ASSESSMENT OF SELECTED SPRINGS AND WELLS AND IMPLICATIONS FOR RECHARGE IN THE PAHRUMP VALLEY AND SPRING MOUNTAINS, NEVADA

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Sampling Methodology

Sample collection from spring orifice, Wood Canyon spring

Collection of He sample in copper tubing

Sampling Methodology

Collection of unfiltered sample

Measurement of field parameters

Analyte Suite

Analyte	Detection Limit	unit
arsenic	0.0005	mg/L
calcium	0.2	mg/L
magnesium	0.2	mg/L
potassium	0.3	mg/L
sodium	0.3	mg/L
bromide	0.1	mg/L
chloride	1	mg/L
fluoride	0.1	mg/L
nitrate/nitrite as N	0.02	mg/L
phosphate	0.01	mg/L
sulfate	10	mg/L
alkalinity as CaCO3	2	mg/L
conductivity	1	µmhos/cm
Silica	0.01	mg/L
Strontium	0.01	mg/L
TDS	10	mg/L
TKN	0.33	mg/L
pH	NA-	

Isotopes	Detection Limit or Precision	unit
18O - 2H [a]		o/oo
14C (AMS)		
d13C [a]	0.25	o/oo
tritium (3H)	0.6	T.U. (Tritium units)

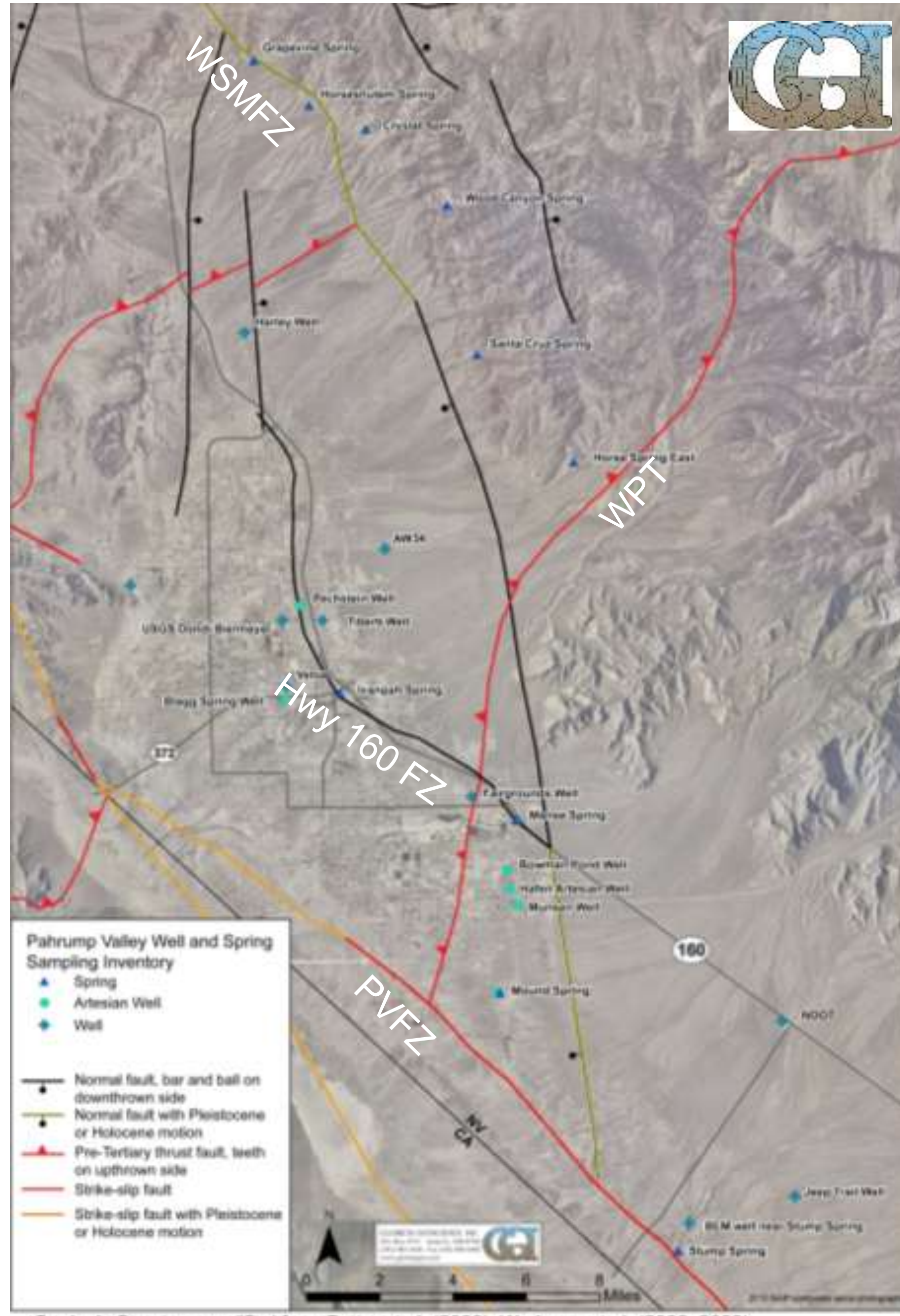
[a] Stable isotope ratio analysis.

Introduction

- Conducted assessment of springs in the Spring Mountains and Pahrump Valley in March 2012, sampling of springs and wells to evaluate recharge sources, timing of recharge, and to improve the hydrologic characterization of the area

