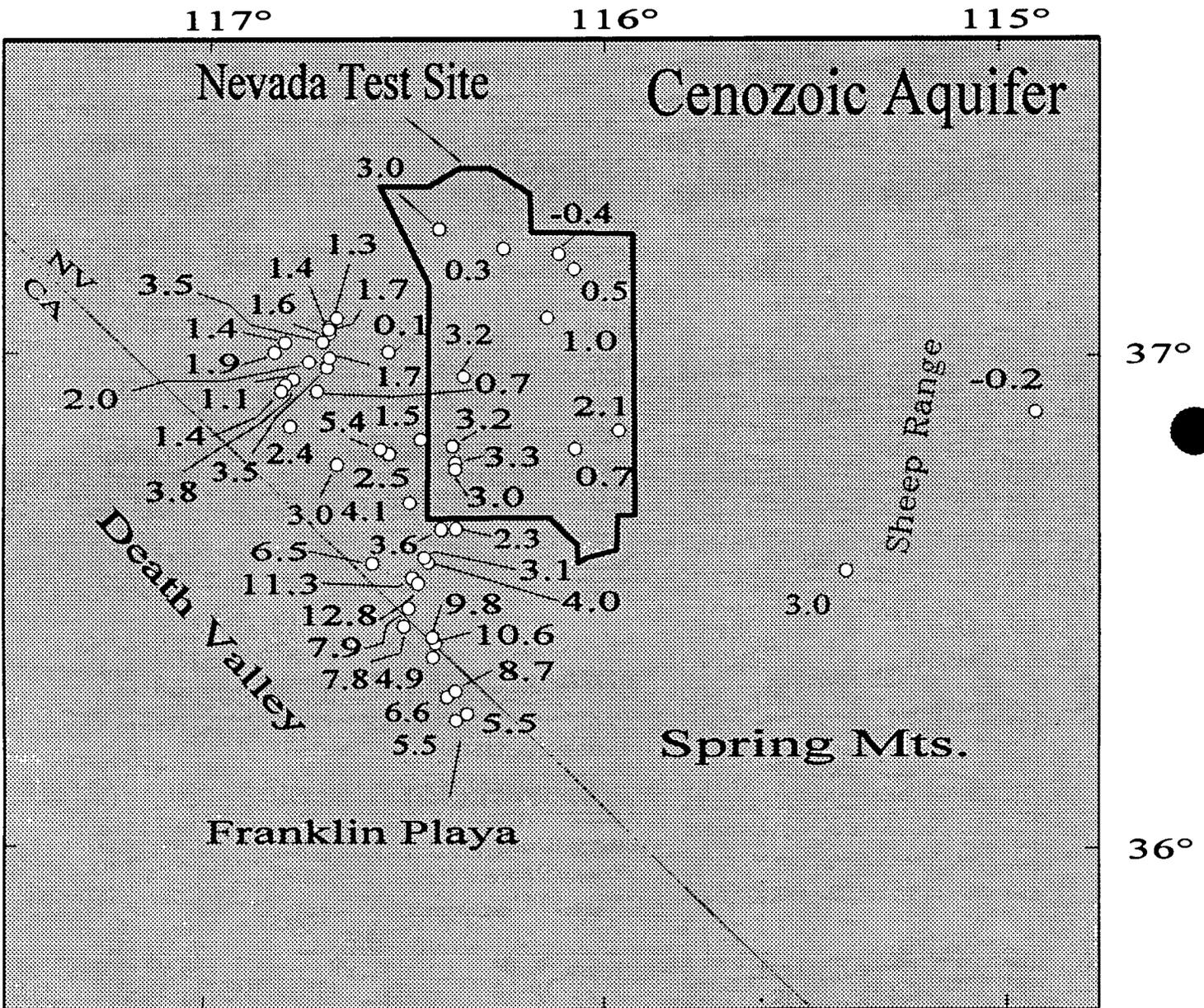
$$\delta^{87}\text{Sr} = \left[\frac{\left({}^{87}\text{Sr} / {}^{86}\text{Sr} \right)_{\text{sample}}}{\left({}^{87}\text{Sr} / {}^{86}\text{Sr} \right)_{\text{seawater}}} - 1 \right] \times 1000$$

