

PRELIMINARY ANALYSIS: Radon and Uranium in ground water from glacial stratified drift and crystalline bedrock aquifers



Data

----- **NETWORK=SUS** -----

The FREQ Procedure

LU_Group

LU_Group	Frequency	Percent	Cumulative Frequency	Cumulative Percent
////////////////////				
MIXED	730	100.00	730	100.00

----- **NETWORK=LUS** -----

LU_Group

LU_Group	Frequency	Percent	Cumulative Frequency	Cumulative Percent
////////////////////				
AG	568	60.11	568	60.11
OTHER	54	5.71	622	65.82
URBAN	323	34.18	945	100.00



Data

----- **NETWORK=SUS** -----

The FREQ Procedure

Wat_Use

Wat_Use	Frequency	Percent	Cumulative Frequency	Cumulative Percent
#####				
COMMERCIAL	9	1.28	9	1.28
DEWATER	1	0.14	10	1.42
DOMESTIC	577	81.96	587	83.38
HEALTH CLINIC	1	0.14	588	83.52
INDUSTRIAL	1	0.14	589	83.66
INDUSTRIAL (COOLING)	1	0.14	590	83.81
INSTITUTIONAL	6	0.85	596	84.66
IRRIGATION	1	0.14	597	84.80
OTHER	2	0.28	599	85.09
PUBLIC SUPPLY	47	6.68	646	91.76
RECREATION	2	0.28	648	92.05
STOCK	2	0.28	650	92.33
UNUSED	52	7.39	702	99.72
WILDLIFE CENTER	1	0.14	703	99.86
XMAS TREE FARM	1	0.14	704	100.00



Data

----- NETWORK=LUS -----

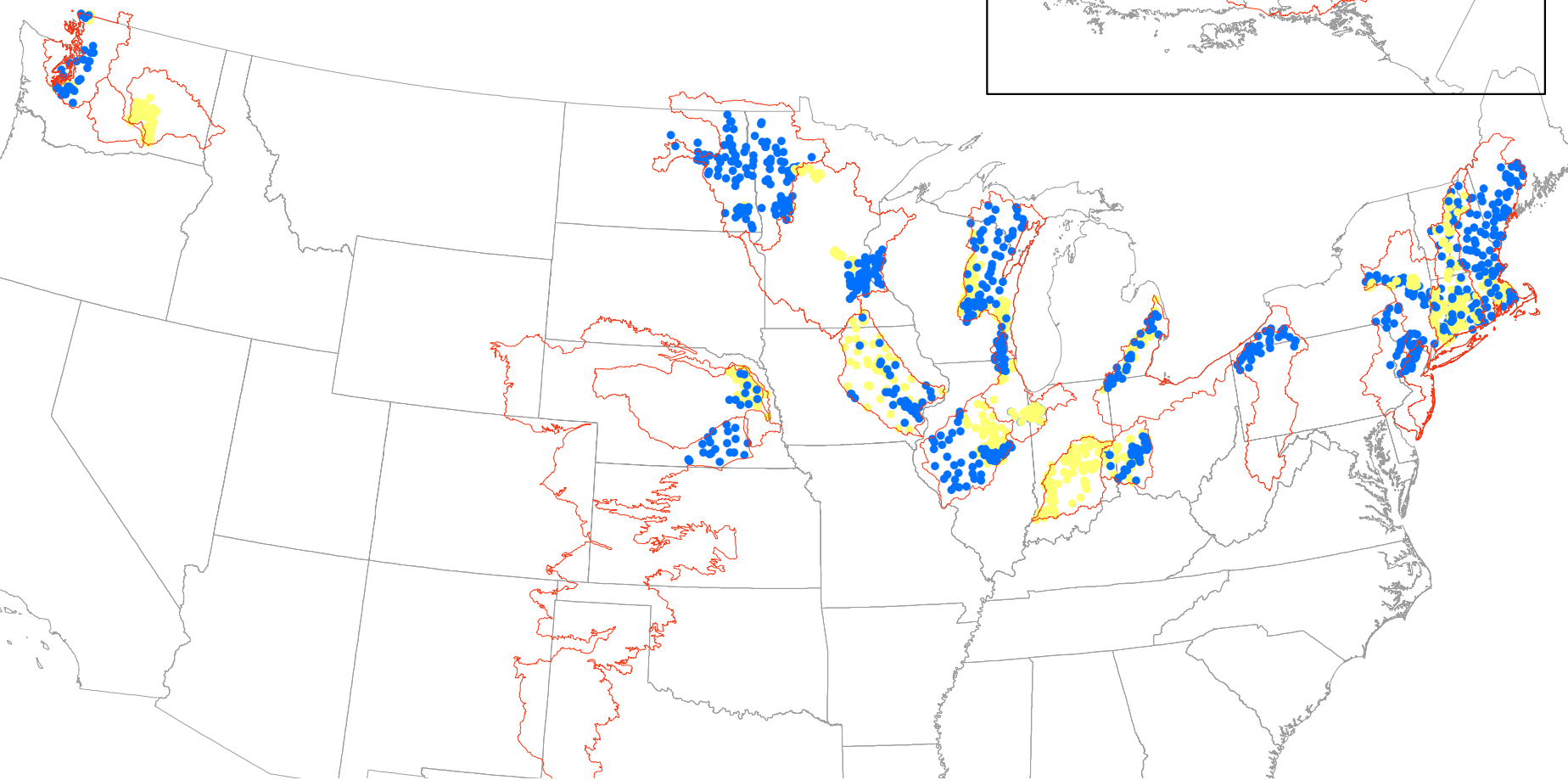
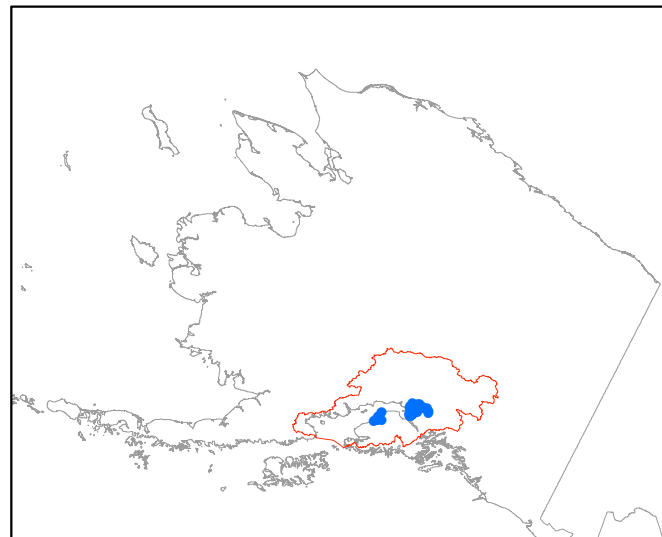
The FREQ Procedure

Wat_Use

Wat_Use	Frequency	Percent	Cumulative Frequency	Cumulative Percent
////////////////////				
DOMESTIC	29	3.18	29	3.18
IRRIGATION	1	0.11	30	3.29
OTHER	2	0.22	32	3.50
PUBLIC SUPPLY	9	0.99	41	4.49
RECREATION	1	0.11	42	4.60
UNUSED	871	95.40	913	100.00

Explanation WELL NETWORK

- LUS
- SUS
- Study Unit boundary



Current Regulations:

URANIUM

- 30 $\mu\text{g/L}$ – United States
- 20 $\mu\text{g/L}$ – Canada
- 10-30 $\mu\text{g/L}$ – Range of State action levels