Structural Setting

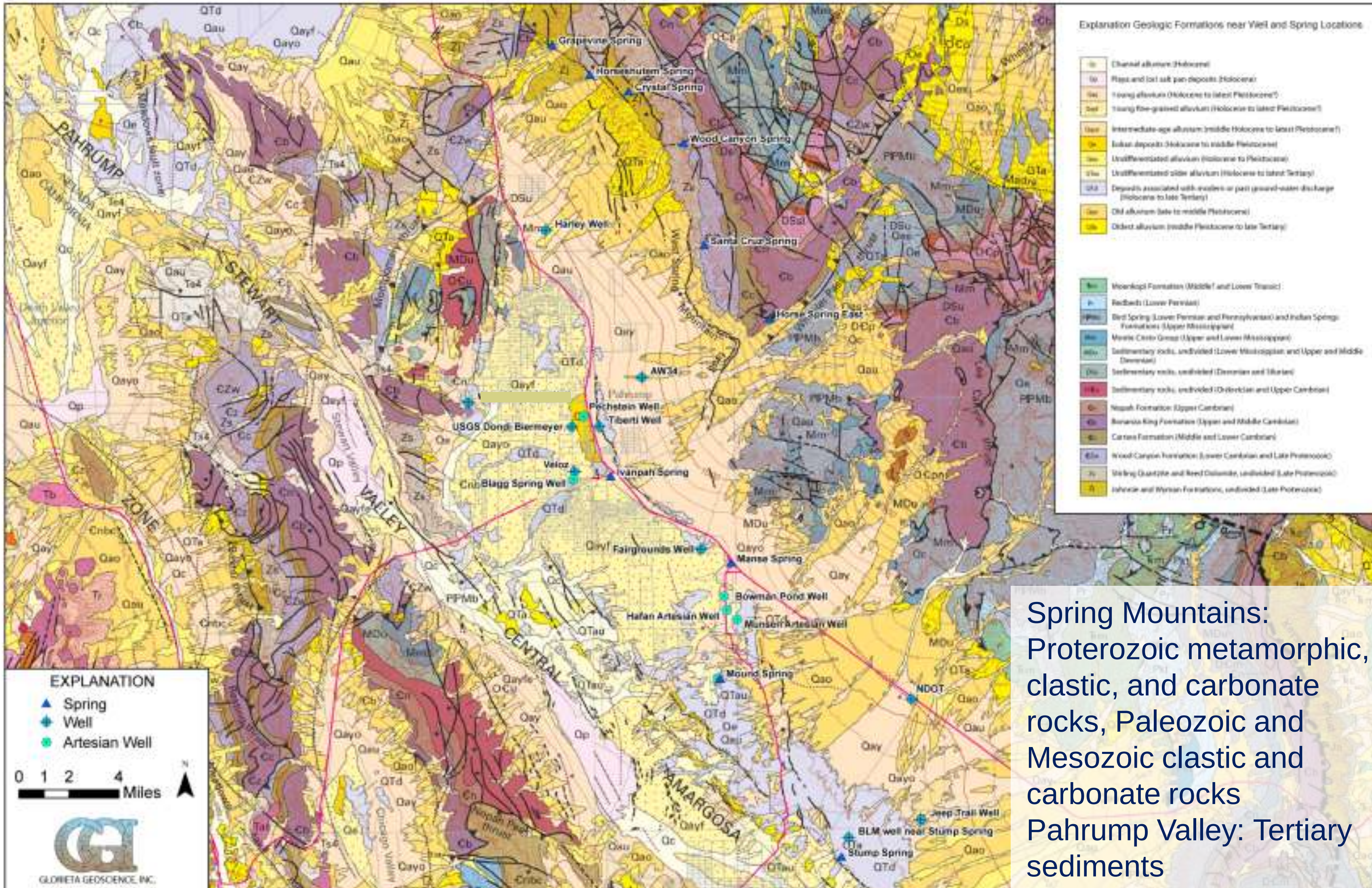
- Mountain-block springs NE of Pahrump
- 2 valley-floor springs “Hwy 160 FZ”
- 2 valley-floor springs close to state-line fault
- NW trending Pahrump Valley fault zone (PVFZ) (part of the State Line Fault Zone) likely controls Stump Spring/Mound Spring discharge
- Wheeler Pass Thrust (WPT) an important NNE trending fault
- Mountain front normal faults (West Spring Mountains Fault Zone; WSMFZ) bound the east side of the basin north of the Wheeler Pass thrust



Geologic Structure modified from Potter et al. (2002); Workman et al. (2002; 2008)

Geologic Setting

Modified from Workman et al. (2002)



Spring Mountains: Proterozoic metamorphic, clastic, and carbonate rocks, Paleozoic and Mesozoic clastic and carbonate rocks

Pahrump Valley: Tertiary sediments

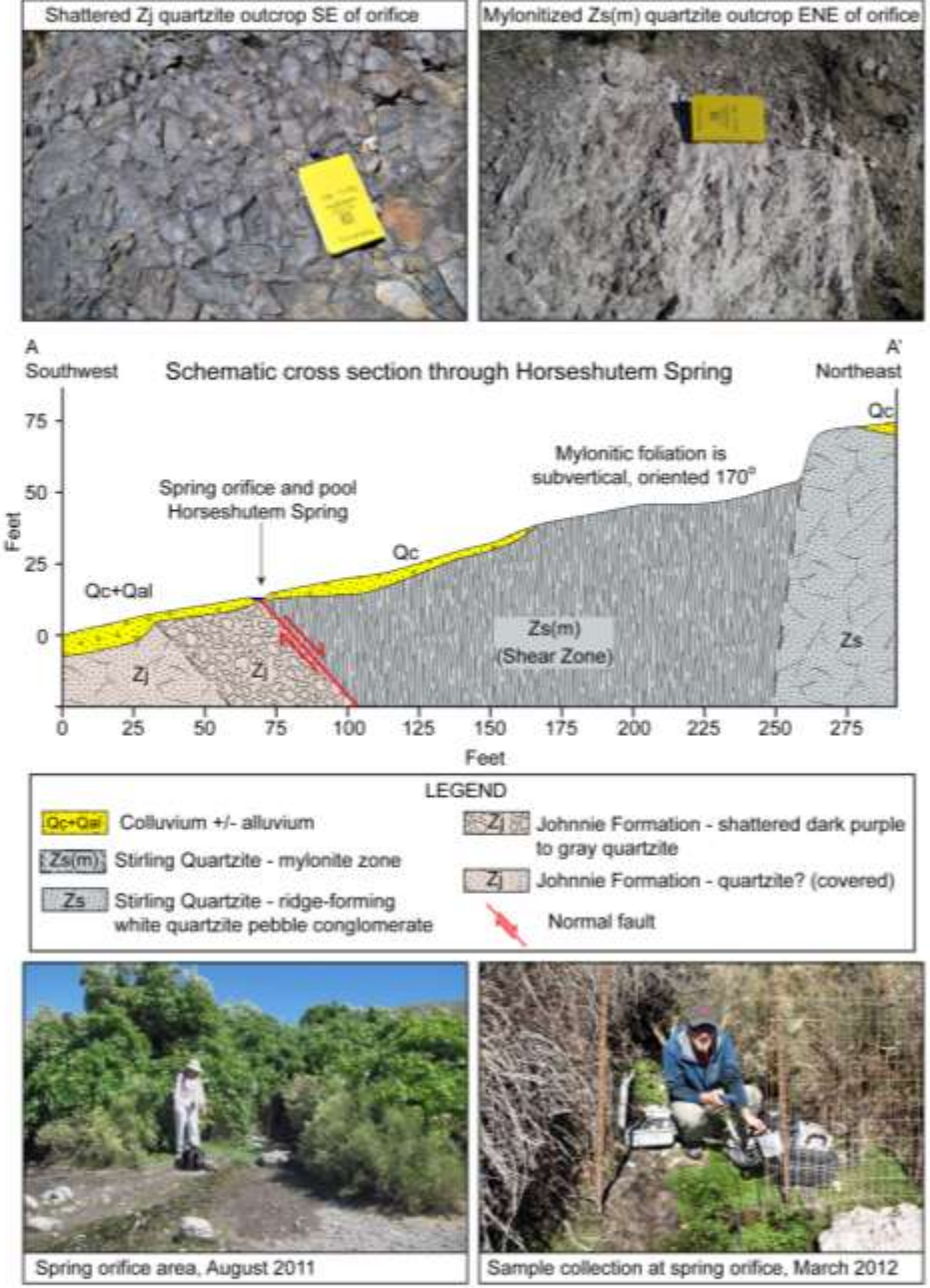
Sampling Scheme

- Water samples from:
  - 4 valley springs
  - 6 mountain-block springs
  - 5 flowing artesian wells
  - 10 non-flowing wells
- Analyzed for:
  - major anions and cations
  - hydrogen, oxygen and carbon isotopes
  - helium isotopes (subset)
- Spring assessment included:
  - Geologic and geomorphic mapping
  - Measurement of spring discharge
  - Measurement of field water quality parameters
  - Spring classification based on Springer et al. (2008)