where

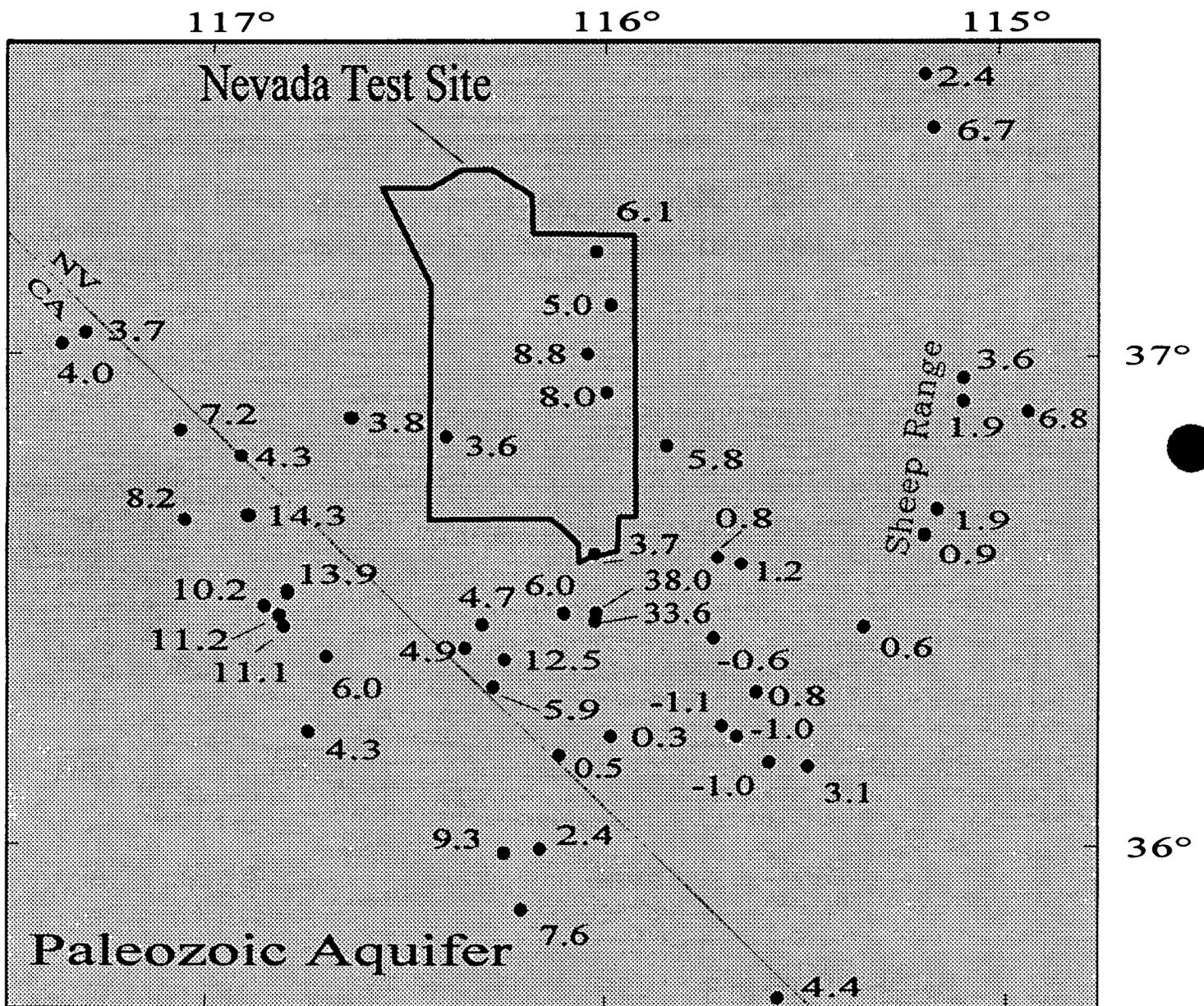
$$\left({}^{87}\text{Sr} / {}^{86}\text{Sr} \right)_{\text{seawater}} = 0.70920$$