RADON

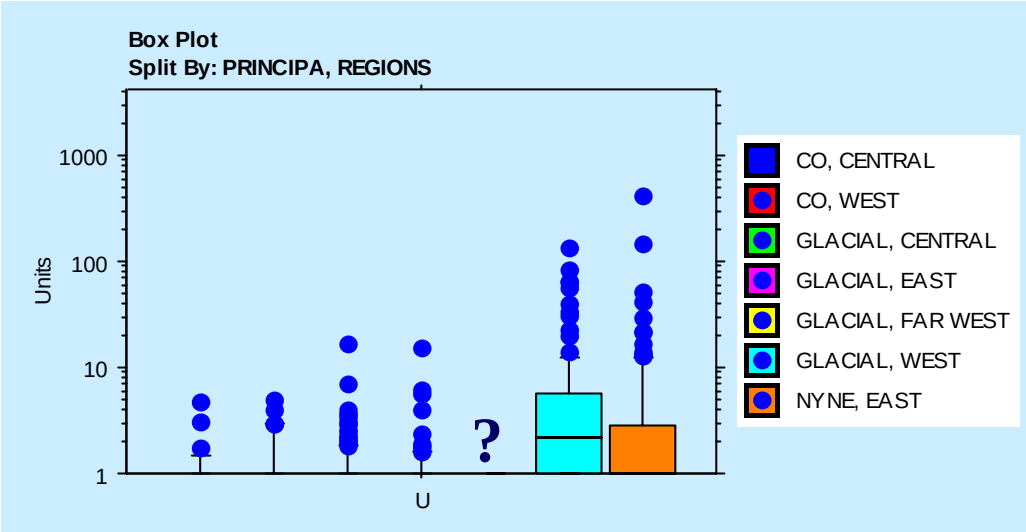
- 300 pCi/L or 4,000 pCi/L – proposed

Initial stratification

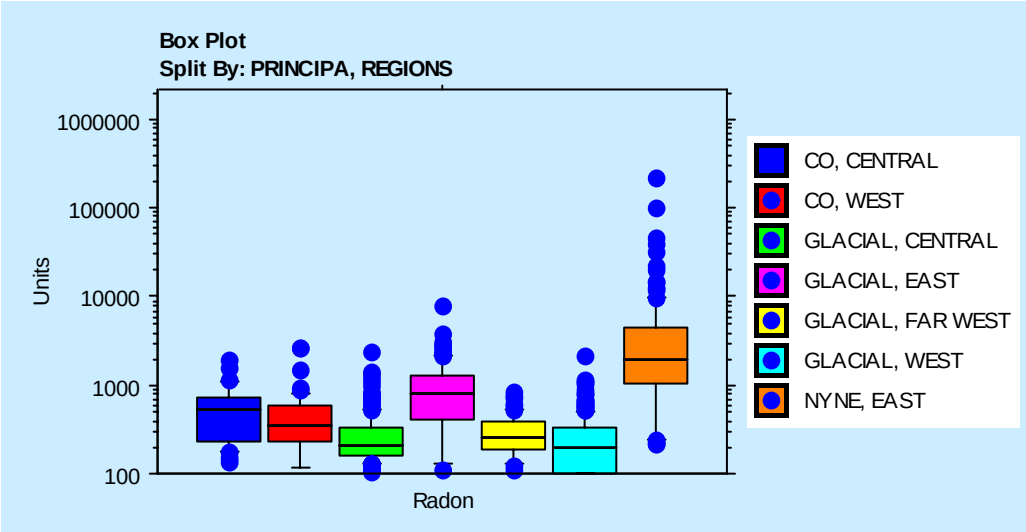
- WELL TYPE
 - SUS vs. LUS wells
- AQUIFER AND SOURCE MATERIAL
 - Glacial Far West
 - Glacial West
 - Glacial Central
 - Glacial East
 - New England/New York Crystalline Bedrock
 - Cambr-Ordovician Bedrock

SUS
wells:

Uranium

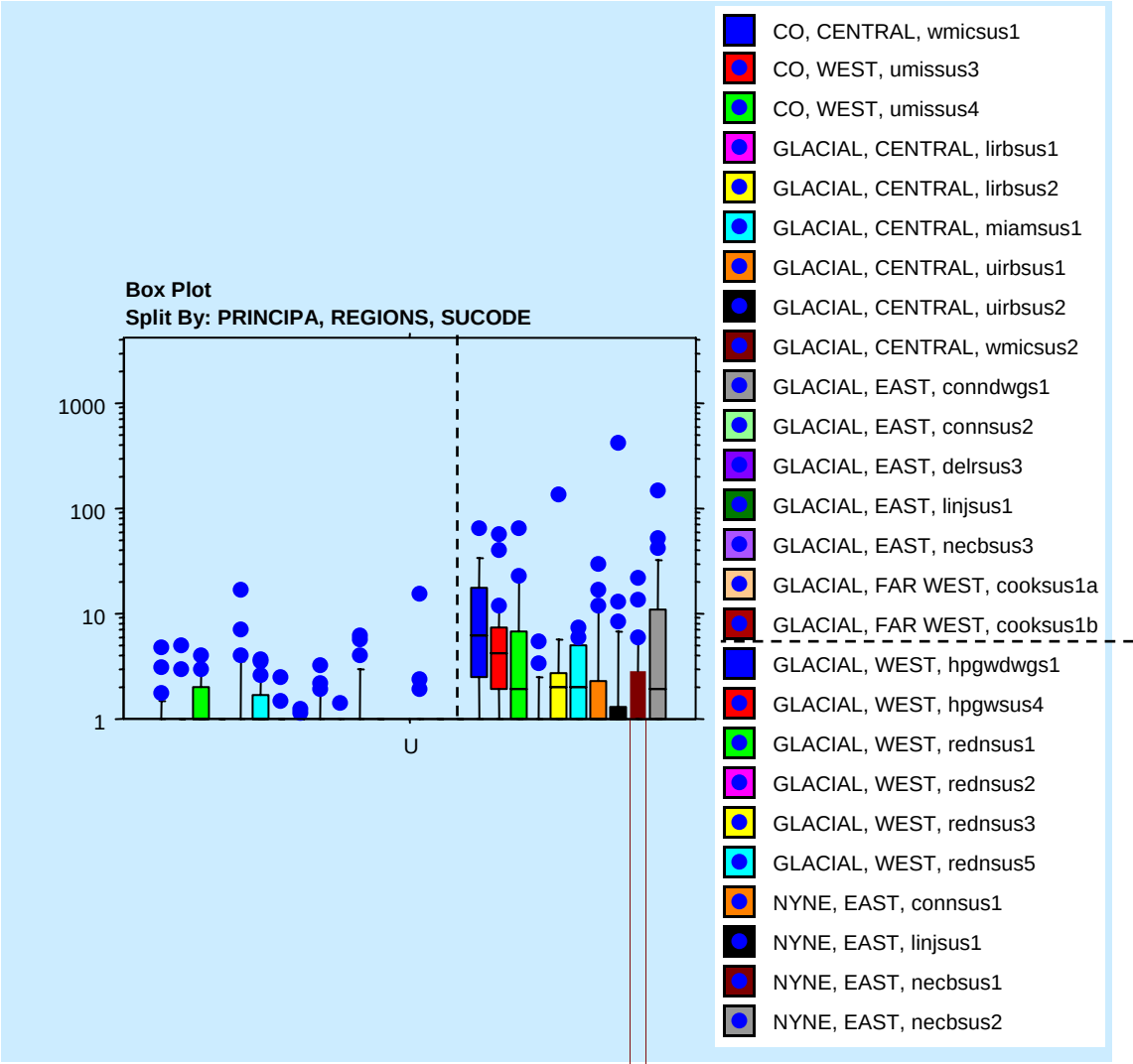


Radon



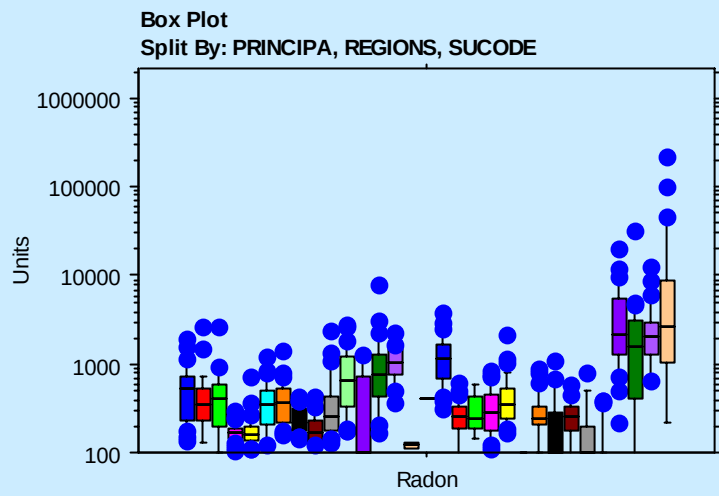
SUS
wells

Uranium



SUS wells

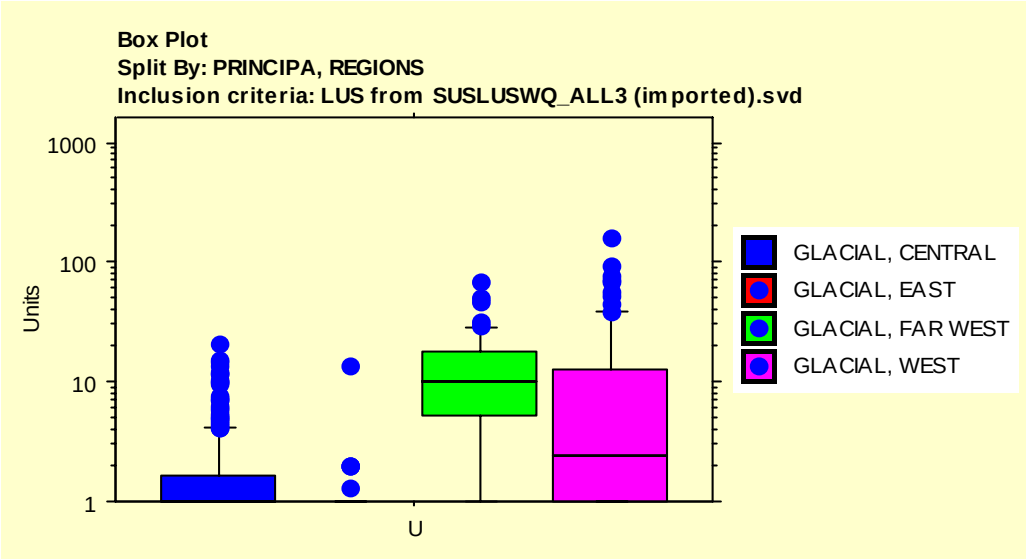
Radon



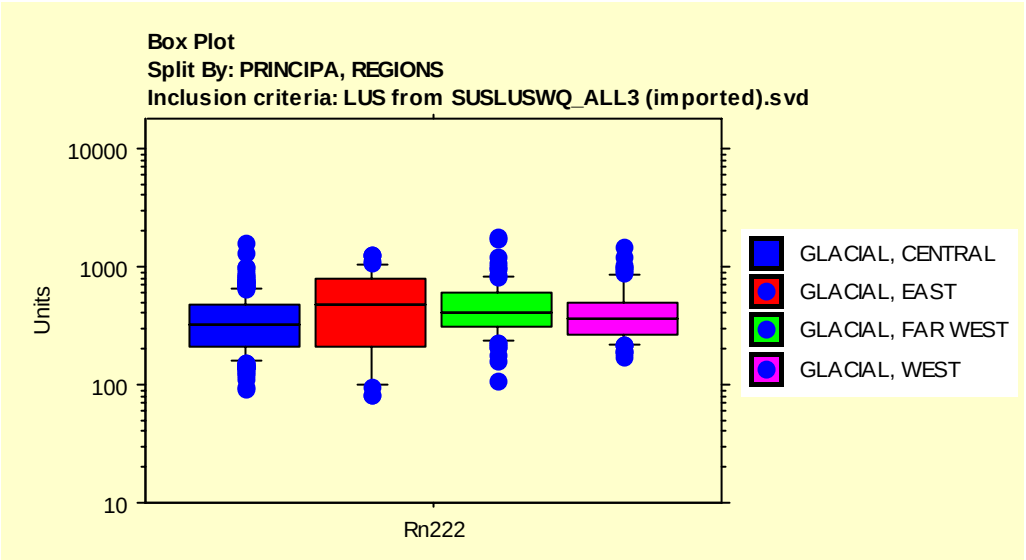
- CO, CENTRAL, w micsus1
- CO, WEST, umissus3
- CO, WEST, umissus4
- GLACIAL, CENTRAL, lerisus1
- GLACIAL, CENTRAL, lirbsus1
- GLACIAL, CENTRAL, lirbsus2
- GLACIAL, CENTRAL, miamsus1
- GLACIAL, CENTRAL, uirbsus1
- GLACIAL, CENTRAL, uirbsus2
- GLACIAL, CENTRAL, w micsus2
- GLACIAL, EAST, almnsus2
- GLACIAL, EAST, conndw gs1
- GLACIAL, EAST, connsus2
- GLACIAL, EAST, delrsus3
- GLACIAL, EAST, hdsnsus1
- GLACIAL, EAST, linjsus1
- GLACIAL, EAST, necbsus3
- GLACIAL, FAR WEST, cooksus1a
- GLACIAL, FAR WEST, cooksus1b
- GLACIAL, FAR WEST, pugtsus1
- GLACIAL, WEST, eiw asus2
- GLACIAL, WEST, hpgw dw gs1
- GLACIAL, WEST, hpgw sus4
- GLACIAL, WEST, rednsus1
- GLACIAL, WEST, rednsus2
- GLACIAL, WEST, rednsus3
- GLACIAL, WEST, rednsus5
- NYNE, EAST, connsus1
- NYNE, EAST, linjsus1
- NYNE, EAST, necbsus1
- NYNE, EAST, necbsus2