Results:

Mountain Block Springs

- The mountain block springs flow from fractured bedrock
- The northern five springs emerge from highly fractured or mylonitized quartzite of the Johnnie Fm, Stirling Quartzite, Wood Canyon Fm
- The springs were classified as Rheocrene (emerges in stream channel) or hillslope springs
- Q between 1 and 15 gpm

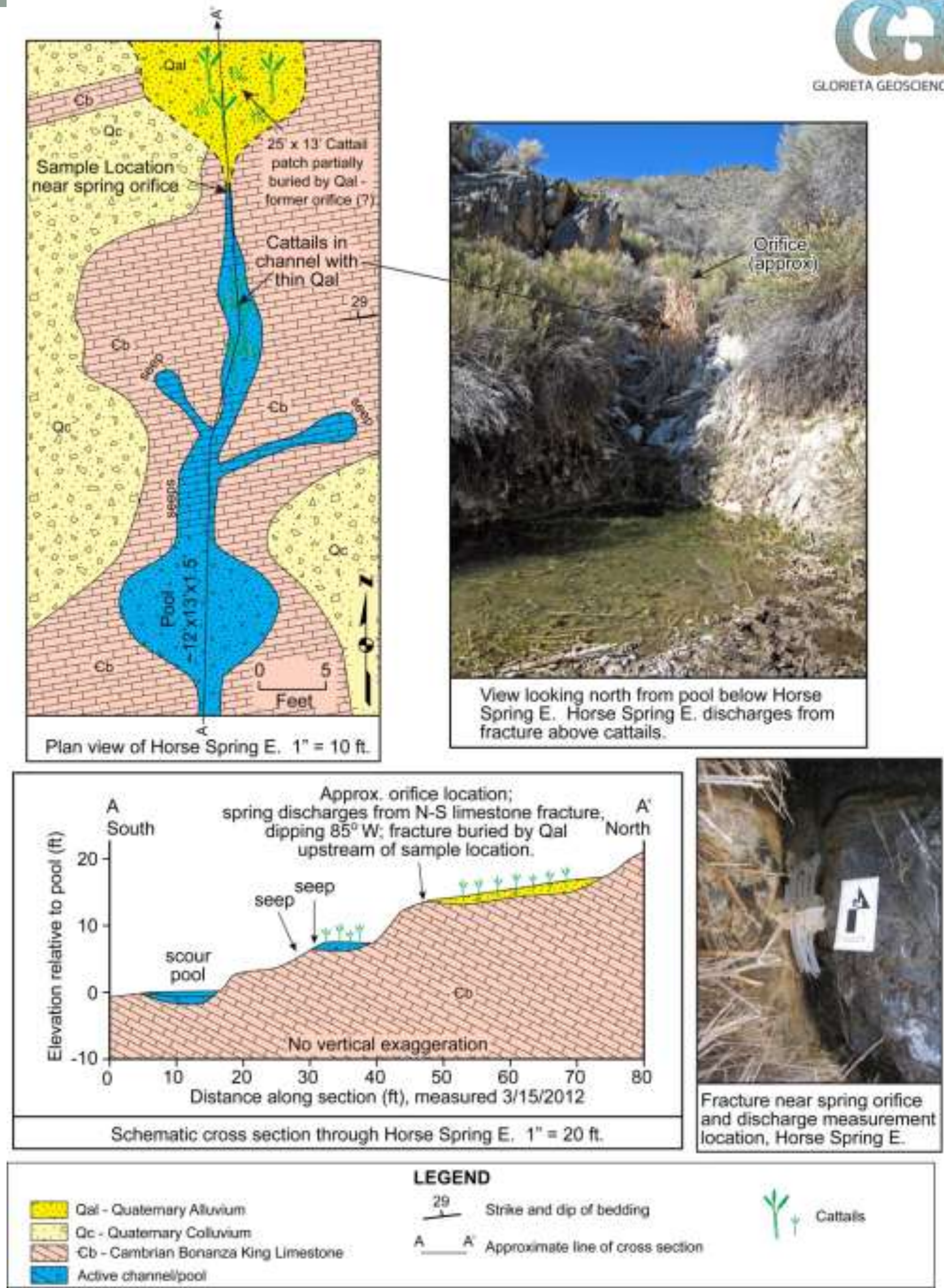


Horseshutem Spring emerges from base of sheer zone along normal fault

Results:

Mountain Block Springs II

- Horse Spring East emerges from a N-S fracture in Bonanza King
- Rheocrene/fracture spring



Results: Valley Floor Springs

- Valley-floor springs are associated with mapped/inferred structures cutting alluvial formations
- Ivanpah and Manse springs located along Hwy 160 fault
- Mound and Stump springs located along State Line fault zone
- Valley-floor springs classified as: limnocrene (emerges in pools), caldron, hypocrene/buried, and rheocrene
- Q between 0.2 (Stump) and 1000-1200 gpm (Manse)