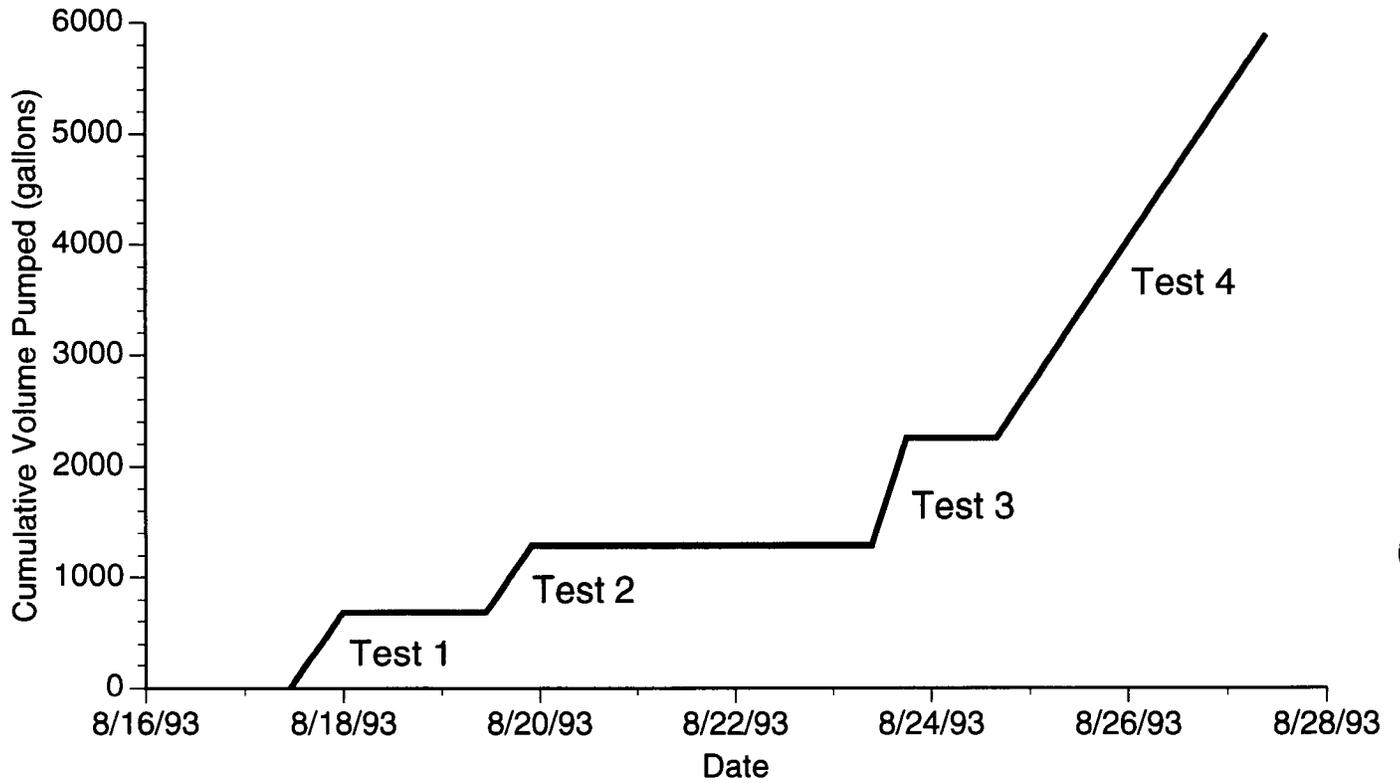
$\delta^{87}\text{Sr}$



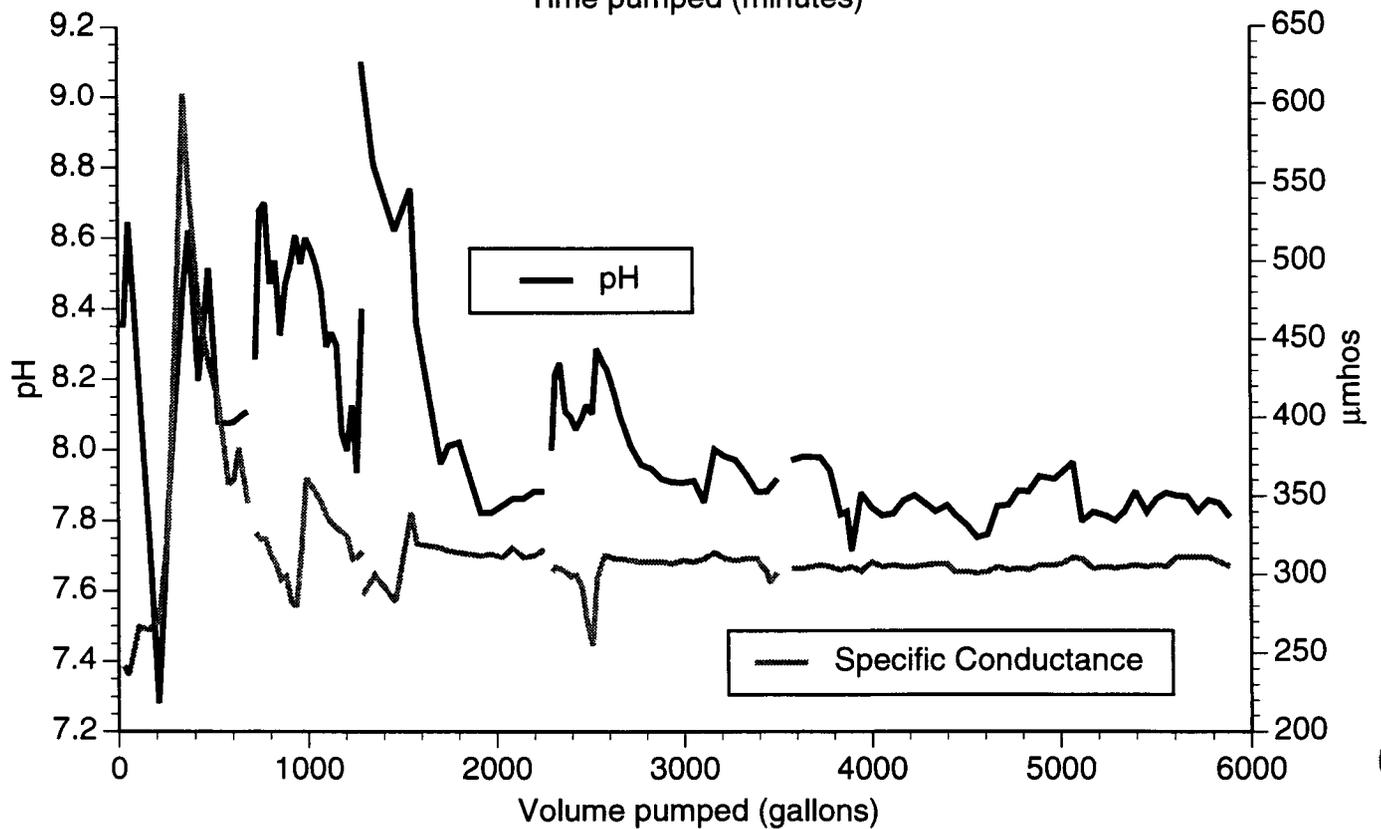