LUS
wells

Uranium

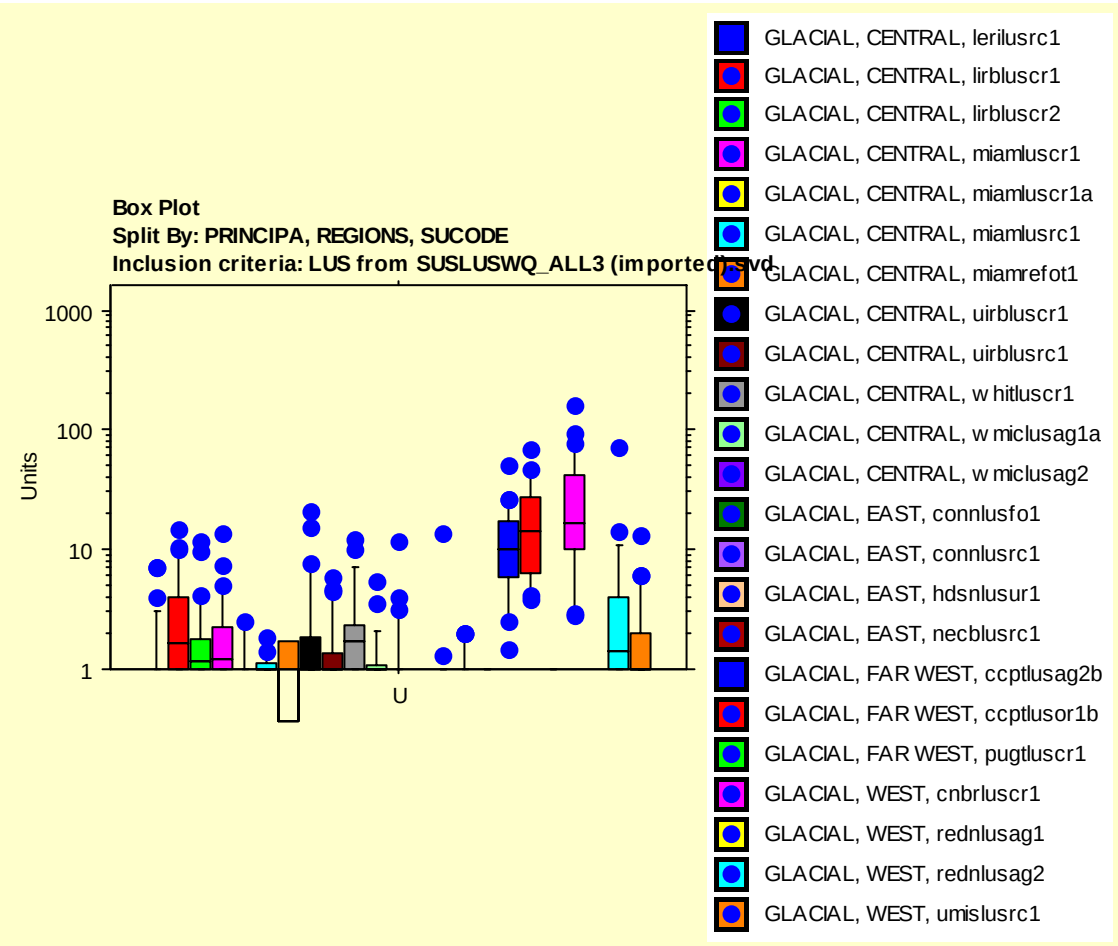


Radon



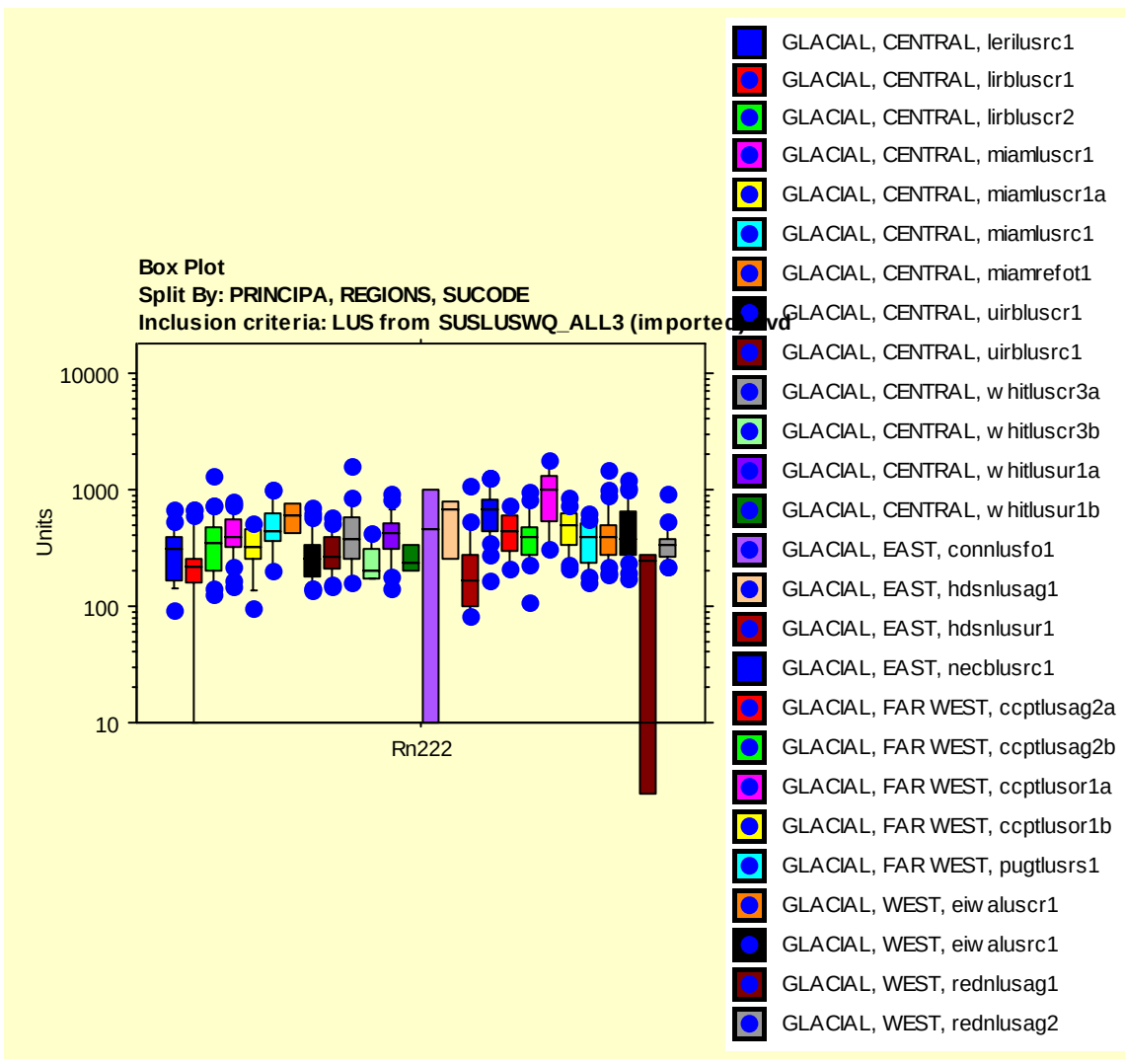
LUS
wells

Uranium



LUS wells

Radon



Initial correlations

SUS wells by principal aquifer...

