Nye County's Early Warning Drilling Program:

Update & Geochemistry

Presentation to the U.S. Nuclear Waste Technical Review Board

By

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1 May 2000

Early Warning Drilling Program Update

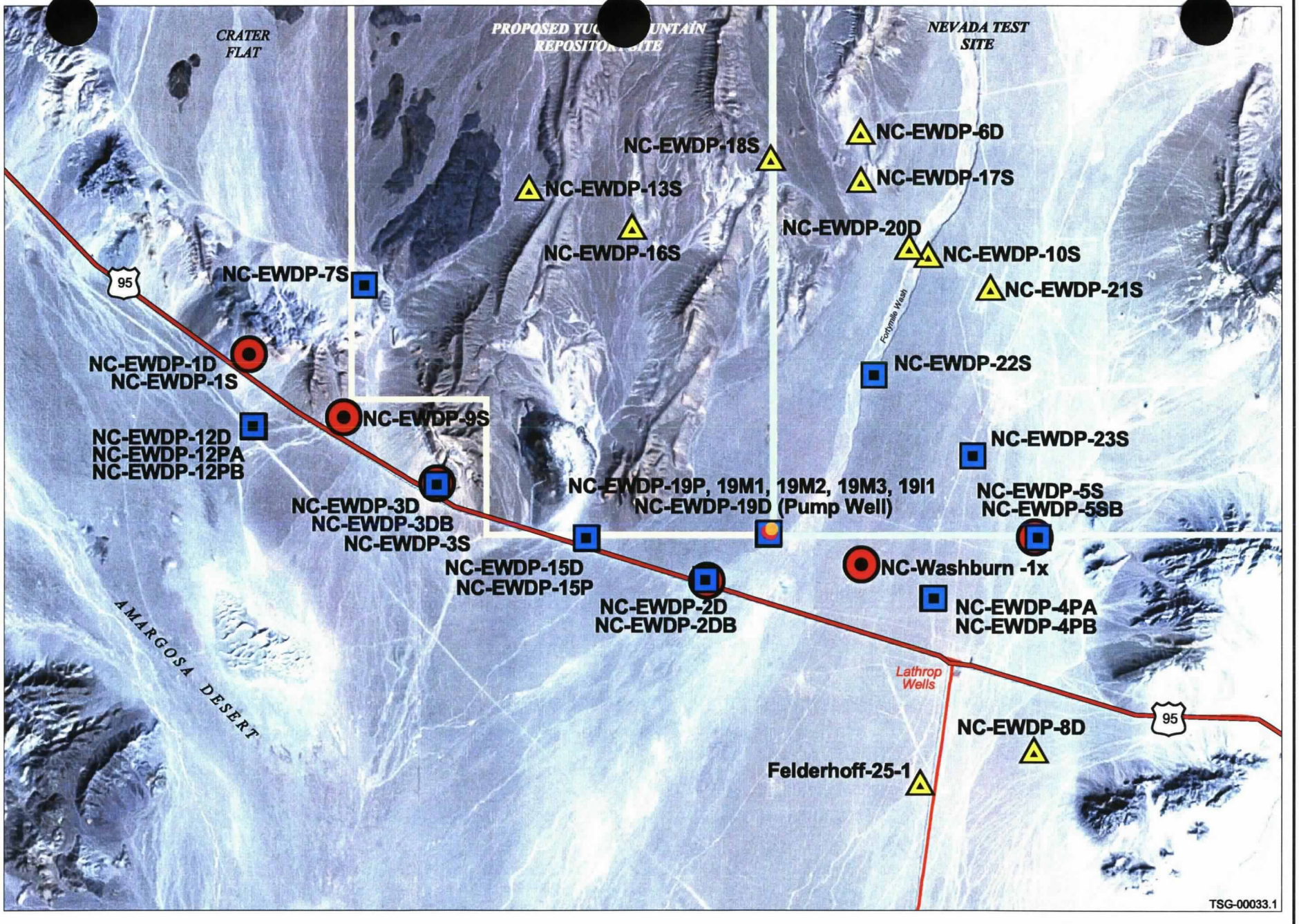
(Through April 2000)

EWDP to DATE

- More than 17,000 feet of exploratory drilling
- Seventeen wells and piezometers at 10 locations
- Geologic samples, geophysical logs, and first water samples at all sites
- Five aquifer tests completed
- Aeromagnetic and gravity surveys completed

Phase II

- One six completion well and one piezometer in spring deposit area in Crater Flat (NC-EWDP-7s and -7p)
- Test well and piezometer at alluvial tracer complex (NC-EWDP-19d and -19p)
- Three piezometers at Carrara Fault test site (NC-EWDP-12d)
- Deep (500 ft) conductor casings set at three locations for preparation to drill to carbonate system (NC-EWDP-2db, -3db, and -15d)
- Two piezometers north of Lathrop Wells (NC-EWDP-4pa and -4pb)
- Initial round of water sampling will be in late May



NYE COUNTY, NEVADA

EARLY WARNING DRILLING PROGRAM DRILLHOLE LOCATIONS

0 1 2 3 4 5 6 7 8 9 10 Miles

N W E S

- Phase I Drillholes
- Phase II Drillholes
- Phase II Monitoring Wells
- Phase II Injection Well
- Phase III Drillholes

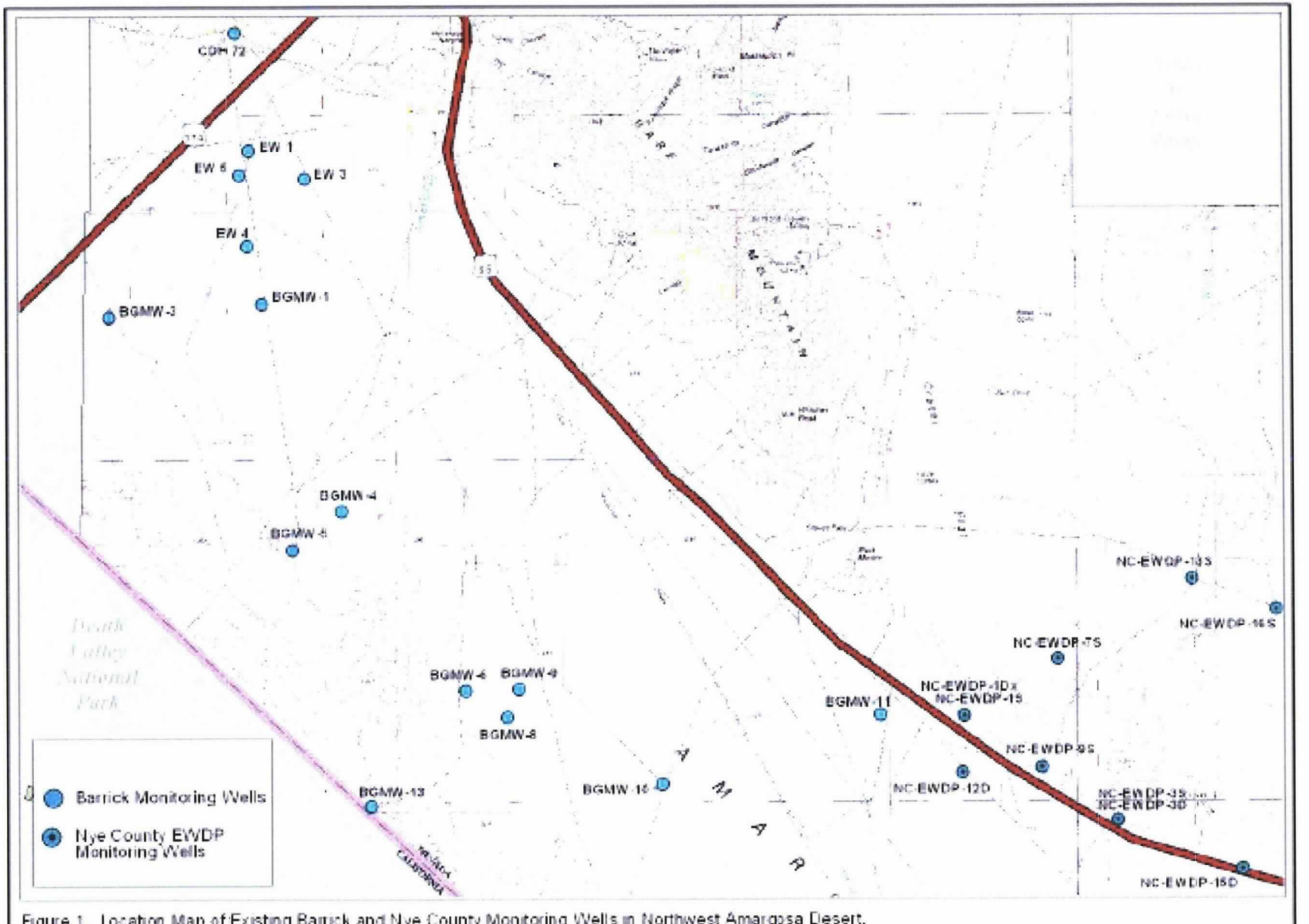


Figure 1. Location Map of Existing Barrick and Nye County Monitoring Wells in Northwest Amargosa Desert.