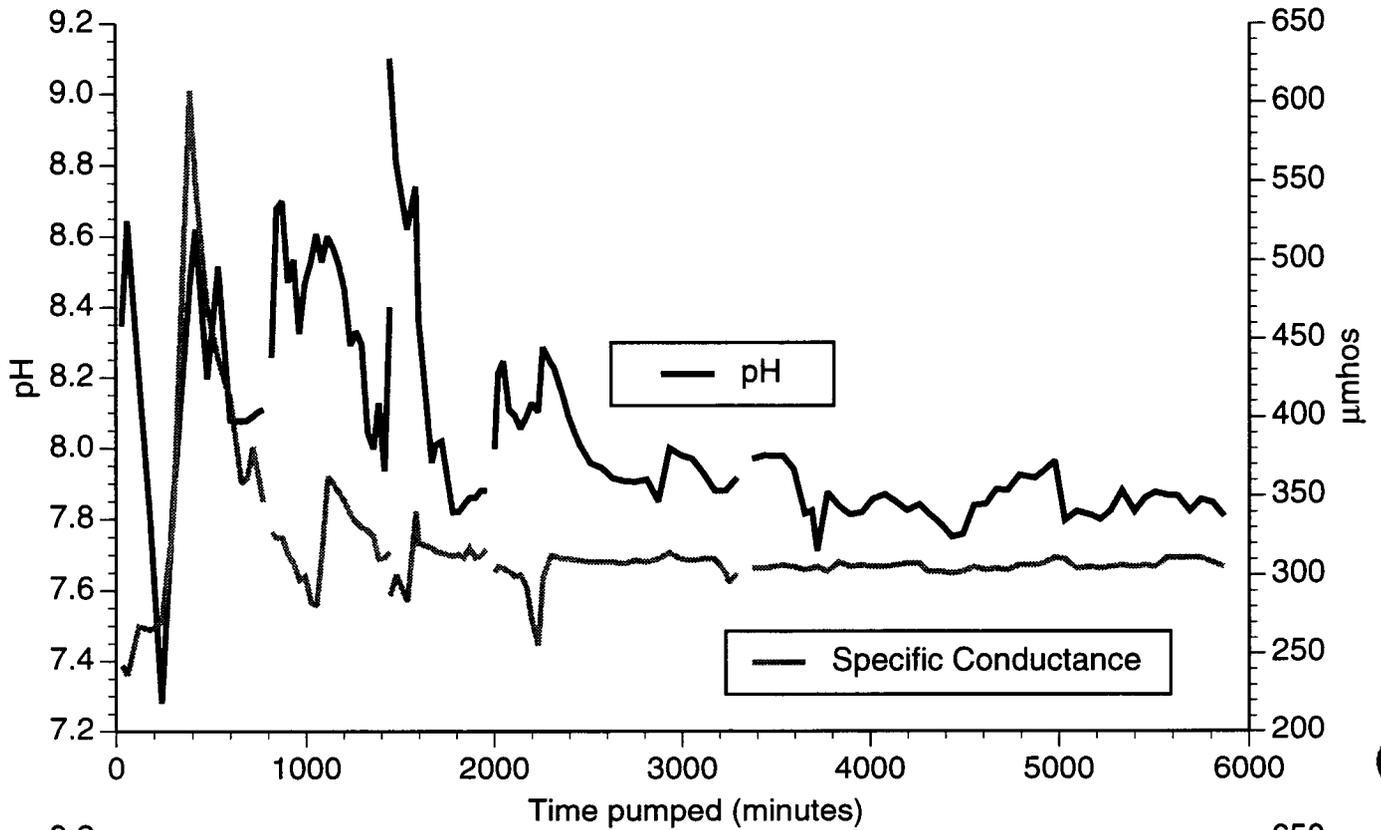
$\delta^{87}\text{Sr}$