...correlations higher than +/-0.33



SUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_FAR WEST N=64

Obs	_NAME_	U	Rn222
56	Al	.	-0.42101
57	As	.	-0.40109
58	Rn222	.	1.00000
59	WATDUWEL	.	-0.48890

SUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_WEST N=174

Obs	_NAME_	U	Rn222
60	Dates	0.44439	0.02086
61	FLD_COND	0.35673	-0.02761
62	LAB_COND	0.37085	0.06115
63	TURBDY	.	-0.35318
64	TDS	0.48705	0.04691
65	CO3	0.37515	-0.02180
66	NO3	0.33702	0.04274
67	P	-0.35510	0.11571
68	K	0.60873	0.03890
69	Ca	0.47507	-0.06518
70	Na	0.41537	0.14961
71	Si	0.34414	-0.00901
72	SO4	0.51243	0.06680
73	Fl	0.35732	0.13608
74	Cu	0.43012	0.05870
75	FeTOT	-0.44320	-0.21420
76	Li	0.36865	0.05350
77	Se	0.52305	0.06300
78	Sr	0.47611	-0.01674

Obs	_NAME_	U	Rn222
79	U	1.00000	0.19818
80	Rn222	0.19818	1.00000
81	precip90	-0.36138	-0.01718
82	Btm_Open	0.35800	-0.00933
83	Thickness	-0.34005	-0.20831
84	Erodibility	0.35928	0.17900
85	Sandpct	-0.34347	-0.22508
86	Organicpct	-0.42799	-0.22950
87	Soil_AD	-0.34025	-0.25466
88	Num200sieve	0.34349	0.23676
89	Siltpct	0.35745	0.21993
90	wind_erode	0.40855	0.23657
91	fo_deci	-0.39850	-0.06327
92	fo_mix	-0.44063	-0.05415
93	row_crop	0.39117	0.10798
94	wood_wet	-0.49209	-0.04202
95	RECHARGE_BFI	-0.43087	0.01468
96	RUNOFF	-0.55174	-0.01354



SUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_CENTRAL N=195

Obs	_NAME_	U	Rn222
16	WidestCasingDia	0.25128	0.46518
17	DO	0.10936	0.35114
18	NO3	0.32796	0.55717
19	NH3	-0.33913	-0.39680
20	SO4	0.33176	0.06799
21	Cu	0.20639	0.47630
22	FeTOT	-0.22622	-0.47719
23	Mn	0.03422	-0.33916
24	Ni	0.42061	0.23990
25	U	1.00000	0.30251
26	alpha	0.06566	-0.47884
27	beta	0.30568	-0.34261
28	Rn222	0.30251	1.00000
29	Case_Dia	0.24200	0.46644
30	Btm_Case	-0.33689	-0.33735
31	Top_Open	-0.33309	-0.33988

SUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_EAST N=109

Obs	_NAME_	U	Rn222
32	FLD_COND	0.33349	-0.33123
33	LAB_COND	0.34069	-0.29233
34	WTEMP	0.01045	-0.33043
35	TDS	0.31992	-0.33135
36	ANC	0.40322	-0.36551
37	HCO3	0.38372	-0.04658
38	NH3	-0.02379	-0.36250
39	K	0.34000	0.07086
40	Ca	0.31715	-0.33337
41	SO4	0.44284	-0.12737

Obs	_NAME_	U	Rn222
42	Mb	0.33225	0.03435
43	U	1.00000	-0.05551
44	O18	-0.40618	-0.17576
45	D2H2	-0.40618	-0.23636
46	alpha	0.61470	-0.13872
47	Tritium	.	0.50000
48	Rn222	-0.05551	1.00000
49	Age_Est	.	-0.39641
50	Age_min	.	-0.66689
51	Erodibility	-0.17229	-0.35404
52	watertable_In	-0.15531	0.35225
53	Num200sieve	-0.20133	-0.35045
54	Soil_drain_class	0.06730	-0.41357
55		.	



SUS Spearman correlation coeff ge +/-0.33

PA=NEW YORK & NEW ENGLAND N=117

Obs	_NAME_	U	Rn222
99	Ba	-0.23253	-0.34727
100	Pb	0.25687	0.37809
101	Mb	0.34955	0.18695
102	Sr	0.09722	-0.34728
103	U	1.00000	0.59782
104	alpha	0.71922	0.53656
105	beta	0.33341	0.42442
106	Rn222	0.59782	1.00000



SUS Spearman correlation coeff ge +/-0.33

PA=CAMBRO-ORDIVICIAN N=80

Obs	_NAME_	U	Rn222
1	WidestCasingDia	-0.41383	-0.12623
2	pH_LAB	-0.36213	0.20253
3	FLD_COND	0.35834	-0.00625
4	LAB_COND	0.36612	-0.04566
5	ANC	0.47824	0.07952
6	Ca	0.41539	-0.05219
7	Mg	0.39184	0.03099
8	Mn	0.35495	0.00127
9	TI	0.27677	0.39344
10	Ni	0.47158	-0.17922
11	U	1.00000	0.08723
12	Rn222	0.08723	1.00000
13	fo_ever	-0.37623	0.03116
14	WATOTH	-0.33905	0.06871
15	RUNOFF	-0.33557	0.17540

Initial correlations

LUS wells by principal aquifer...

...correlations higher than ± 0.33

LUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_FAR WEST N=124

Obs	_NAME_	U	Rn222
60	Dates	0.45581	0.05511
61	FLD_COND	0.78419	0.17508
62	LAB_COND	0.79073	0.19545
63	TDS	0.76364	0.20364
64	ANC	0.78391	0.10735
65	HCO3	0.82701	0.00455
66	DOC	0.55081	0.09782
67	NO2	-0.44814	-0.00631
68	NH3_N	0.65829	0.07358
69	P	0.44007	-0.21902
70	PO4	0.36312	-0.12857
71	Ca	0.40204	0.22652
72	Na	0.77011	0.23834
73	Mg	0.58721	0.05178
74	SO4	0.63835	0.36477
75	Br	0.40018	0.39843

Obs	_NAME_	U	Rn222
76	Cl	0.40608	0.38017
77	Al	-0.41418	-0.01664
78	B	0.41827	-0.20227
79	Cu	0.58644	0.12224
80	Mb	0.41443	0.23060
81	Ni	0.36423	0.32271
82	Li	0.46918	0.50982
83	Se	0.43212	0.21586
84	Sr	0.51785	-0.05349
85	U	1.00000	0.17620
86	Rn222	0.17620	1.00000
87	RECHBFI	-0.45378	-0.20206
88	RUNOFF	-0.55596	-0.20206
89	SLOPE	0.57757	0.32951
90			

LUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_WEST N=222

Obs	_NAME_	U	Rn222
118	FLD_COND	0.43473	0.06948
119	LAB_COND	0.44733	0.07050
120	TURBDY	-0.29151	0.33839
121	TDS	0.48391	0.07454
122	ANC	0.37779	0.21272
123	CO3	0.72760	.
124	HCO3	0.61392	0.15821
125	NH3_N	-0.52807	-0.10650
126	K	0.59748	-0.07118
127	Ca	0.36469	0.09013
128	Na	0.53472	0.06849
129	SO4	0.33090	0.07426
130	FI	0.60980	-0.01199
131	Al	-0.59722	.
132	As	0.37696	

Obs	_NAME_	U	Rn222
133	B	0.76902	.
134	Cr	-0.39187	.
135	FeTOT	-0.50852	-0.27898
136	Mn	-0.39579	-0.11297
137	Ni	-0.33303	.
138	Li	0.80733	.
139	Se	0.73446	.
140	Sr	0.48385	.
141	Zn	-0.44780	.
142	U	1.00000	0.13663
143	Rn222	0.13663	1.00000
144	Bore_depth	-0.21153	-0.67427
145	Altitude	0.64703	0.15637
149	past_hay	0.33314	-0.12182
150	row_crop	0.54153	-0.10959



LUS Spearman correlation coeff ge +/-0.33

PA=GLACIAL_CENTRAL N=394

Obs	_NAME_	U	Rn222
1	NO3	-0.06873	0.54757
2	NH3	0.08968	-0.40454
3	NH3_N	0.02782	-0.41326
4	SO4	0.41442	-0.16382
5	As	0.16156	-0.42762
6	Co	0.36548	-0.24578
7	FeTOT	0.07490	-0.45475
8	Mn	0.49635	-0.38623
9	Tl	0.14826	-0.56914
10	Mb	0.36516	-0.38725
11	Ni	0.41000	-0.16757
12	Li	0.16102	-0.34917
13	U	1.00000	-0.25104
14	Rn222	-0.25104	1.00000