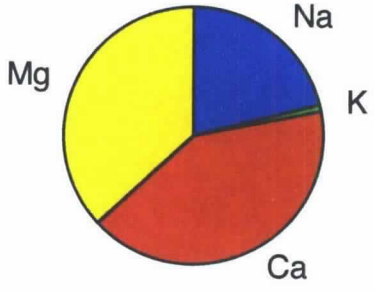
Introduction

"Snapshot of Geochemistry"

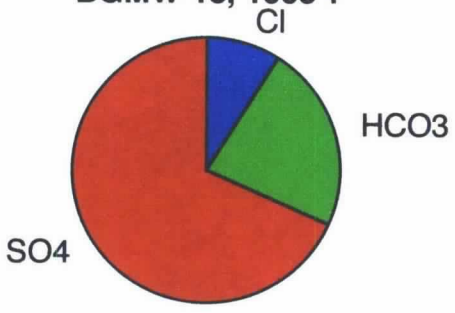
1. Gross Chemistry & Metals - DRI WRC Waterlab
2. Stable Isotopes (H,O,C,S,N) - Geochron Lab.
3. U/Pb/Sr isotopes - Geochron / Dr. S. Bowring, MIT
4. Gross Alpha & Beta, Tritium - Barringer Lab.
5. Chlorine-36 - Dr. M. Zreda, Dept. H.W.R.,Univ. of Arizona
6. Radiocarbon, tritium, TDIC, Stable Isotopes (H,O,C) - Inst. for Geol. and Nuclear Sciences, New Zealand
7. Petrography & geochemistry of cuttings: Dr. M.E. Morgenstein, GMII

Nye County EWDP Site: Major Chemistry

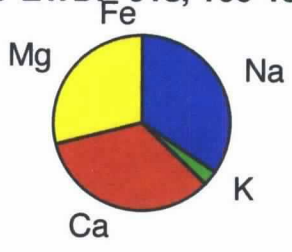
BGMW-13, 1005'+



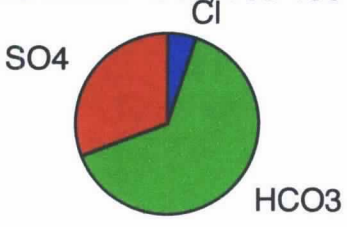
BGMW-13, 1005'+



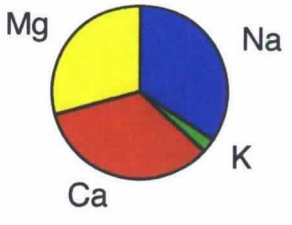
NC-EWDP-01s, 160-180'



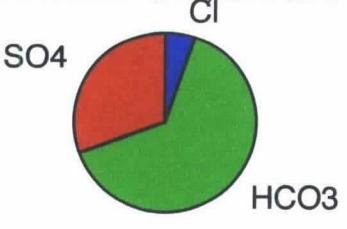
NC-EWDP-01s, 160-180'



NC-EWDP-01s, 211-271'

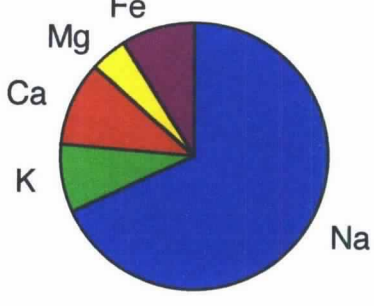


NC-EWDP-01s, 211-271'