Manse Spring – Upper Pool

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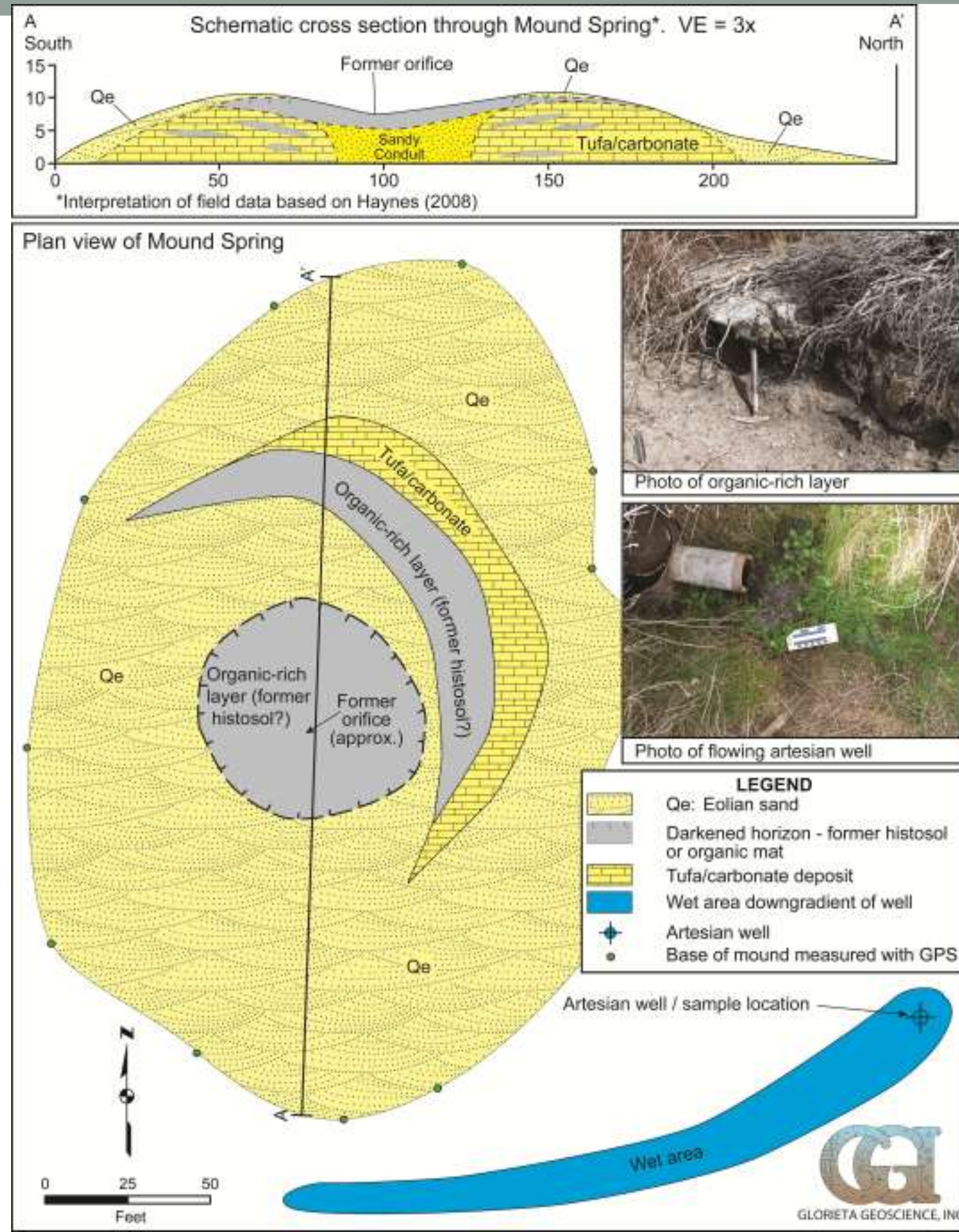
Results:

Valley Floor Springs II

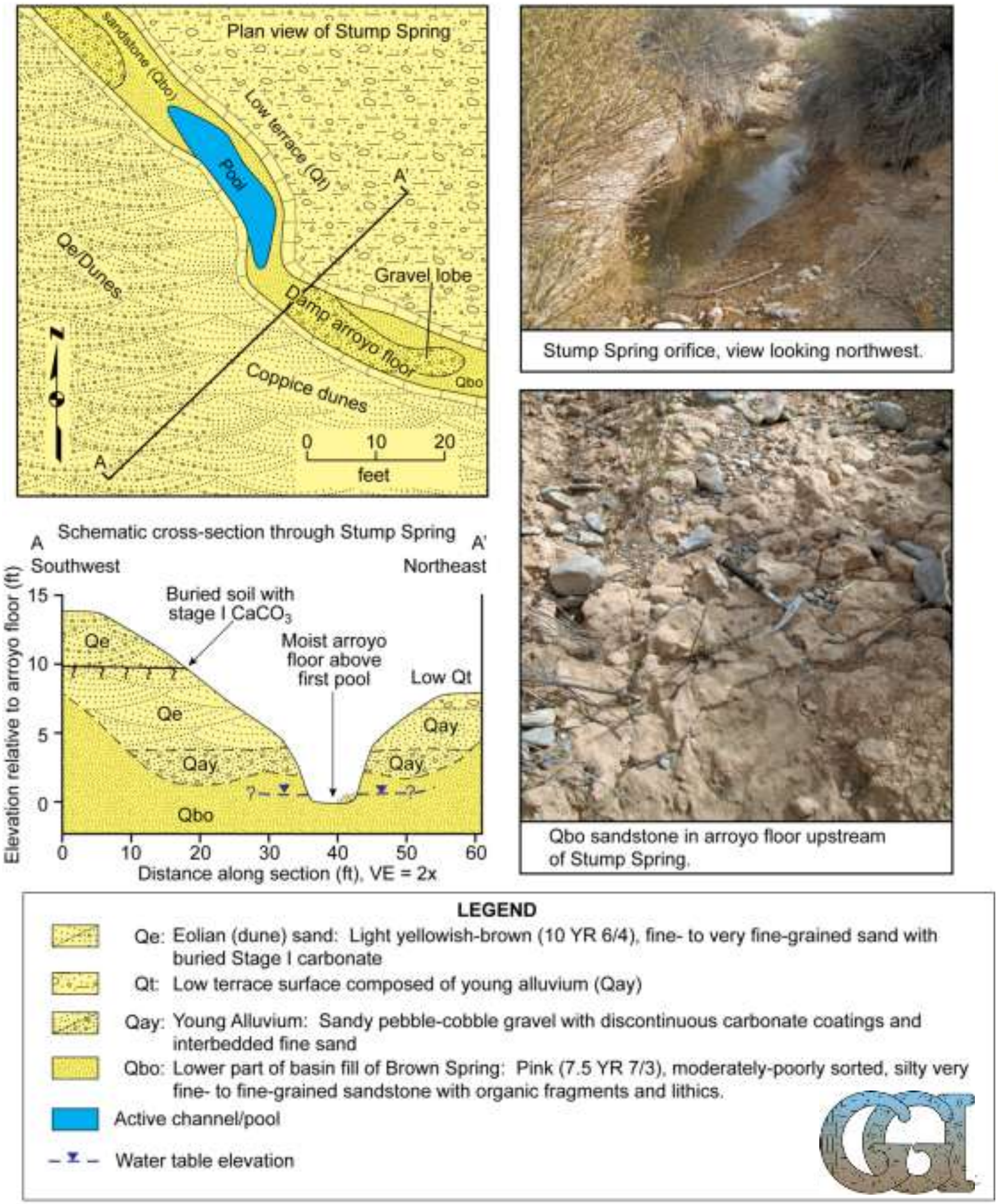
- Mound Spring is caldron (hypocrene) spring
- Artesian well drilled next to spring may have resulted in drying up of spring orifice
- Discharge west of PVFZ (possible splay?)
- Well flow measured at 2.3 gpm



Results:

Valley Floor Springs III

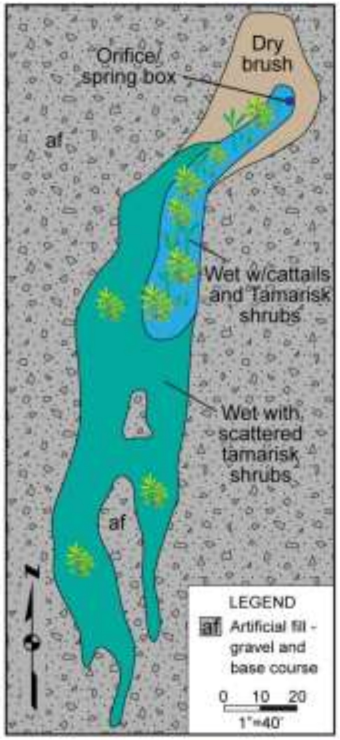
- Stump Spring
- Discharge along PVFZ
- Low discharge (0.2 gpm)
- Rheocrene spring



Results:

Valley Floor Springs IV

- Ivanpah Spring
- Discharge along "Hwy 160" FZ
- Low discharge (0.3 gpm)
- Recently began flowing after several years dry




Sample setup and collection at Ivanpah Spring

View looking north at Ivanpah spring

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Results: Well Sampling Program

Wells completed in alluvial basin fill sediments sampled as part of this investigation

Bypassing pressure tank to collect sample from non-flowing domestic well after completion of purging.

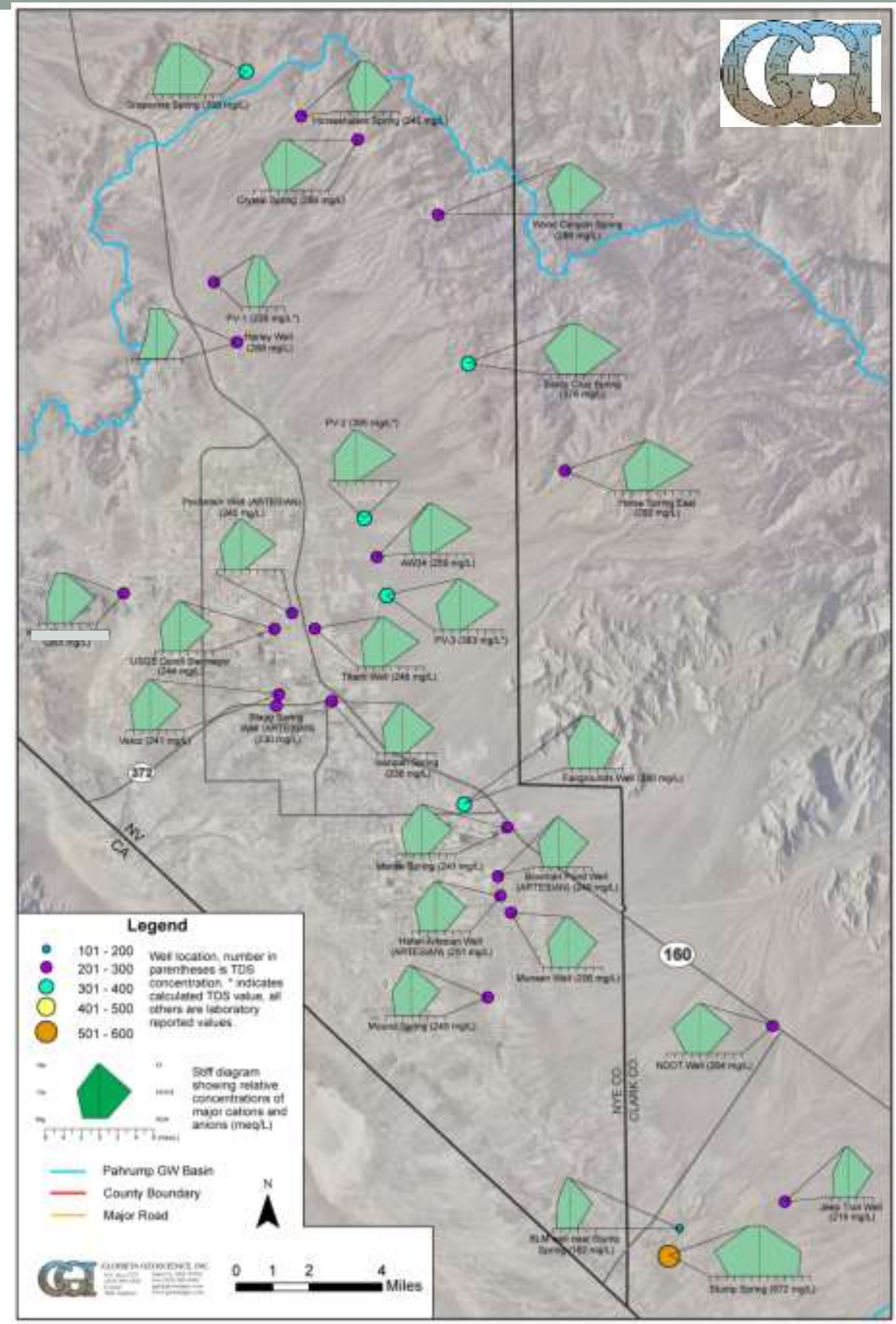
Assessment of artesian well for inclusion in sampling program

Uncased well provided key data point in southern part of study area

Results:

General Chemistry

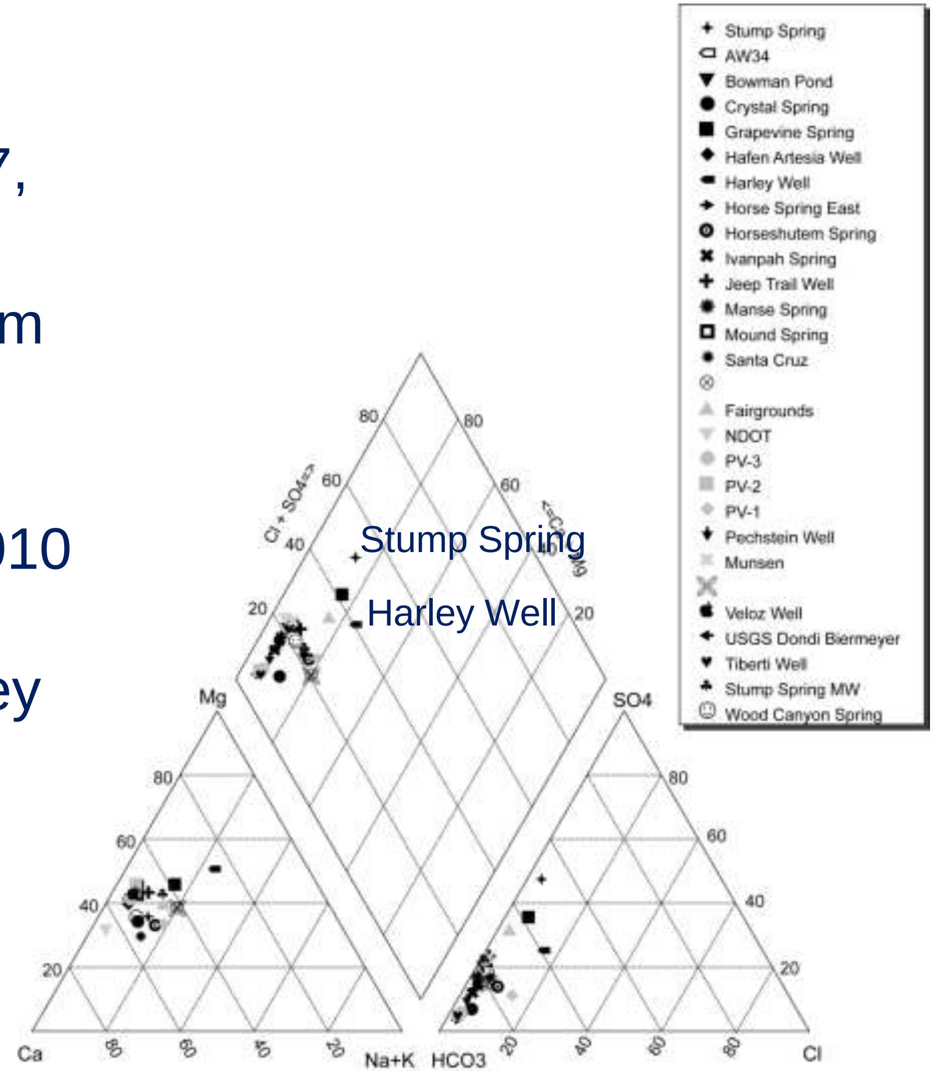
- Majority of samples
  - Ca-Mg-HCO3 water type
  - low TDS (200-400 mg/l)
- Consistent with interaction of dolomite +/- limestone
- Relatively short residence time/interaction with carbonate & silicate clasts
- Exceptions - Higher TDS and/or SO_4
  - Stump & Grapevine Springs
  - Harley & Fairgrounds Wells



Results:

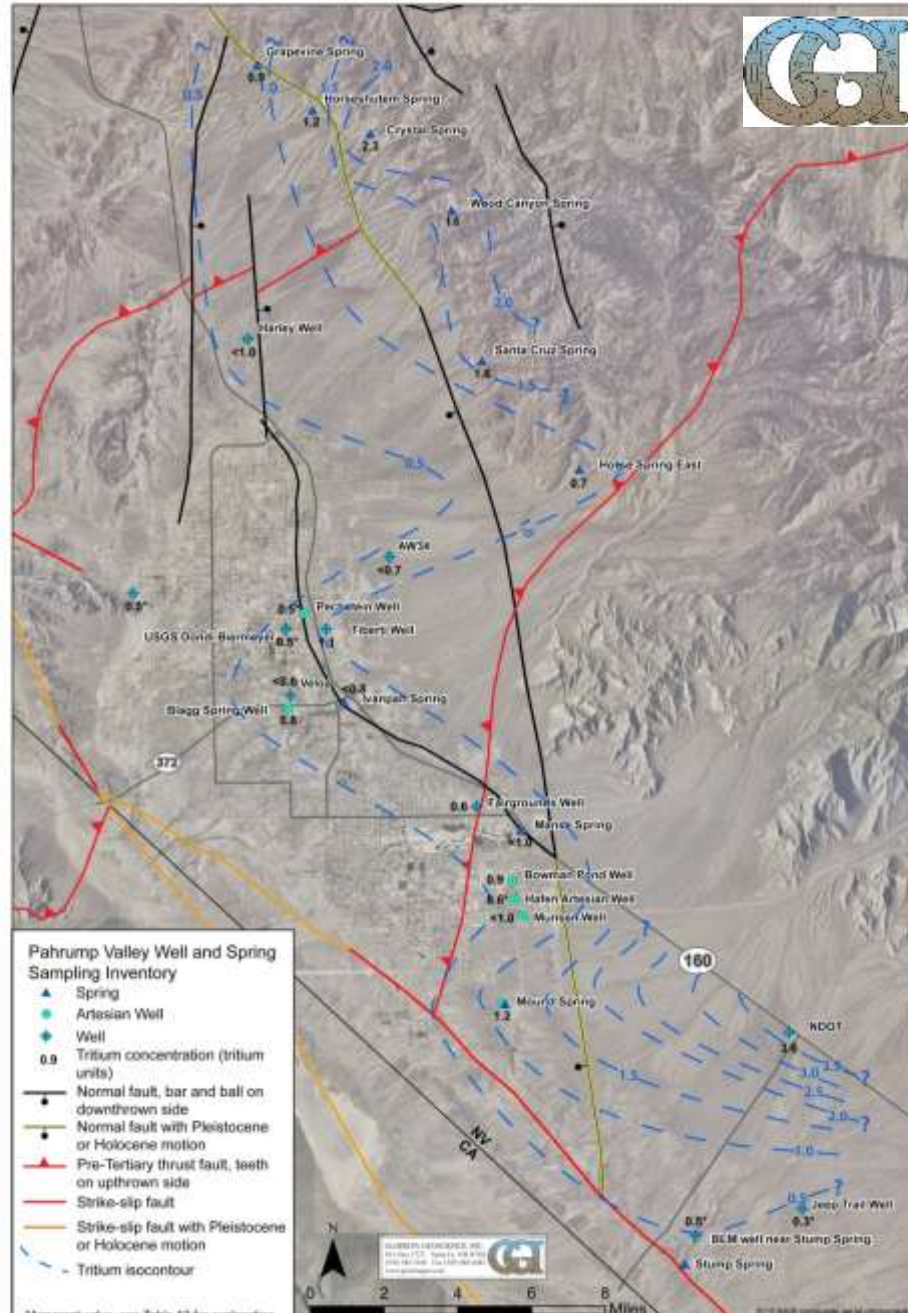
General Chemistry II – Nitrate, Arsenic and Fluoride results

- Nitrate concentration in wells sampled ranged from 0.14 to 0.57, with one sample 1.1 mg/l
- With the exception of Horseshutem (1.2 mg/l) and Stump (2.97 mg/l), springs exhibited < 1 mg/l nitrate
- All wells and springs had As < 0.010 mg/l. Maximum values 0.0041 (Stump Spring) and 0.0047 (Harley Well)
- Fluoride < 1 mg/l at all locations
- High nitrate and As generally correspond to higher sulfate



Results: ^{3}H

- Flow W to SW, consistent with Spring Mtn. recharge
- Estimate 5 to 9 TU in precipitation in Pahrump area precipitation
- TU of >2 indicates <10-20 year old recharge
- TU or <1.5 indicates mixture of modern recharge with pre-1952 recharge
- TU of <0.8/non-detectable tritium indicates predominantly or entirely pre-1952 recharge



Geologic Structure modified from Potter et al. (2002); Workman et al. (2002; 2008)