LUS Spearman correlation coefficient ± 0.33

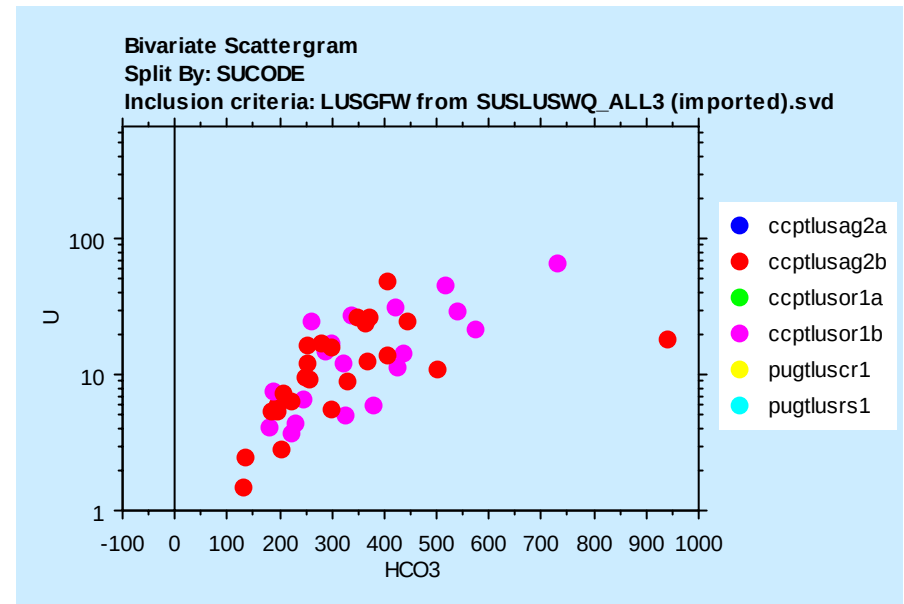
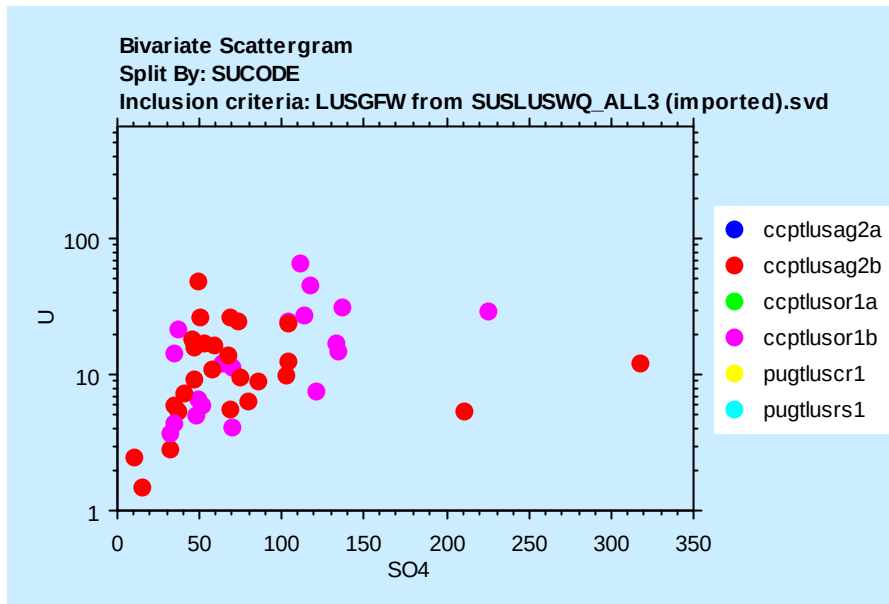
PA=GLACIAL_EAST N=220

Obs	_NAME_	U	Rn222
15	Dates	-0.12234	0.46184
16	pH_LAB	0.29755	-0.51265
17	pH_FLD	0.36429	-0.59197
18	FLD_COND	0.22853	-0.56879
19	LAB_COND	0.22109	-0.55485
20	DO	-0.06502	0.40012
21	TDS	0.19393	-0.57332
22	ANC	0.24827	-0.55881
23	NO3	-0.21208	0.40544
24	NH3	0.25626	-0.45323
25	NH3_N	0.07195	-0.43900
26	PO4	0.02287	-0.34737
27	Ca	0.26269	-0.47952
28	Mg	0.29467	-0.47795
29	SO4	0.31287	-0.50149
30	Br	0.21144	-0.44005

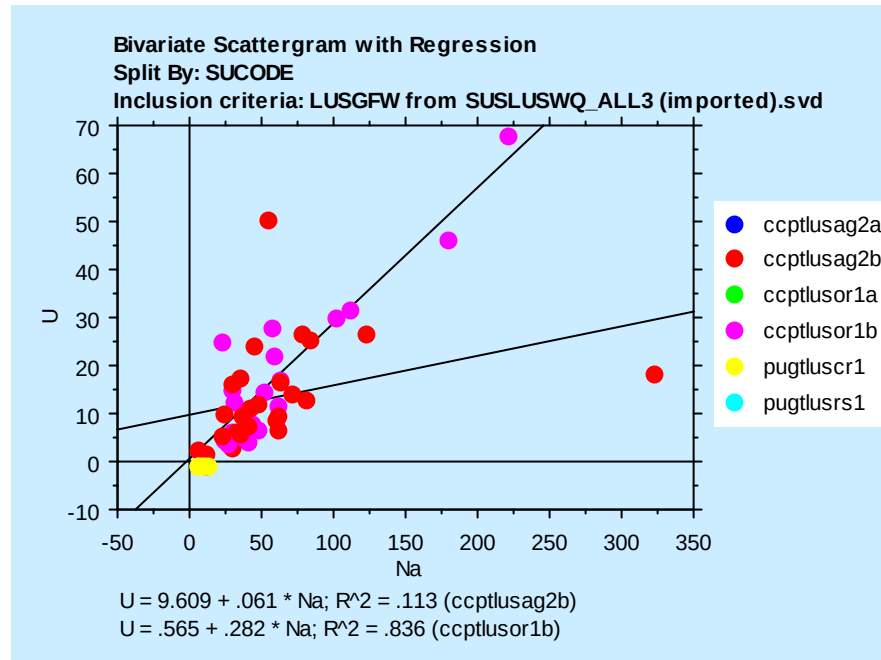
Obs	_NAME_	U	Rn222
31	Al	-0.21830	0.33759
32	As	0.30040	-0.40747
33	Ba	0.20830	-0.38001
34	Cr	0.06427	-0.47305
35	FeTOT	0.27881	-0.44130
36	Mb	0.36183	-0.21897
37	Ni	0.26504	-0.37815
38	U	1.00000	-0.36833
39	Ra224	.	-0.40000
40	Ra226	.	-0.40000
41	Ra228	.	-0.40000
42	Rn222	-0.36833	1.00000
43	precip90	-0.21187	0.60020
44	Atemp90	-0.26974	0.37329
45	Altitude	0.15702	-0.40192
46	Claypct	0.05104	-0.39014