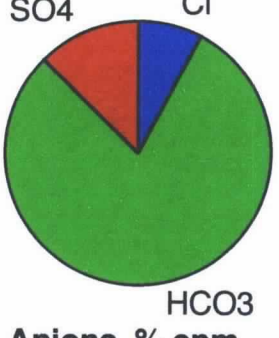
FAULT

NC-EWDP-01dx, 2100'+



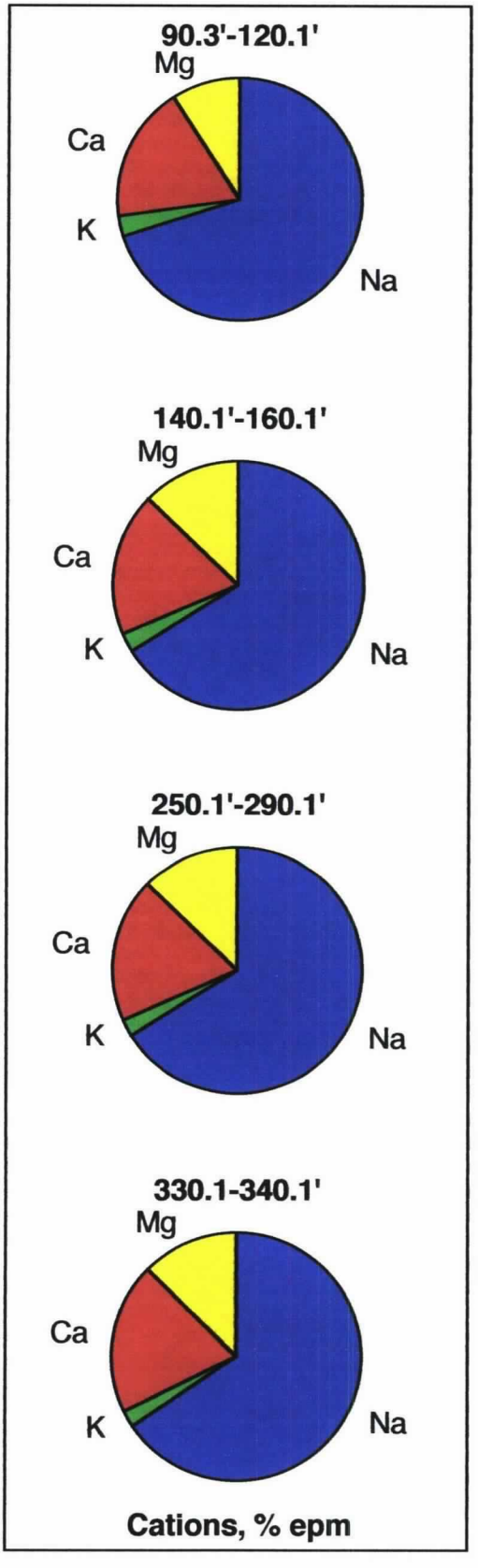
Cations, % epm

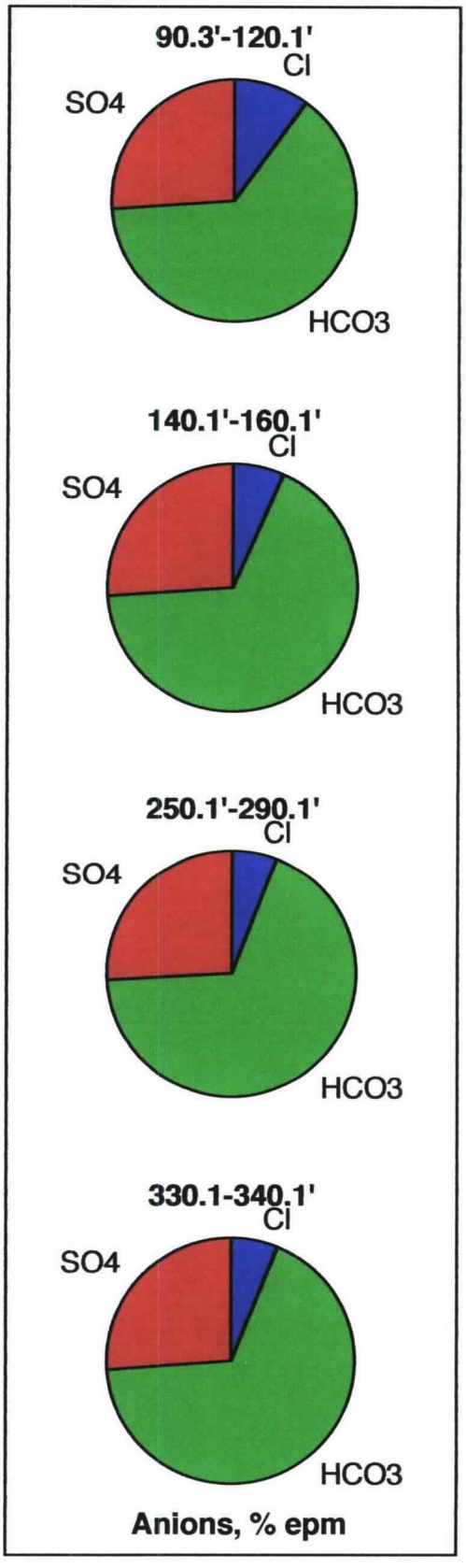
NC-EWDP-01dx, 2100'+



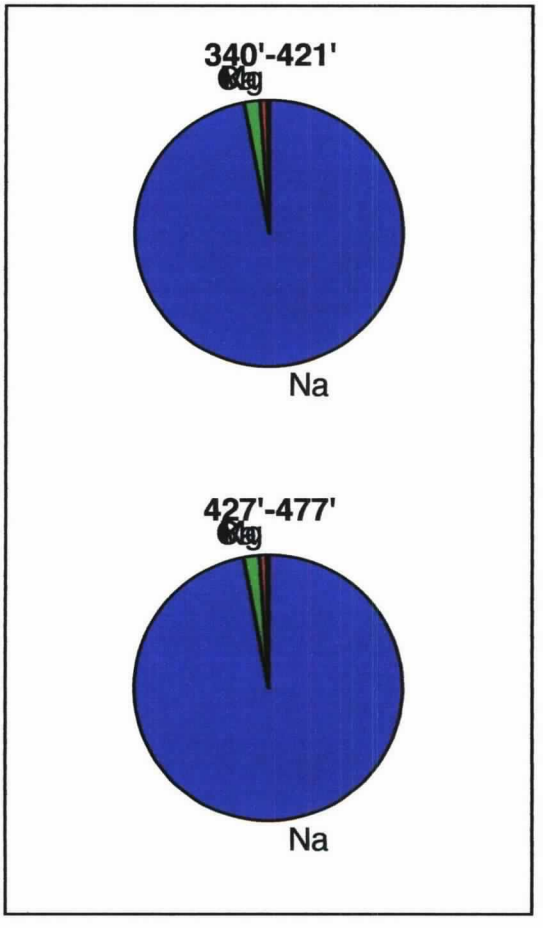
Anions, % epm

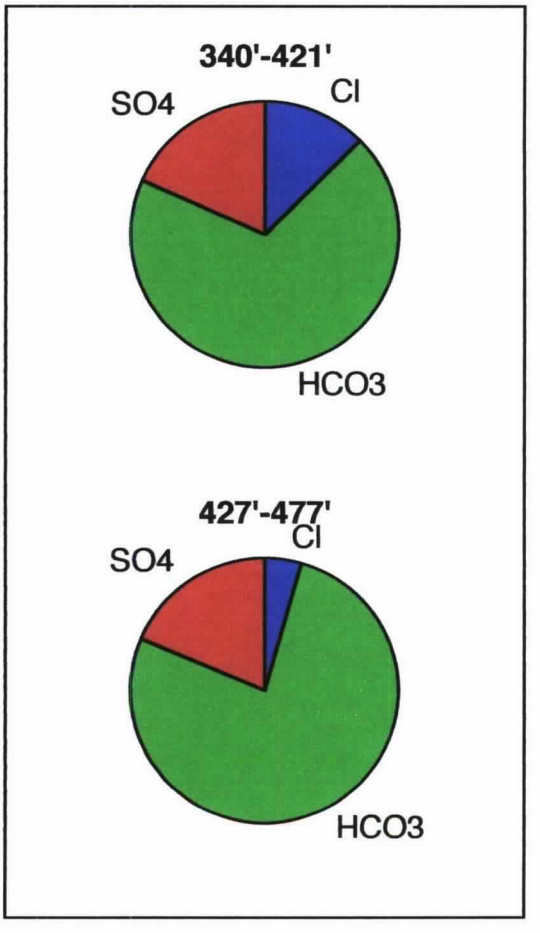
NC-EWDP-09sx Site: Major Chemistry

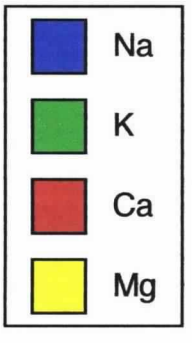


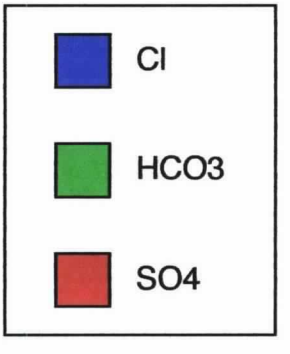


NC-EWDP-03s Major Chemistry



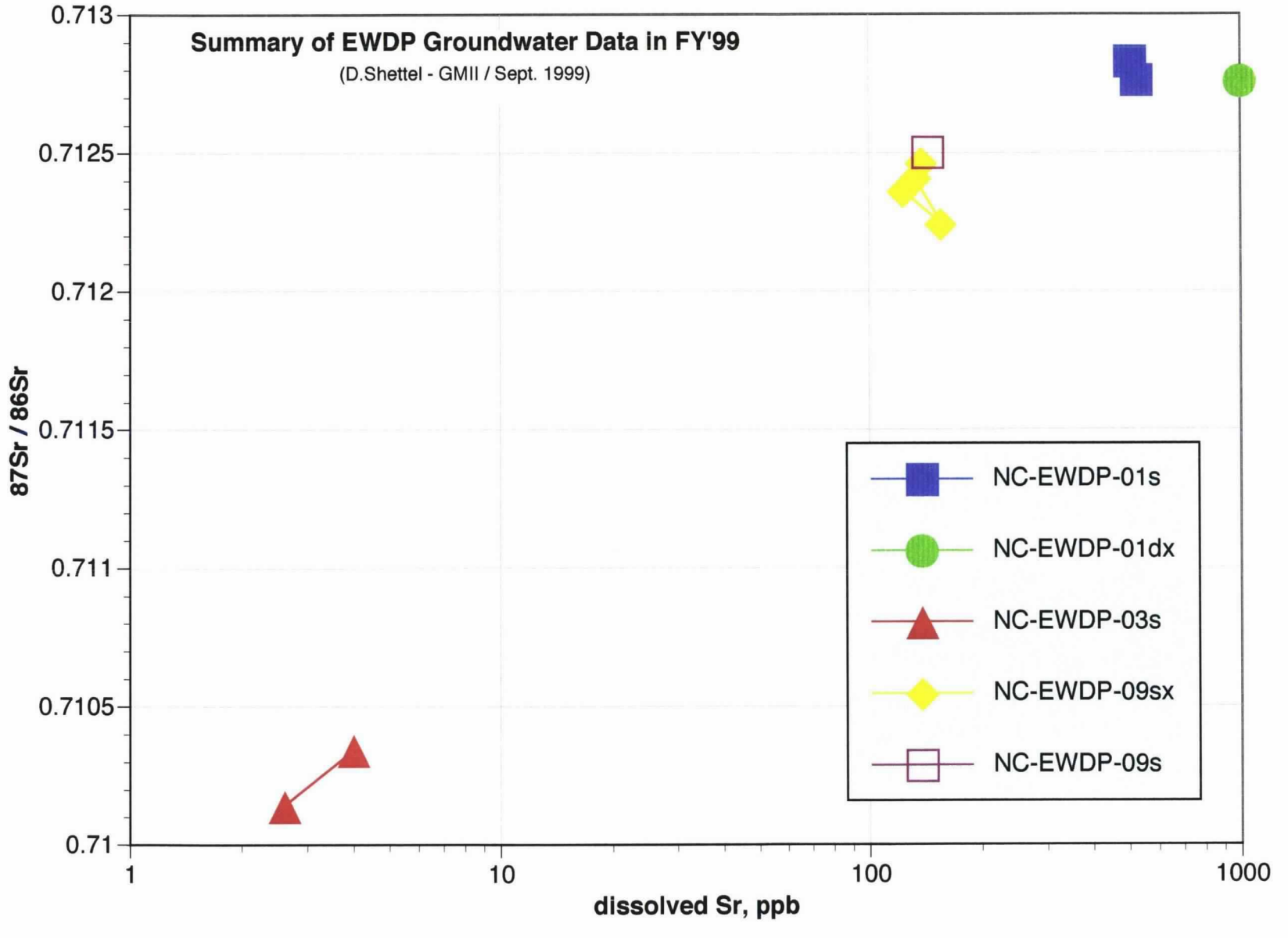


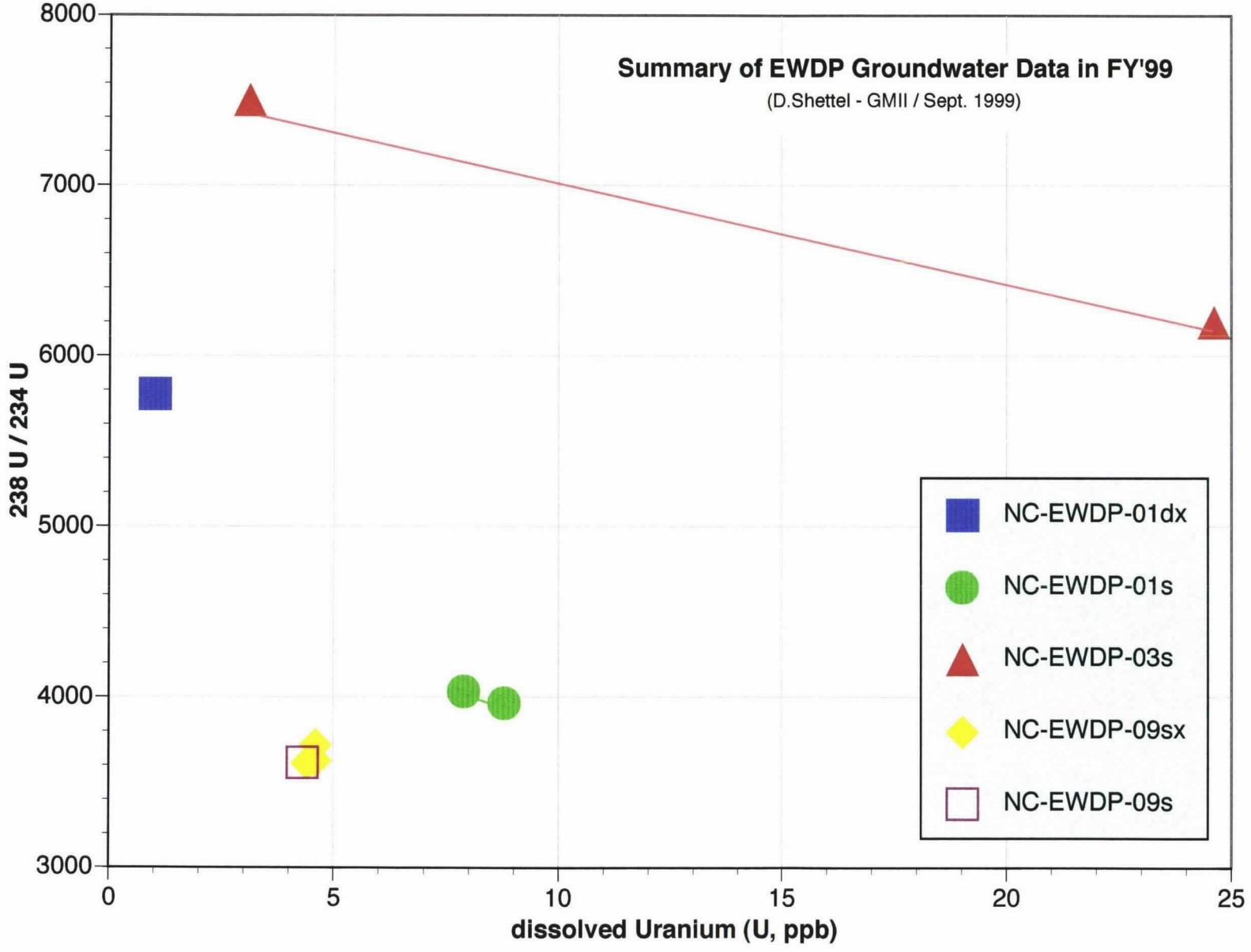


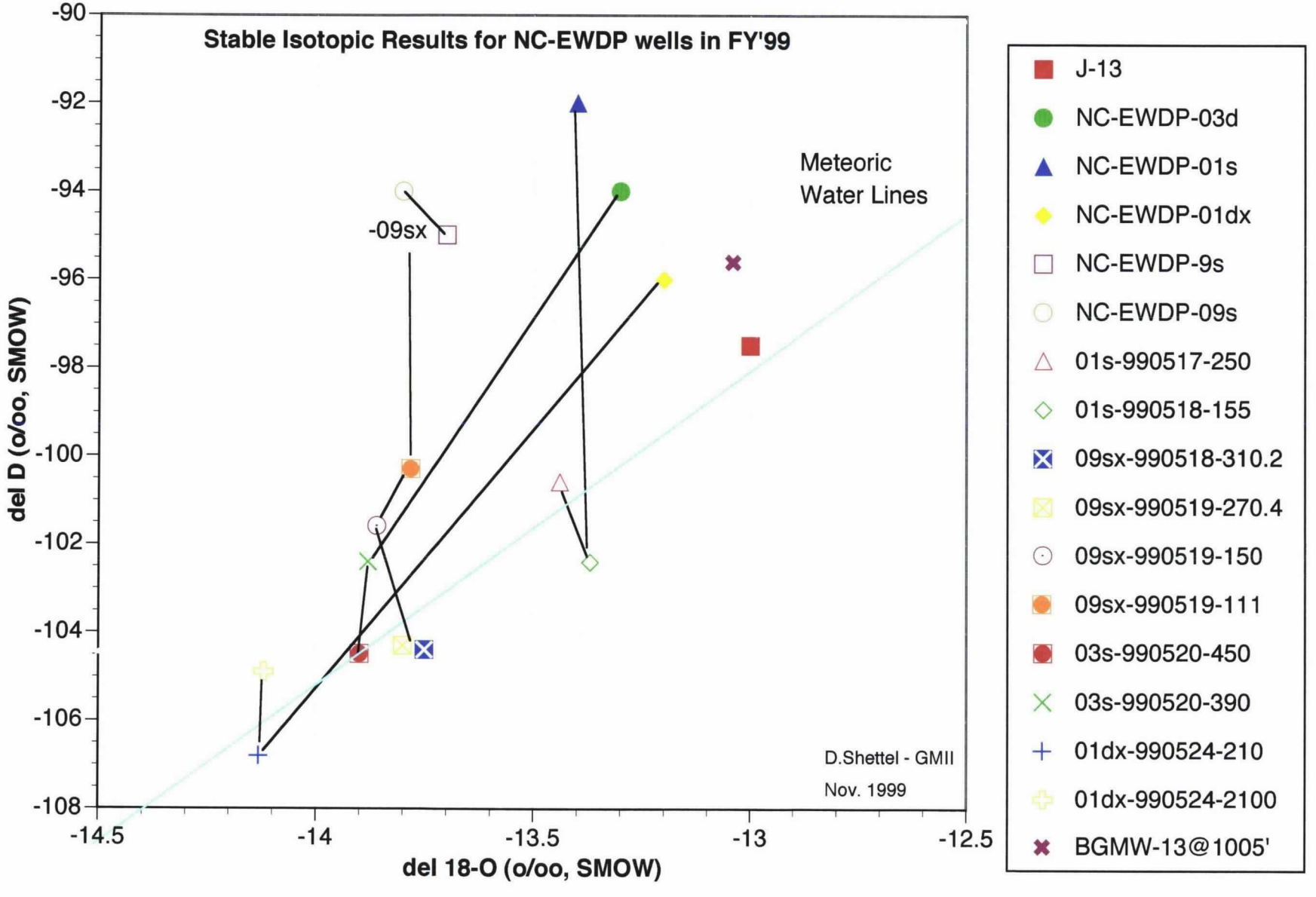


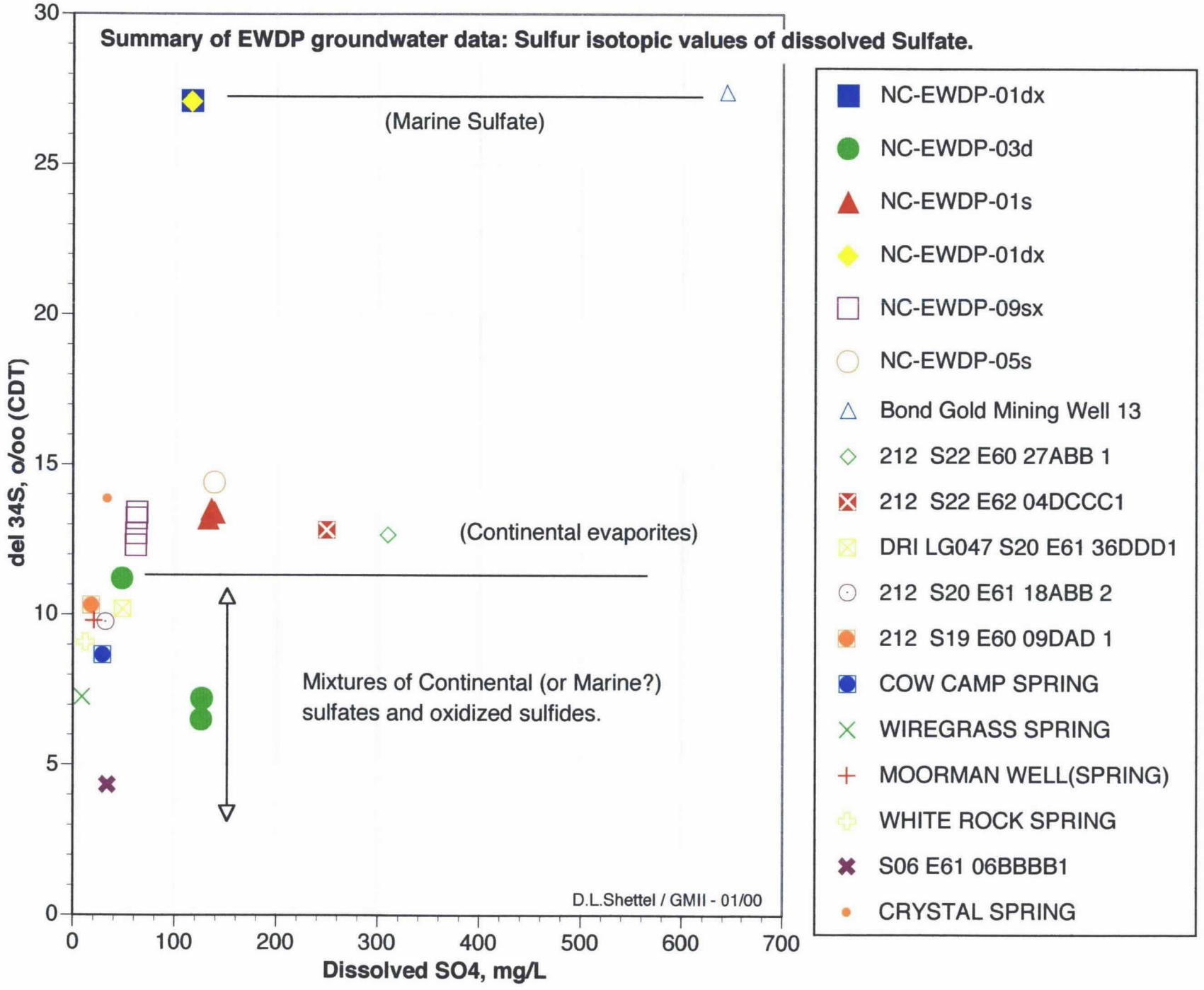
Sample	Date	type	Gross Alpha pCi/L	Gross Beta pCi/L	Tritium pCi/L	U233 +234 pCi/L	U235+236 pCi/L	U238 pCi/L	Th-228 pCi/L	Th-230 pCi/L	Th-232 pCi/L	Ra-226 pCi/L	
Safe Drinking Water Act Std.			15	50	20,000							5	