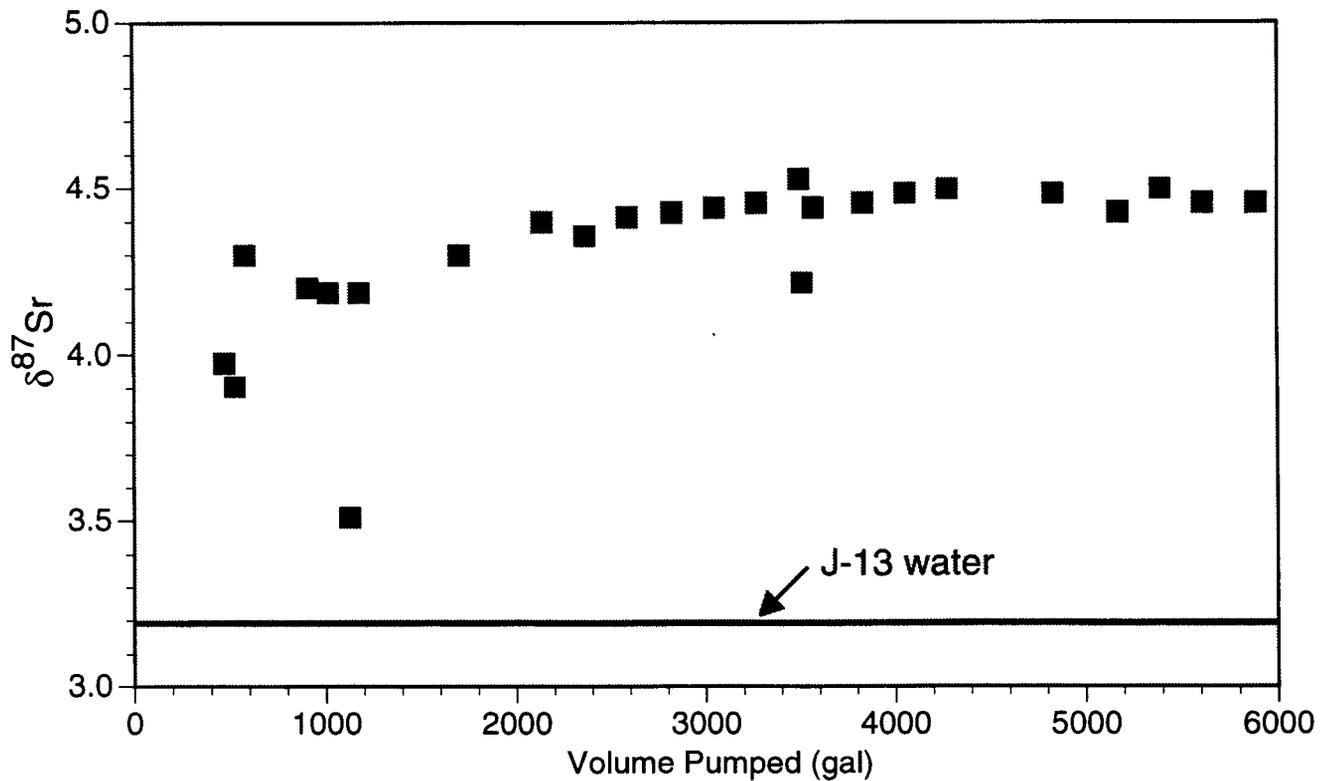