Preliminary graphs

Glacial Far West LUS



Preliminary graphs Glacial Far West LUS



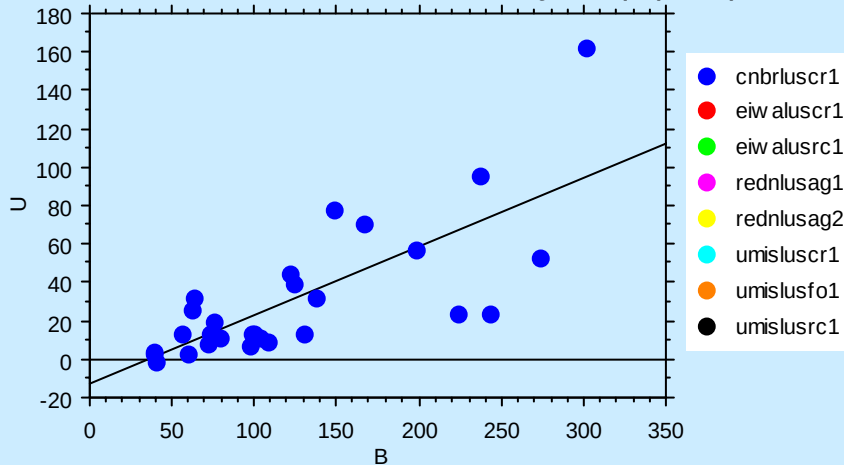
Preliminary graphs

Glacial West LUS

Bivariate Scattergram with Regression

Split By: SUCODE

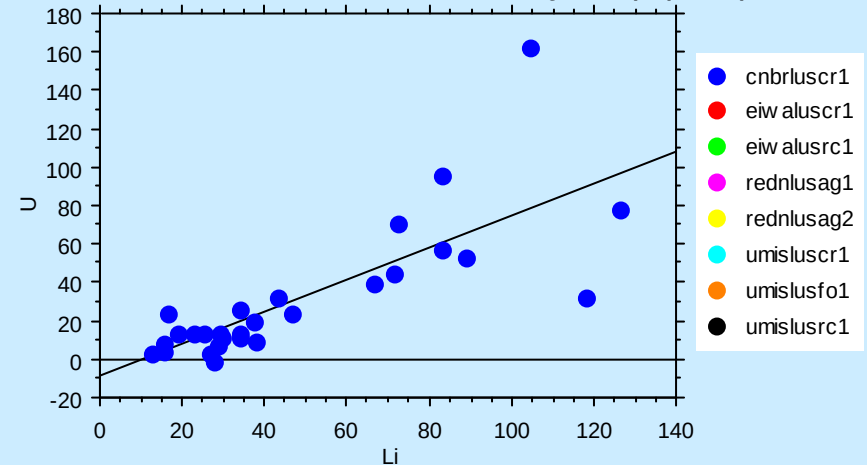
Inclusion criteria: GWLUS from SUSLUSWQ_ALL3 (imported).svd



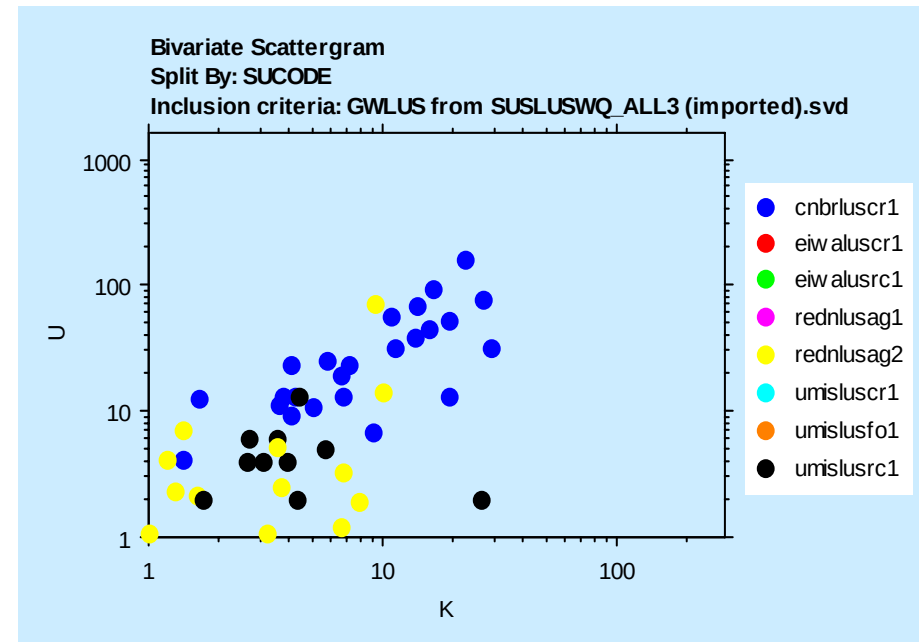
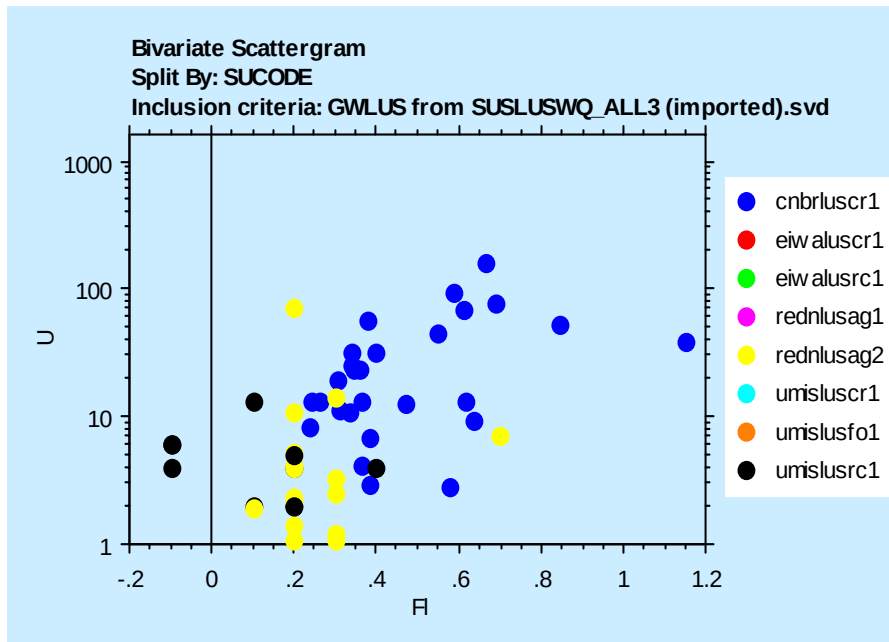
Bivariate Scattergram with Regression