NC-EWDP-04pa	9-Jan-00	total	340±250	640±200	160±230								bailed
NC-EWDP-04pa	9-Jan-00	total	390±300	400±220									bailed
NC-EWDP-04pa	9-Jan-00	diss.	2.0±2.6	3.9±2.2		1.4±1.9	0.35±.83	.5±1	2.5±2.8	11±7.5	3.4±3		bailed
NC-EWDP-04pa	23-Feb-00	diss.	3.4±2.3	2.7±2.2		1.9±9.7	0.49±0.5	0.89±0.6					bailed
NC-EWDP-04pb	23-Feb-00	diss.	9±3.2	7.6±2.6		1.9±1.1	0.11±0.47	0.7±0.64					bailed
NC-EWDP-04pa	2-Mar-00	diss.	0.65±2.1	3.6±2.2		0.6±2.1	0.7±0.82	0.42±1.2	0.65±1.8	4.8±4.6	1.7±2.2		pumped
NC-EWDP-04pb	2-Mar-00	diss.	0.15±2.6	3.6±2.2		3.2±2.3	0.96±0.98	0.12±1.2	2.2±1.9	13±4.5	1.4±1.6		pumped
Amargosa Valley School		diss.	2.7±3.1	9±2.5								0.00023 ±0.25	pumped

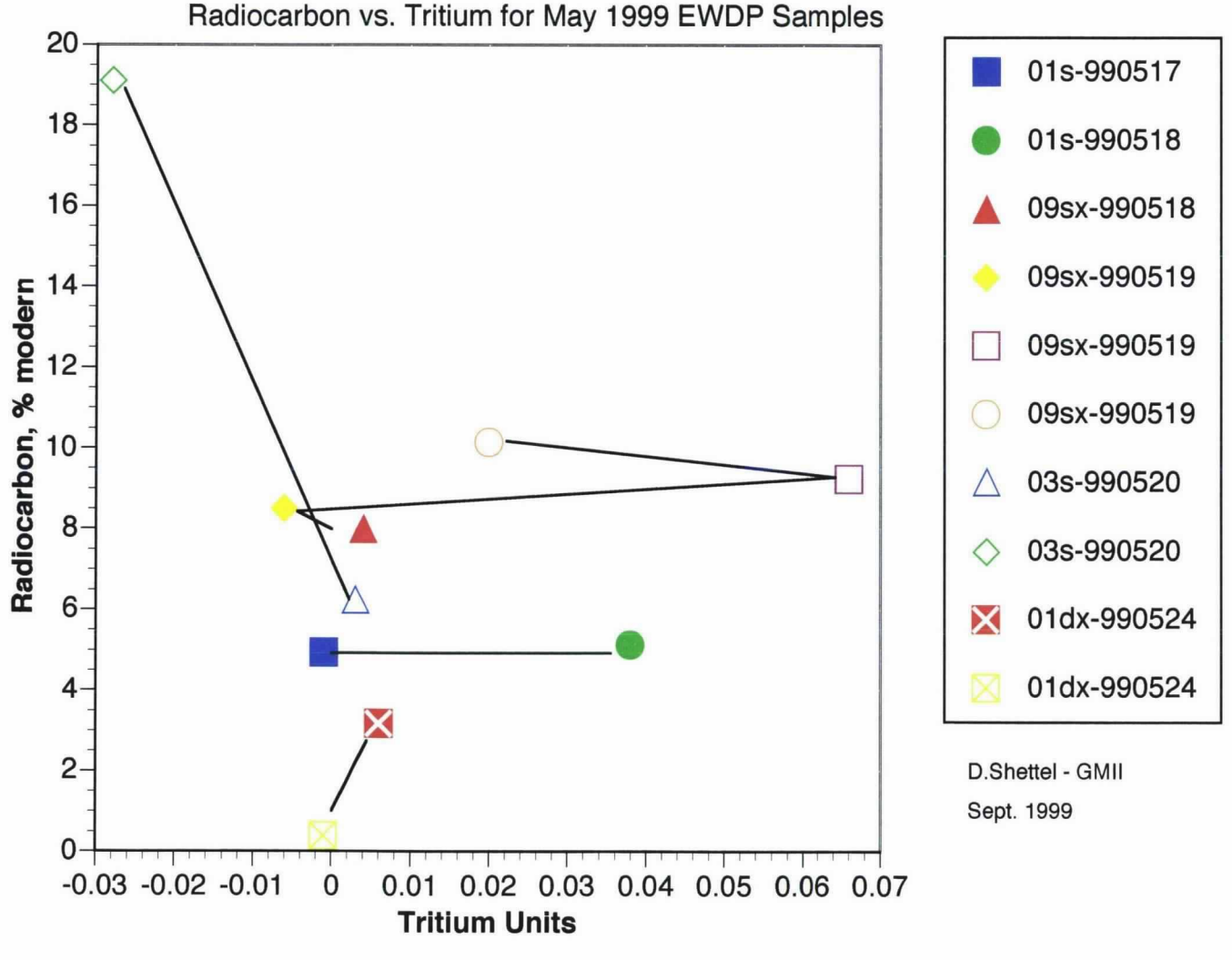
Note: ± 2 sigma; 1 pCi = 0.037 counts per second.
Logging background: <100 counts per second.