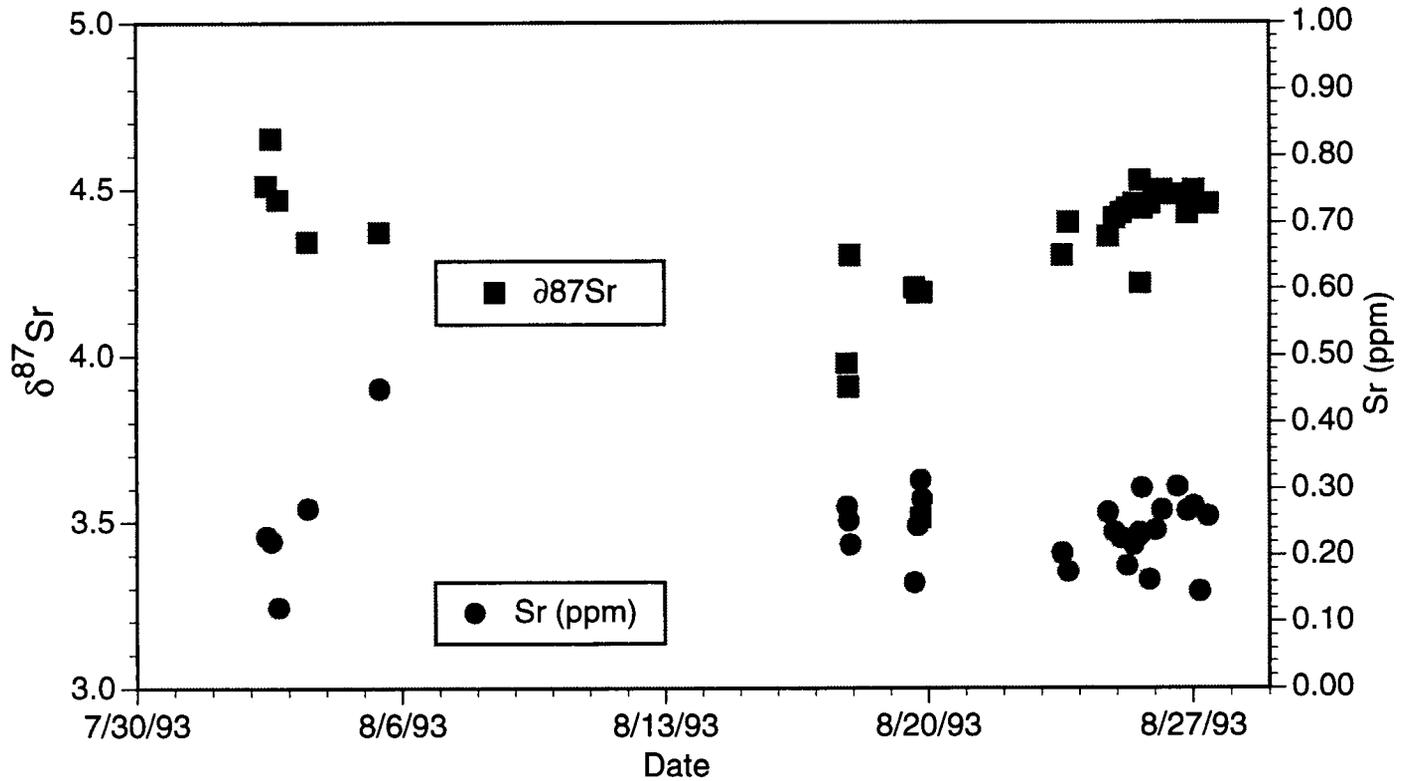
Volume Pumped vs Date