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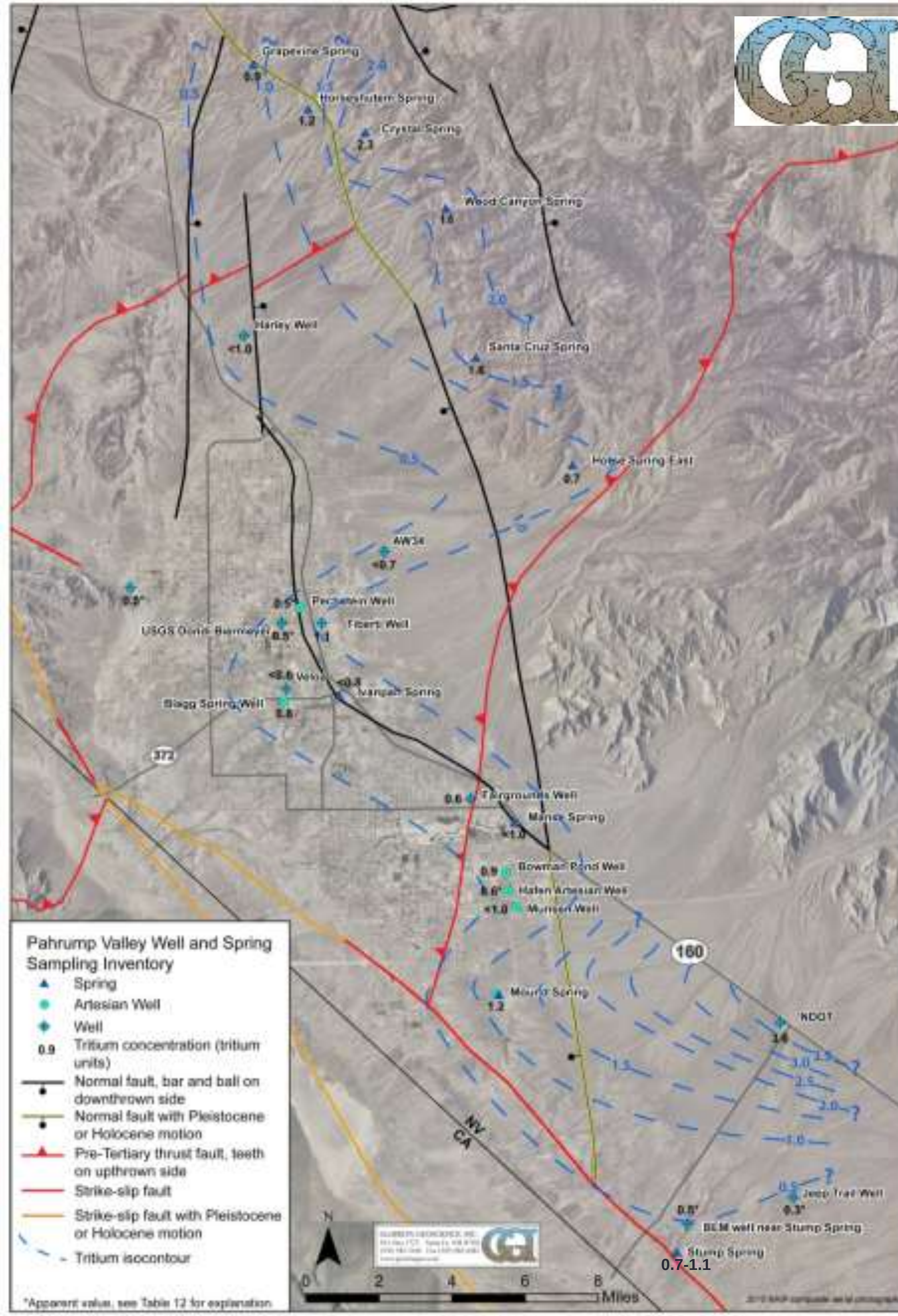
Results: ^{3}H cont.

- Most northern mountain block springs show < 10-20 year old recharge
- Central and western Pahrump wells have ^{3}H values indicating predominantly or entirely pre-1952 recharge
- Mound and Stump Springs have relatively high ^{3}H values of 0.9-1.2 TU (mixture of modern and pre-1952 recharge)



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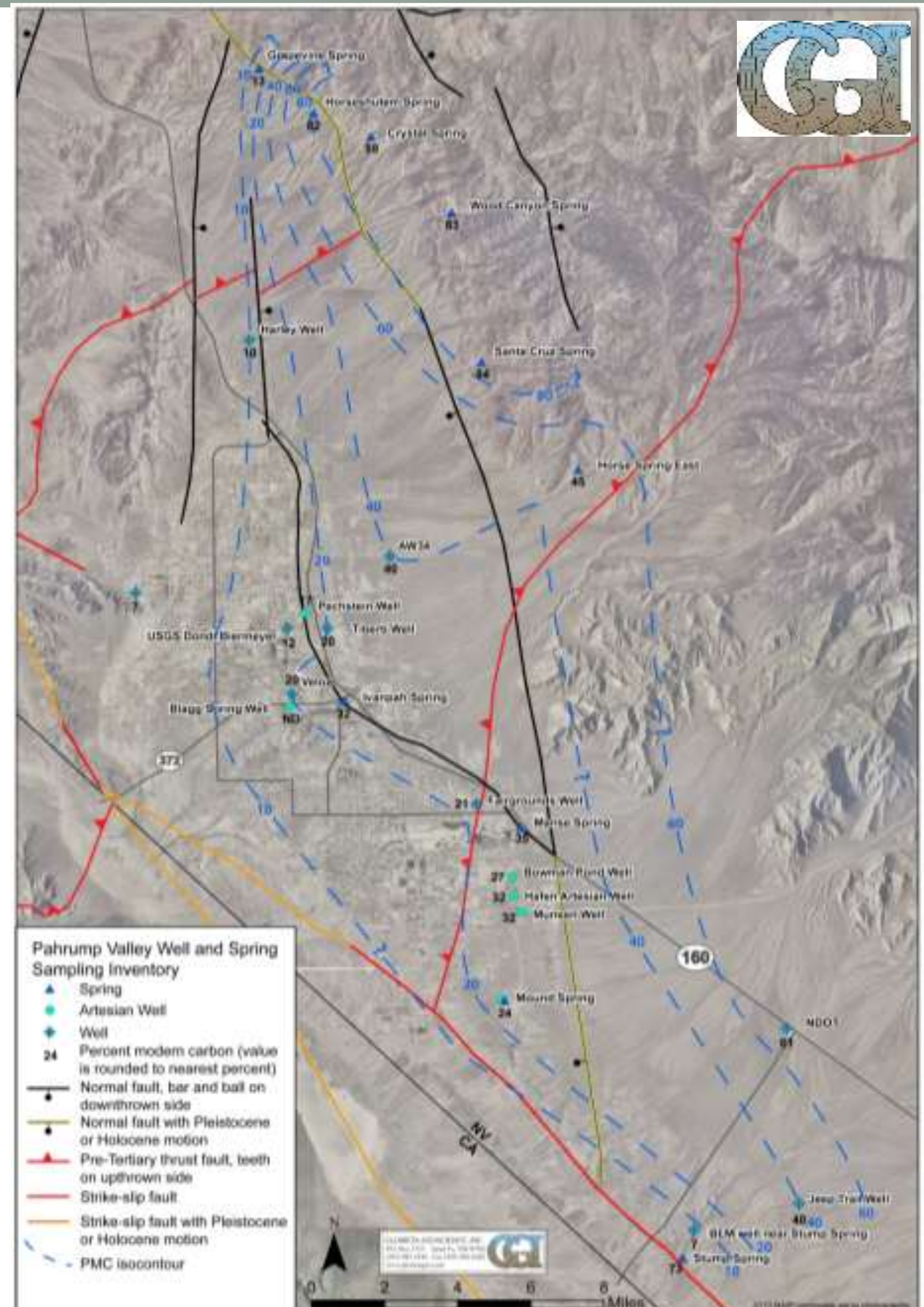
Results: PMC