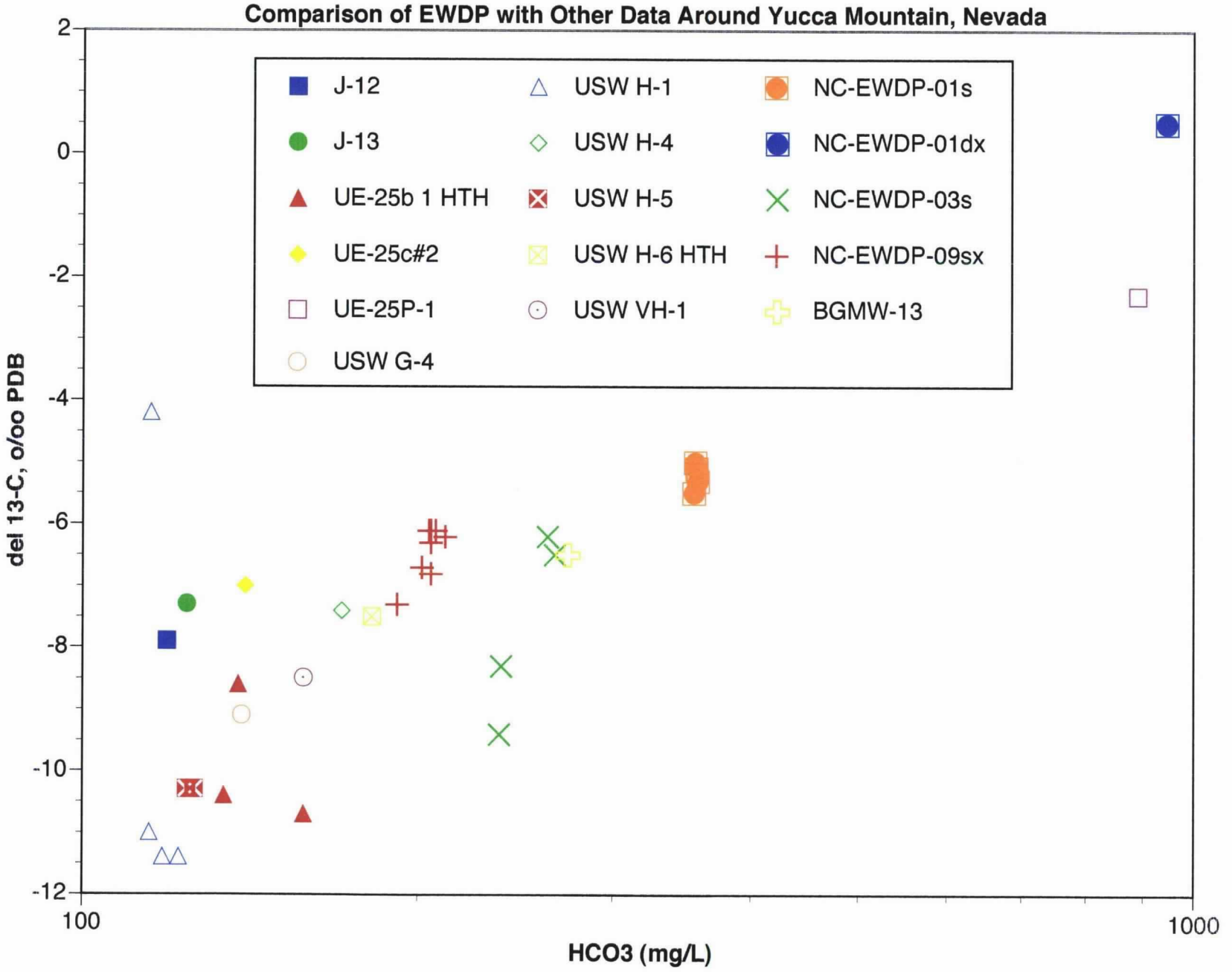

Summary of EWDP Groundwater Data in FY'99
(D.Shettel - GMII / Sept. 1999)
0.713
0.7125
0.712
0.7115
0.711
0.7105
0.71
87Sr / 86Sr
1
10
100
1000
dissolved Sr, ppb
NC-EWDP-01s
NC-EWDP-01dx
NC-EWDP-03s
NC-EWDP-09sx
NC-EWDP-09s

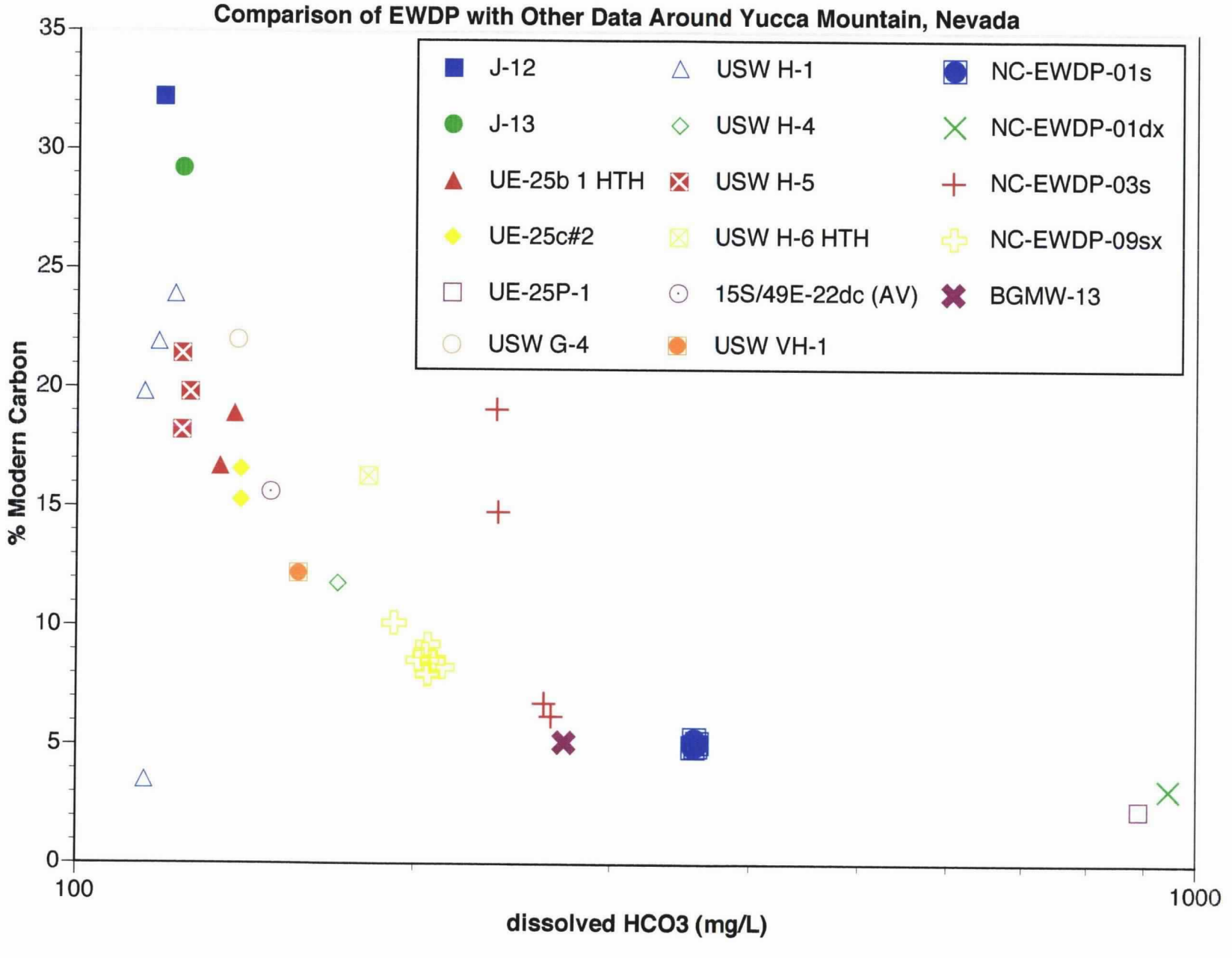

Summary of EWDP Groundwater Data in FY'99
(D.Shettel - GMII / Sept. 1999)
238 U / 234 U
dissolved Uranium (U, ppb)
8000
7000
6000
5000
4000
3000
0
5
10
15
20
25
NC-EWDP-01dx
NC-EWDP-01s
NC-EWDP-03s
NC-EWDP-09sx
NC-EWDP-09s