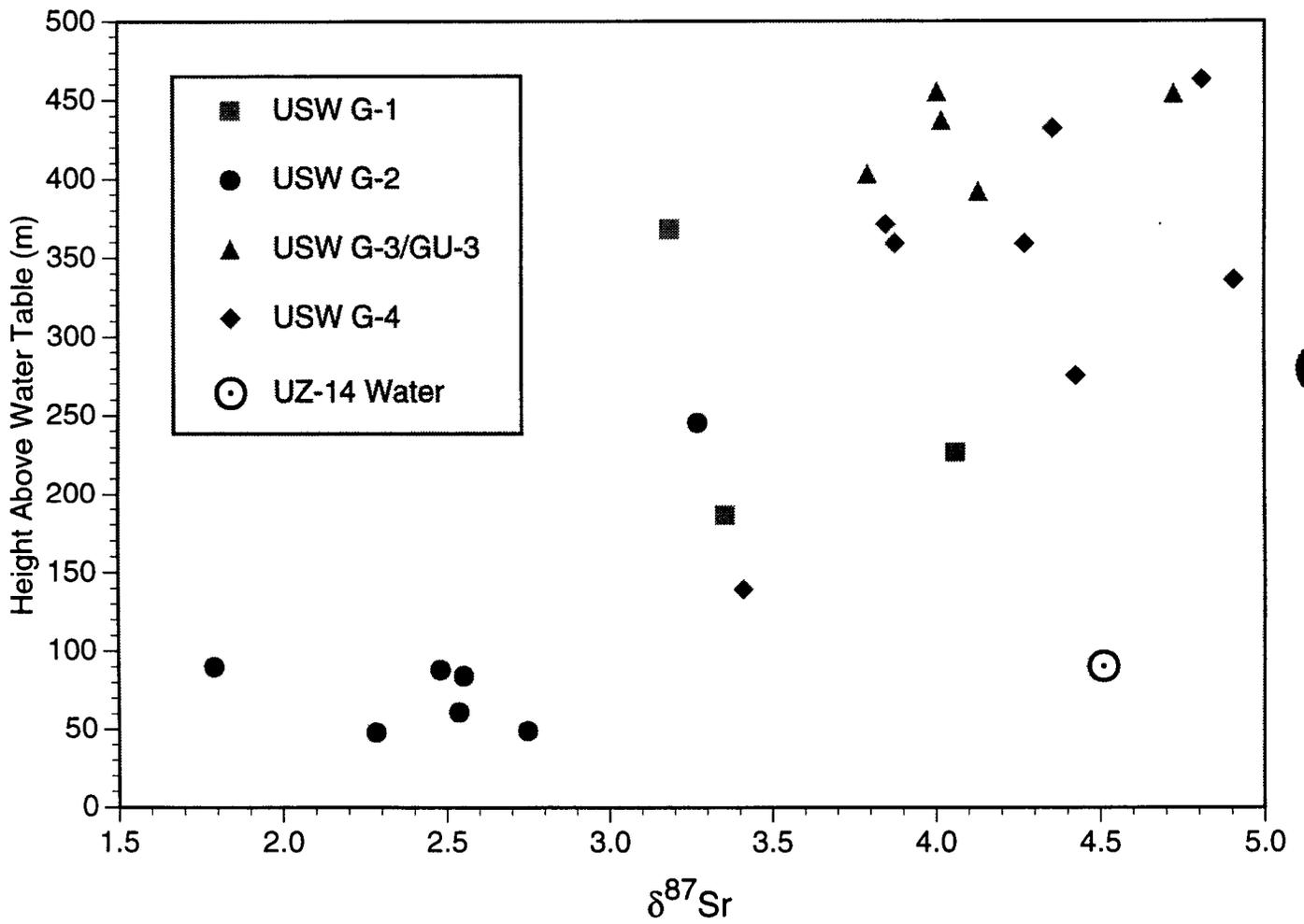
pH & Conductance



Strontium in UZ-14



UZ Fracture Fillings



Strontium Compositions

Material	$\delta^{87}\text{Sr}$	σ	N
Surficial carbonate	4.43	0.40	88
UZ Fracture Fillings	4.03	0.53	17
UZ-14 water	4.45	0.08	13
Tertiary Aquifer Water	3.03	1.06	13