Split By: SUCODE

Inclusion criteria: GWLUS from SUSLUSWQ_ALL3 (imported).svd

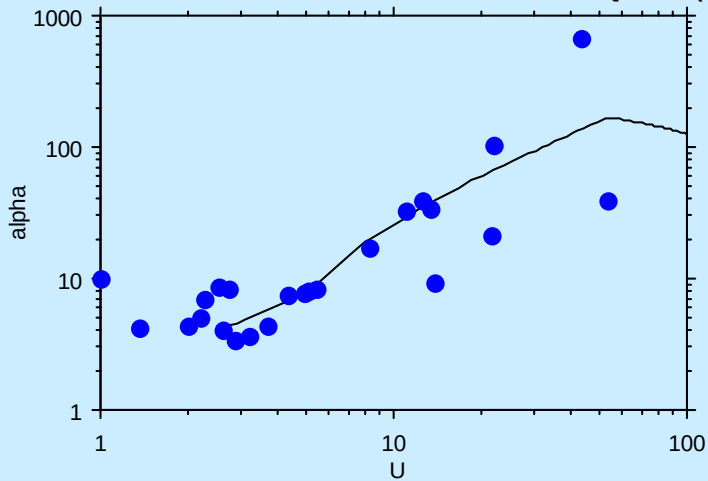


Preliminary graphs Glacial West LUS

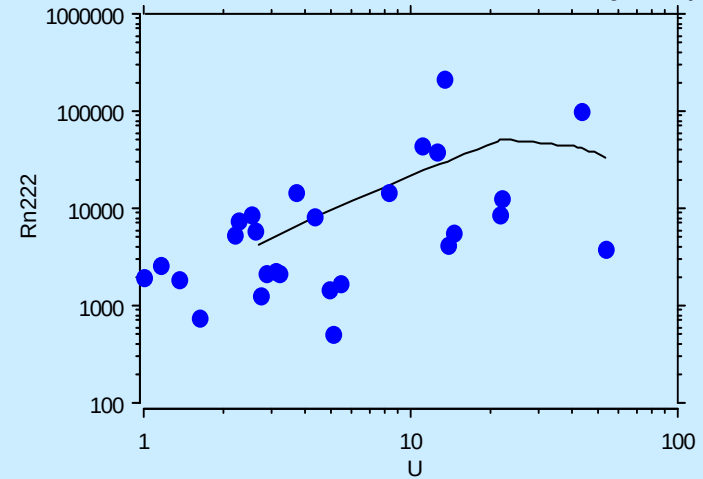


Preliminary graphs NYNE Crystalline SUS

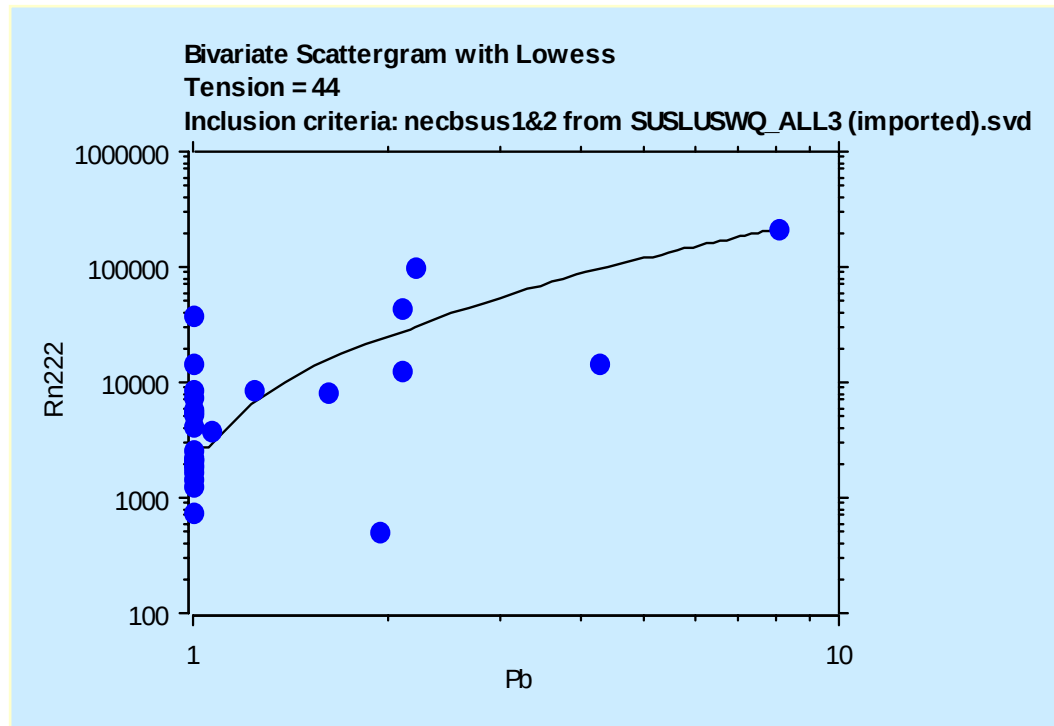
Bivariate Scattergram with Lowess
Tension = 66
Inclusion criteria: necbsus1&2 from SUSLUSWQ_ALL3 (imported).svd



Bivariate Scattergram with Lowess
Tension = 99
Inclusion criteria: necbsus1&2 from SUSLUSWQ_ALL3 (imported).svd



Preliminary graphs NYNE Crystalline SUS



Report outline

- Introduction

- New NAWQA data set; comp. explanatory variables; water use
- Occurrence and Distribution at regional scale, relevance
- Radionuclide rule
- Past investigations

- Approach and Methods

- Regional analysis--aggregated study units with common data analyses/explanatory variables
- Occurrence by aquifer type (PA), aquifer source material, well (network) type
- Examine factors related to U and Rn222 in anomalously high areas
 - U in Glacial Far West, West, NYNE
 - Rn222 in NYNE, elsewhere

- Results

- Occurrence and distr. section
- Related factors section

- Discussion

- Relate occurrence findings to new regulations based on aquifer/water use
- Relate explanatory factors from anomalous areas rest of study area, if appropriate; discuss implications

- References...

EndNote 7 (Bld 98)

File Edit References Tools Window Help

Plain Font Plain Size B I U P A¹ A₁ Σ

USGS 7th ed

RadonUranium.enl

0	Author	Year	Title
	Aieta	1987	Radionuclides in drinking water
	Asikainen	1979	Anomolously high concentrations of uranium, radium, and radon in water from drills
	Brutsaert	1981	Geologic and hydrologic factors controlling radon-222 in ground water in Maine
	Culbert	1988	Young uranium
	Dixon	1989	Radon in ground water supplies
	Duval	1990	The role of national uranium resource evaluation aerial gamma-ray data in assess
	Fenlon	1996	Radon in the fluvial aquifers of the White River basin, Indiana
	Finch	1996	Uranium provinces of North America--their definition, distribution, and models
	Fleischer	1983	Theory of alpha recoil effects on radon release and isotopic disequilibrium
	Focazio	2001	Occurrence of selected radionuclides in ground water used for drinking water in th
	Gascoyne	1989	High levels of uranium and radium in groundwaters at Canada's Underground Res
	Gunderson	1989	Anomolously high radon in shear zones
	Gunderson	1993	The correlation between bedrock geology and indoor radon: Where it works and w
	Hall	1985	Radon gas in ground water of New Hampshire
	Hall	1987	Geologic controls and radon occurrence in New England
	Hess	1985	The occurrence of radioactivity in public water supplies in the United States
	Hsi	1985	Adsorption of uranyl onto ferric oxyhydroxides: application of the surface complex
	Kay	1999	Radium in ground water from public-water supplies in northern Illinois

Focazio, M.J., Szabo, Z., Kraemer, T.F., Mullin, A.H., Barringer, T.H., and dePaul, V.T., 2001, Occurrence of selected radionuclides in ground water used for drinking water in the United States: U.S. Geological Survey Water-Resources Investigations Report 00-4273, 40 p.

Showing 43 out of 43 references. Hide Preview

Time Line

Planned analyses

- Evaluation of correlations to develop ‘related factors’ stories
- Evaluation of NURE data, in interpolated grid format
- Examination of subsets of explanatory data, where appropriate
 - For ex., mapped lineament data for New Hampshire
 - New England Lithochemistry
- Examination of selected additional data, where appropriate
 - For ex., National Cancer Institute’s 72-hr and 30-day Gross alpha and beta data for New England (over 900 samples)
 - Others?

Collaborations in progress...

- Z. Szabo on explaining geochemical relations
- G. Robinson on radiochemistry of bedrock in the northeast, elsewhere; use and interpretation of interpolated NURE data on radiochemistry

Also,

- Contact SU's for input on correlation analyses