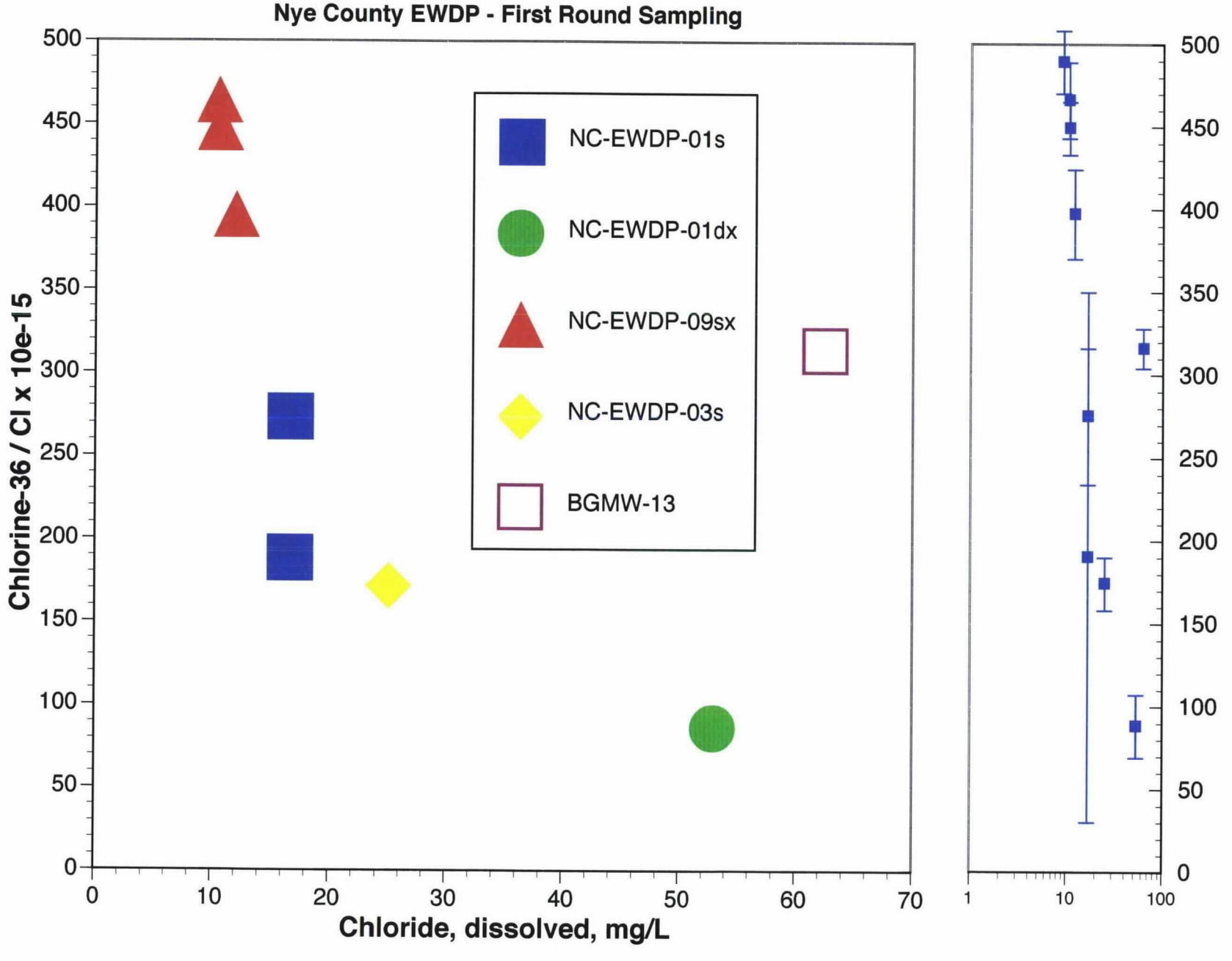

Stable Isotopic Results for NC-EWDP wells in FY'99
Meteoric
Water Lines
-09sx
D.Shettel - GMII
Nov. 1999
del D (o/oo, SMOW)
del 18-O (o/oo, SMOW)
-90
-92
-94
-96
-98
-100
-102
-104
-106
-108
-14.5
-14
-13.5
-13
-12.5
J-13
NC-EWDP-03d
NC-EWDP-01s
NC-EWDP-01dx
NC-EWDP-9s
NC-EWDP-09s
01s-990517-250
01s-990518-155
09sx-990518-310.2
09sx-990519-270.4
09sx-990519-150
09sx-990519-111
03s-990520-450
03s-990520-390
01dx-990524-210
01dx-990524-2100
BGMW-13@1005'


Summary of EWDP groundwater data: Sulfur isotopic values of dissolved Sulfate.
(Marine Sulfate)
(Continental evaporites)
Mixtures of Continental (or Marine?) sulfates and oxidized sulfides.
D.L.Shettel / GMII - 01/00
del 34S, o/oo (CDT)
Dissolved SO4, mg/L
0
5
10
15
20
25
30
0
100
200
300
400
500
600
700
NC-EWDP-01dx
NC-EWDP-03d
NC-EWDP-01s
NC-EWDP-01dx
NC-EWDP-09sx
NC-EWDP-05s
Bond Gold Mining Well 13
212 S22 E60 27ABB 1
212 S22 E62 04DCCC1
DRI LG047 S20 E61 36DDD1
212 S20 E61 18ABB 2
212 S19 E60 09DAD 1
COW CAMP SPRING
WIREGRASS SPRING
MOORMAN WELL(SPRING)
WHITE ROCK SPRING
S06 E61 06BBBB1
CRYSTAL SPRING


Radiocarbon vs. Tritium for May 1999 EWDP Samples
Radiocarbon, % modern
20
18
16
14
12
10
8
6
4
2
0
-0.03 -0.02 -0.01 0 0.01 0.02 0.03 0.04 0.05 0.06 0.07
Tritium Units
01s-990517
01s-990518
09sx-990518
09sx-990519
09sx-990519
09sx-990519
03s-990520
03s-990520
01dx-990524
01dx-990524
D.Shettel - GMII
Sept. 1999


Comparison of EWDP with Other Data Around Yucca Mountain, Nevada
J-12
J-13
UE-25b 1 HTH
UE-25c#2
UE-25P-1
USW G-4
USW H-1
USW H-4
USW H-5
USW H-6 HTH
USW VH-1
NC-EWDP-01s
NC-EWDP-01dx
NC-EWDP-03s
NC-EWDP-09sx
BGMW-13
2
0
-2
-4
-6
-8
-10
-12
del 13-C, o/oo PDB
100
1000
HCO3 (mg/L)


Comparison of EWDP with Other Data Around Yucca Mountain, Nevada
% Modern Carbon
dissolved HCO3 (mg/L)
0
5
10
15
20
25
30
35
100
1000
J-12
J-13
UE-25b 1 HTH
UE-25c#2
UE-25P-1
USW G-4
USW H-1
USW H-4
USW H-5
USW H-6 HTH
15S/49E-22dc (AV)
USW VH-1
NC-EWDP-01s
NC-EWDP-01dx
NC-EWDP-03s
NC-EWDP-09sx
BGMW-13


Nye County EWDP - First Round Sampling
Chlorine-36 / Cl x 10e-15
Chloride, dissolved, mg/L
NC-EWDP-01s
NC-EWDP-01dx
NC-EWDP-09sx
NC-EWDP-03s
BGMW-13
0
50
100
150
200
250
300
350
400
450
500
0
10
20
30
40
50
60
70
1
10
100

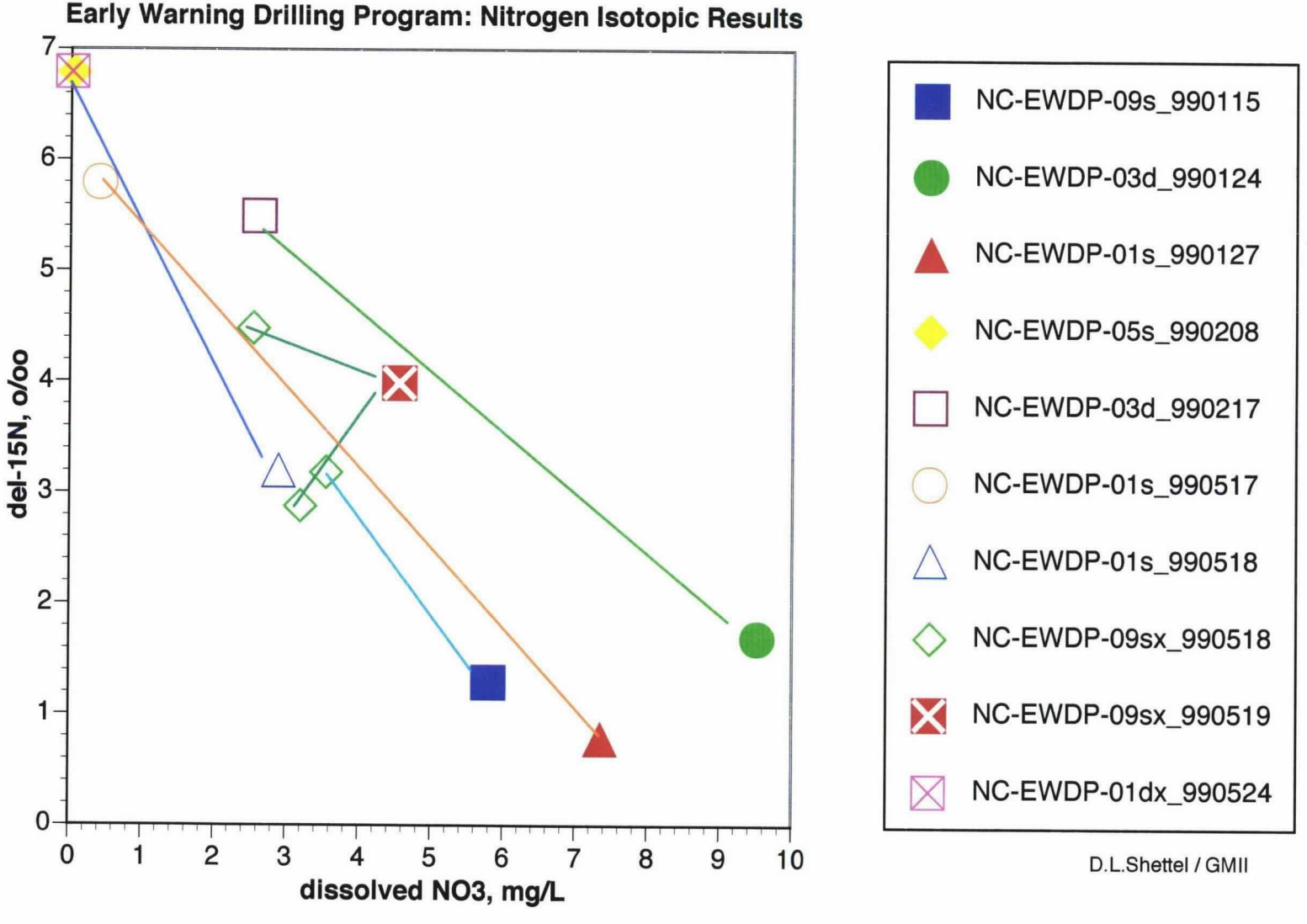
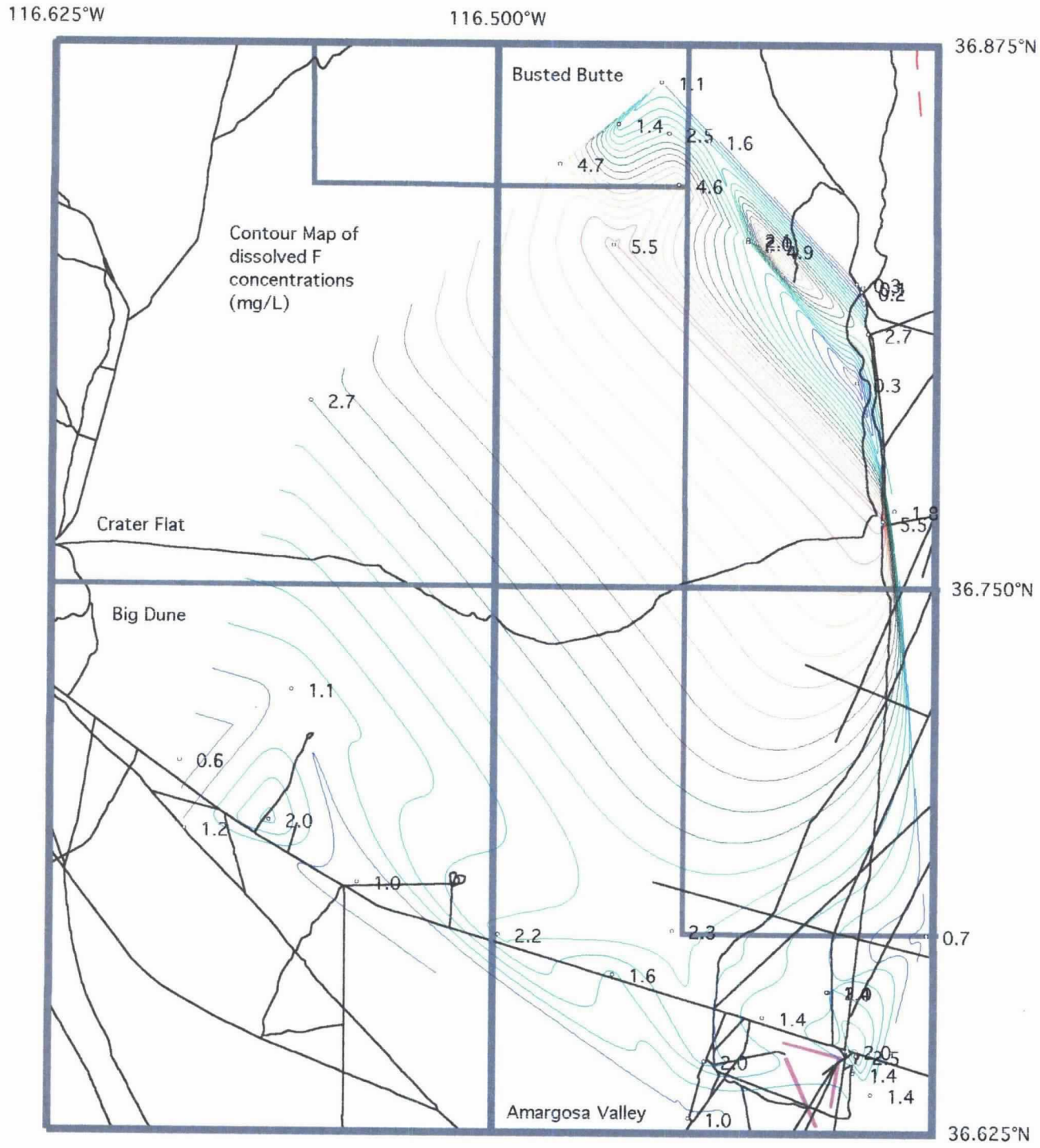