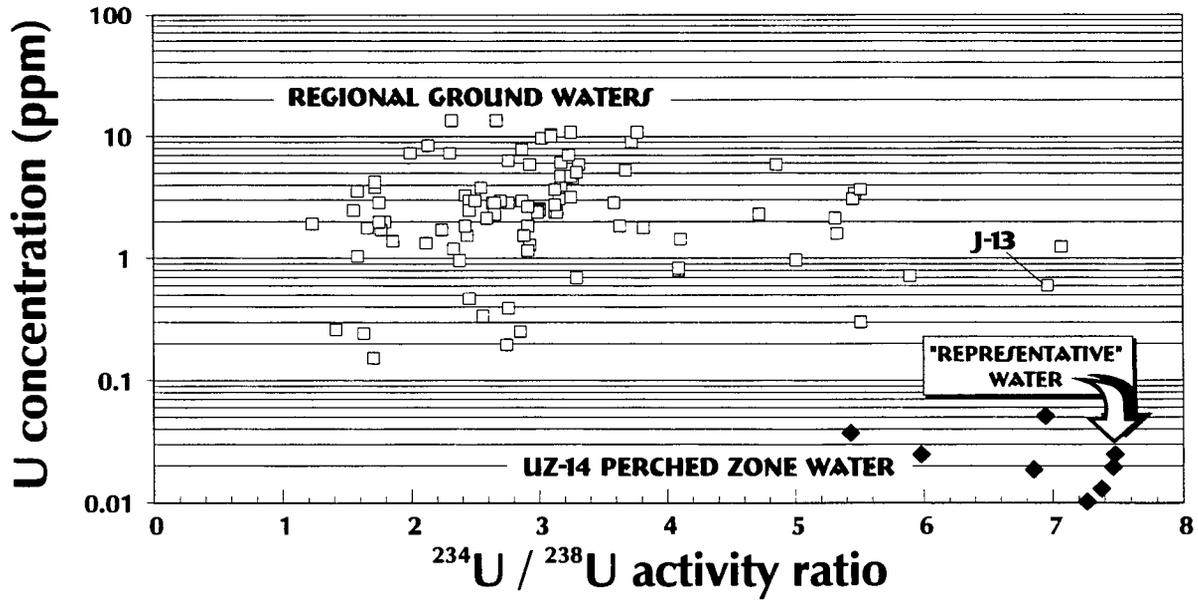
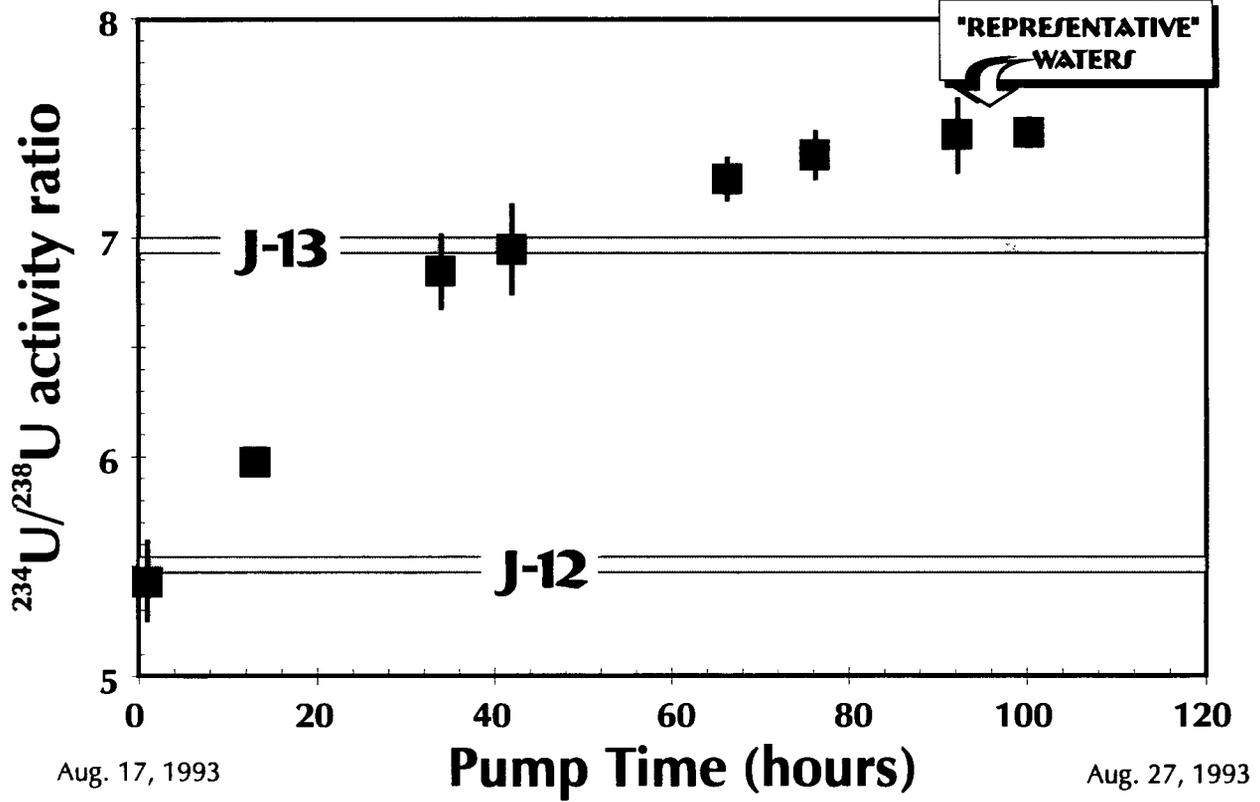
U ISOTOPES AS HYDROLOGIC TRACERS

- ☼ $^{234}\text{U}/^{238}\text{U}$ activity ratios elevated above unity in oxidizing waters.
- ☼ Ground and surface waters near Yucca Mountain range from 1.1 to 7.
- ☼ U isotopes can be applied as a tracer, similar to $^{87}\text{Sr}/^{86}\text{Sr}$, to test consistency of hydrologic models.

U ISOTOPES IN UZ-14 WATER

- ☼ $^{234}\text{U}/^{238}\text{U}$ activity ratios in pump-test waters suggest mixing of early and late components.
- ☼ As with $^{87}\text{Sr}/^{86}\text{Sr}$, $^{234}\text{U}/^{238}\text{U}$ activity ratios for most "representative" water stabilize near the end of the test around a value of 7.3.
- ☼ $^{234}\text{U}/^{238}\text{U}$ activity ratios are similar to, but resolvably higher than J-13 water.
- ☼ U concentrations are over 10 times more dilute than the lowest ground waters and over 100 times more dilute than most southern Nevada ground waters.

UZ-14 PERCHED-ZONE WATERS



Conclusions

Perched water encountered in UZ-14...

- derived strontium from soil zone
- derived uranium from volcanic rocks
- may be responsible for localized alteration of the Topopah Spring Tuff