- Flow W to SW, consistent with Spring Mtn. recharge
- PMC rather than apparent age reported as water has interacted with old carbonate rocks
- PMC data consistent with ^{3}H data
- PMC >80% suggest <20 years old recharge
- PMC <20% suggest >60 years old recharge
- Stump spring anomalously high PMC, in contrast to low PMC in Stump Spring MW



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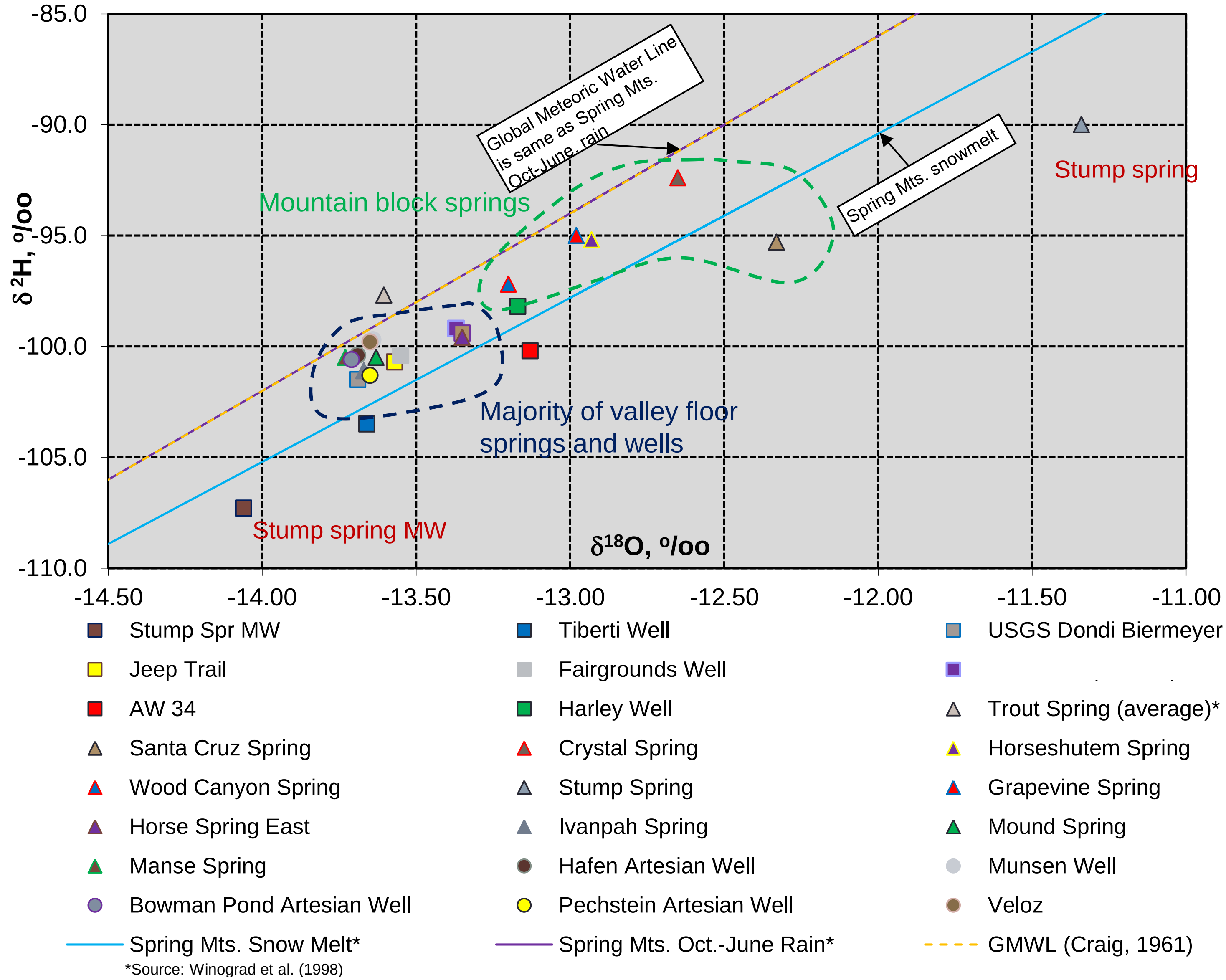
Results: δ²H and δ¹⁸O



Results: δ^2H and $\delta^{18}O$

- Mostly consistent with high-elevation, fall-spring recharge
- Wells and valley-floor springs are typically more depleted, indicating higher elevation recharge than mountain-block springs
- Stump & Santa Cruz Springs have evaporative signatures
- Stump spring MW much more depleted that Stump spring

Results: $^3He/^4He$

- He samples collected from five springs
- Grapevine, Horseshutem, and Crystal Springs were all consistent with an atmospheric He source and relatively young recharge
- Ivanpah Spring has $^3He/^4He$ ratio consistent with mantle helium contribution to the sample, indicating that Ivanpah is a fault-controlled spring (“Hwy 160” fault)

Conclusions

- Recharge varies from < 10 to 20 years for most mountain front springs to > 60 years for wells in western Pahrump
- High elevation, fall through spring recharge is predominant recharge source.
- Faults typically act as low-permeability barriers to groundwater flow in the Pahrump Valley.
- Stump Spring shows anomalous general and isotope geochemistry results

Conclusions continued

- Discharge from Stump Spring and Mound Spring is fault-controlled
- Stump Spring and Stump Spring monitoring well have distinctly different geochemical signatures
- Ivanpah Spring has $^{3}He/^{4}He$ ratio consistent with mantle Helium contribution, indicating that Ivanpah is also fault-controlled
- Water quality in the Pahrump Valley in wells and springs sampled in this study is excellent


QUESTIONS?