Figure 991224a. Nitrogen isotopic values of groundwater samples versus dissolved nitrate for EWDP samples in FY'99. Lines connect samples from same well.


116.625°W
116.500°W
36.875°N
36.750°N
36.625°N
Busted Butte
Contour Map of
dissolved F
concentrations
(mg/L)
Crater Flat
Big Dune
Amargosa Valley
1.1
1.4
2.5
1.6
4.7
4.6
5.5
2.9
0.2
2.7
0.3
5.5
2.7
1.1
0.6
1.2
2.0
1.0
2.2
2.3
0.7
1.6
1.4
2.0
1.4
1.4
1.0

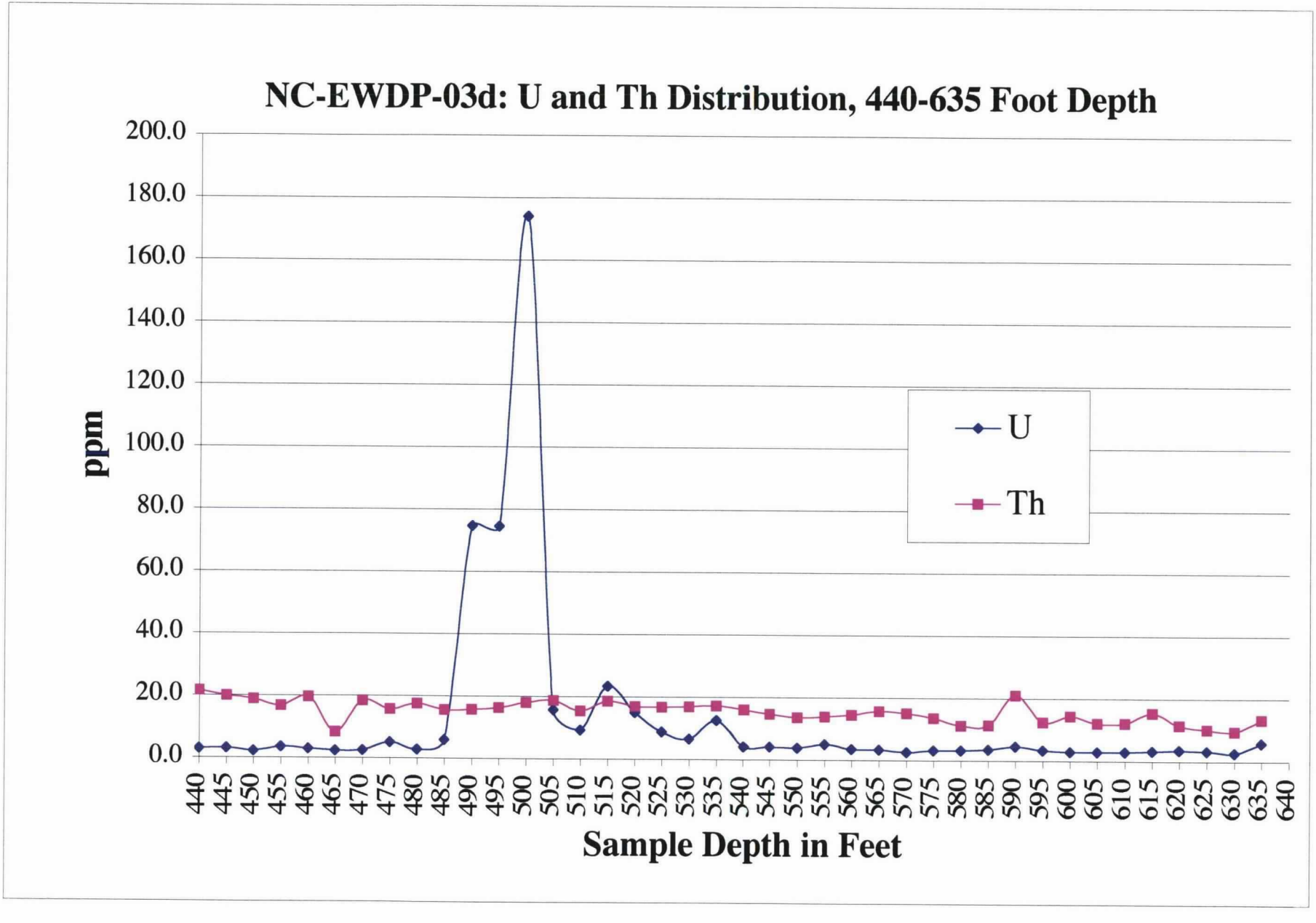
NC-EWDP-03d Cuttings Summary

1. Down-hole gamma logs, differential spectrometer and neutron activation analysis show elevated U concentrations at 500-505 foot depth.

2. This high U value is 174 ppm with a detection limit of 0.1 ppm using delayed neutron counting (neutron activation analysis).

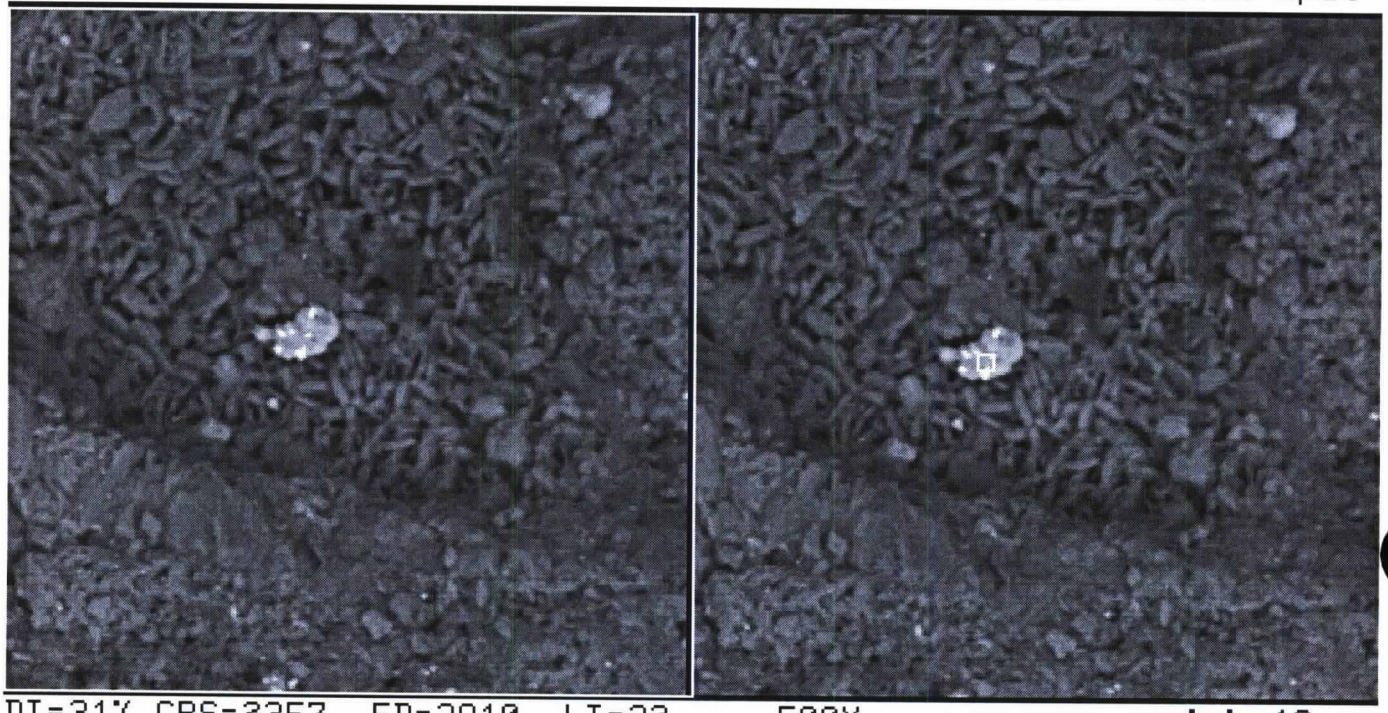
3. Age of uranium mineralization at the 500-505 foot depth has been determined by U-series isochron age dating (R. Ku, USC) to be: 182 ± 7 Ky (late-Middle Pleistocene).
Host is Tertiary Crater Flat Tuff.

4. In addition to uranium, there are high concentrations of Pb, Zn, Cu, Ce, Hg, Mo, Cr, S, As, Cl, and Se.
The uranium formed as coffinite, a silicate.
The other metals only form silicate rarely (such as willemite, a Zn silicate).
They are normally found as sulfides, and less commonly as arsenides, chlorides, and selenides, and phosphates.
They are almost always small crystallites that are less than 15 microns across.


NC-EWDP-03d: U and Th Distribution, 440-635 Foot Depth
ppm
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
U
Th
440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640
Sample Depth in Feet

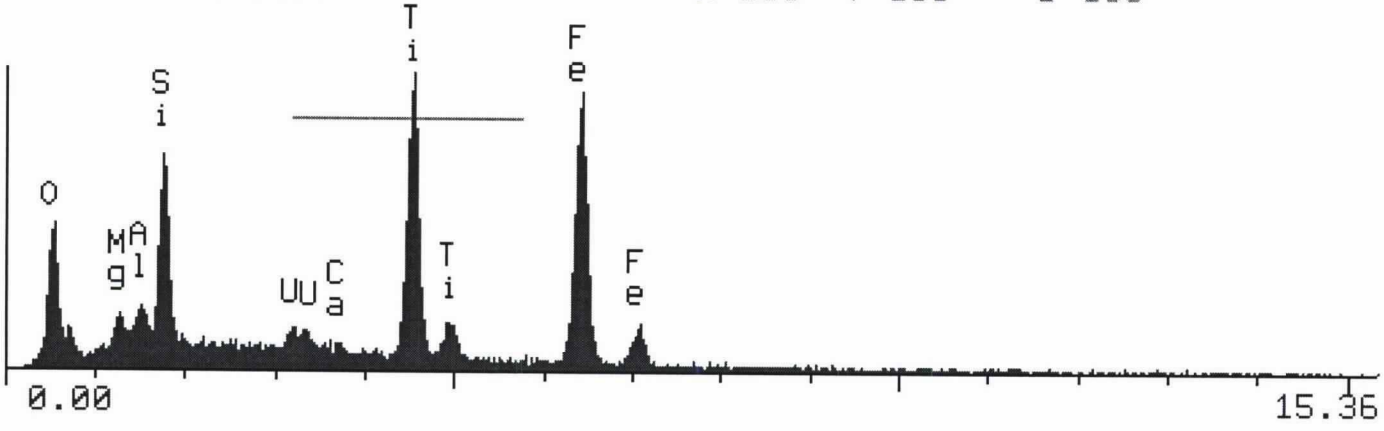
Personal SEM V4.02g Aug 25, 1999 RJ Lee Group,Inc.510-567-0480

500X 10 um 20.0 kV 26 mm 46.1% spot



DT=31% CPS=2357 FD=3810 LT=32 500X 10 um

VFS=1074 (auto) X=109 Y=130 I=198



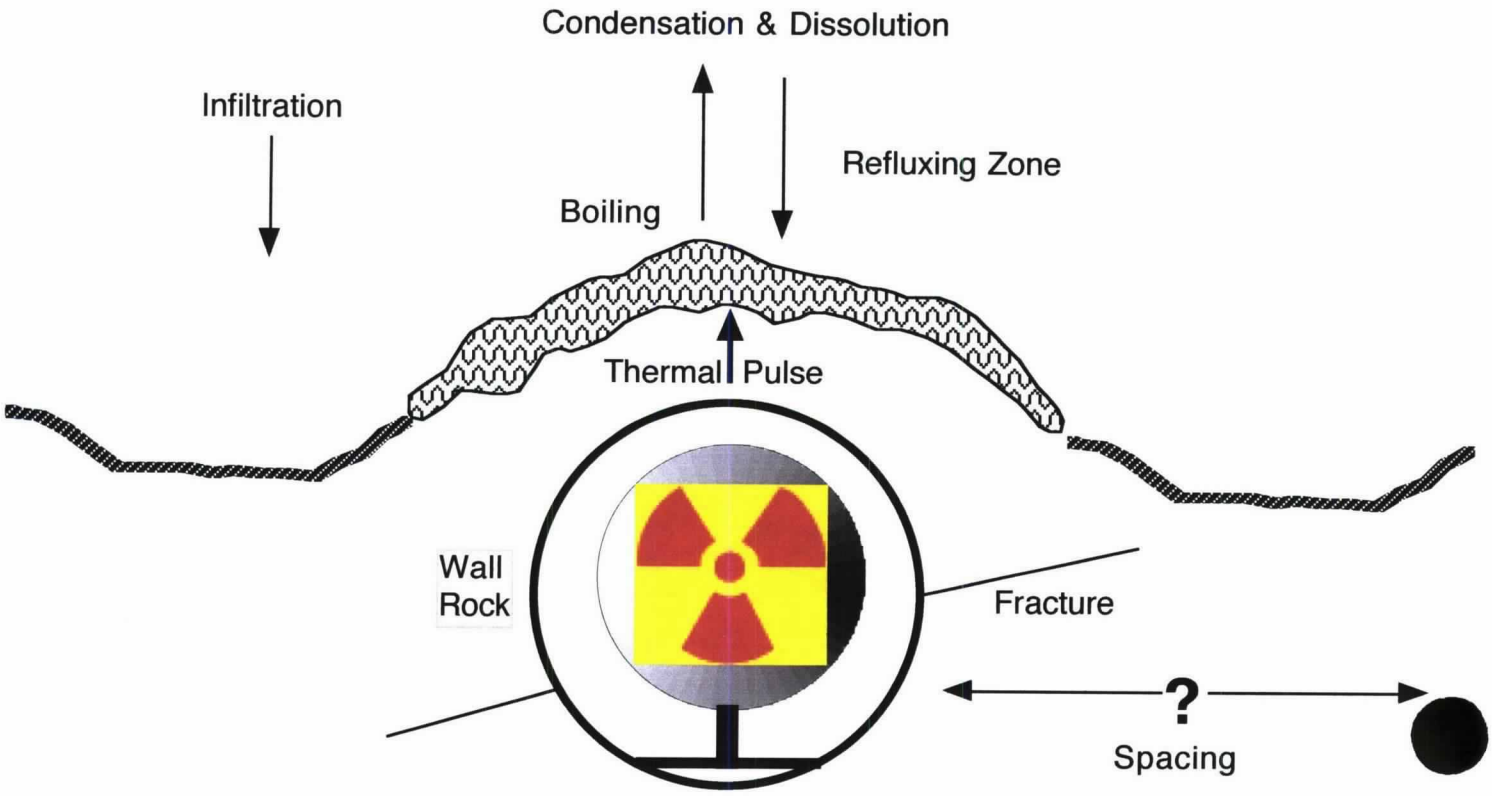
Summary

1. Compartmentalization of Flow Systems.
2. Generally increasing influence of Carbonate aquifer going west from Forty-Mile Wash.
3. Stable isotopes suggest effects of Age, Climate, & Elevation.
4. Moderately reducing zones found west (and deep) of 40-mi. Wash.
5. Pumped water samples are better than bailed ones.

Future Work:

1. Integrate geochemical data with geological & geophysical info.
2. Geochemical modeling & geothermometry.
3. Start EWDP phase II hydrogeochemical sampling later this month.
4. Noble gas geochemistry - paleoclimate info.

Silica Cap - Hydrothermal



Drift Cross Section

(Schematic)

1. Porosity / Permeability develop in Condensation Zone by dissolution.

2. Porosity / Permeability decrease in Boiling Zone due to Silica Ppt.

3. Volcanic glass and silica polymorphs transform - increase porosity.

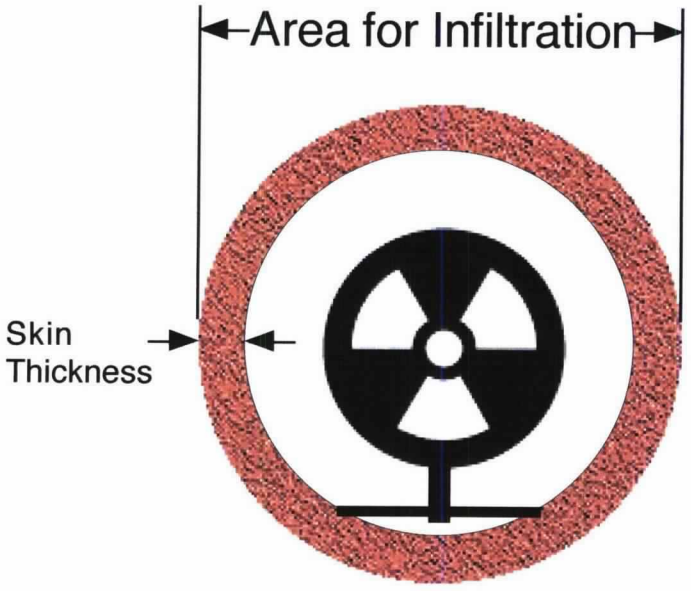
4. Drifts far enough apart, cap acts as umbrella, infiltration goes around drifts.

5. Drifts too close together, perching of water occurs. Upon cooling, fractures may channel perched water into drifts.

6. Spacing of drifts critical in a hot repository.

Evaporative Mineral Precipitation

In a low temperature (below boiling) ventilated high-level nuclear waste repository



Drift Cross Section

Depending on many parameters (amount of infiltration, amount reaching repository level, skin thickness, fracture porosity, water chemistry, temperature air flow, etc.) fractures may plug up in just a few years.

Result: Yucca Mountain would not dry out and TSPA could not rely on Heat of Vaporization of water for cooling effect.

For more information:
http://www.geomii.com/gcnwr.html