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Geologic and geochemical controls on arsenic in groundwater in northeastern Wisconsin

Final Report to the Wisconsin Department of Natural Resources: Appendixes B—I

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Open-File Report 2003-01

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Appendix B
Description of samples analyzed for whole rock geochemistry

B-1

Samples for Total Ar Content

LE 4A: Pyritic very hard nodule (Almost no sandstone surrounding it) 68.4 gr

LE 1Ba: Identical to the one in plaster and to the mottled blue chip for thin section. (Bioturbated well sorted gr. sandstone)
23.83 gr. One side has yellowish dark grey colour

LE 2A: Crust (The very upper crust the absence of crust (Rusty)) 20.75g

LE 2B: Dark grey, well sorted fine to medium grained sandstone with greenish pyritic tiny nodules.
Imprint nodular mineralization.
23.25 gr

LE 1Bb: Oxidized dark grey irregular nodule/band

White sandstone
Area set to analysis { Rusty Dark Grey band
dark grey sandstone
White sandstone
20.94 gr

LE 3A: True Crust (Orangy purple rusty color) 1/1
22.94 gr

LE 3B: Tiny nodules in white sandstone matrix

✓ I tried to take as less as possible of ss. but it was impossible

No puede discriminar

20.4 gr

la py en la muestra así que este todo mezclado pedacitos de Py y arena

B-2

LE 4 : Orange Rusty Purple, one side black
crust 33.05 gr.

LE 5 : Rounded piece of medium/dark grey sandstone
homogeneous in color with external mineralization of
white and yellow sulphur (like dust)
See big sample in box
It doesn't look like the thin section ≈ 40 gr

LE 7 Oxidized Band
Just like the one in the thin section
and the big sample. Almost no sandstone matrix
surrounding it 27.36 gr.

LE 9 Dark grey, well sorted medium grained
sandstone
28.09 gr

LE 13 \rightarrow Crust (to the irregular contact
see description in field book)
22.93 gr
Some minor % sandstone (7%.)

LE 14. Light gray gr. fine to medium grained
laminated sandstone
27.14 gr

B-3

LE 15 Burrowed area where the mineralization
is more intense orangy and dark grey patches
29.93 gr

LE 16 Very py patch in dark/grey yellow sulphuric weathered
sandstone 22.6 gr

LE 20 Dark Orange oxidized dark grey on bottom side
crust
26.53 gr

LE 22 : Very Shiny Goldish Dy Nodule
20.91 gr

LE 23: Beautiful elongated py nodule oxidized ^(Rusty) on
parts of the surface

(Specular) Other face of the thin section

21.52 gr

LE 25 A Greenwood Fm. or base of Plattville
Bioturbated Sandy Carbonate
19.5 gr

B-4

LE 25 B Py Nodule with an oxidized rim
More Than 140 gr

LE 25C Orange Crust.
29 gr.

LE 31 Dark grey strongly cemented (Hard to break)
py sandstone.
23.86 gr

B-5

April 27, 2001

Muestras a ser mandadas a Bondar Clegg

Ben Carre

BC 3B Dark Grey Py Nodule (almost no sandy matrix)
18.25 gr

BC 4B Less dark grey Py nodule (almost no sandy matrix)
24.8 gr

BC 5 Fine Grained sandstone with Green-Yellow surface
mineralization 31.3 gr

(I'm curious about the green stuff on the surface, It is like algae
only lighter green in color)

BC 30A Beautiful Qtz Well Sorted White Ss. (Background)
Weathered Colour Orange
31.5 gr

BC 10A Qtz Sandstone with a lot of oxidation areas
(Hixture) 32.2 gr

BC 10 B Qtz Ss. moderately sorted Base of the cutting channel
(Background) 24.8 gr

BC 16A Py Nodule (Dark Grey) (Some Sandy Matrix)
15.7 gr

B-6

P4.

BC 16B Nice Big Nodule (Almost No matrix) 2nd Bag

→ Compare with the one with some matrix in it and see the results

38 gr.

BC 30B Black Py Nodule (No Matrix)

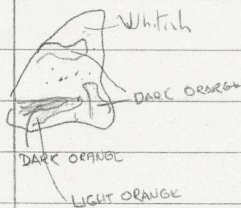
7.4 gr.

BC 22 Black Py Nodule (No Matrix)

24.1 gr.

BC 26 Fine grained ss with irregular orange and dark patches sort of like what you see in the cores ~~go~~ only that in this case is less intense.

33.8 gr.



BC 33 Py Nodule (No matrix) 37.4 gr.

BC 34 Py Nodule (A little bit of Matrix)

Lighter grey

23.9 gr.

B-7

BC 36 B Py Nodule with some matrix
19.4 gr

BC 37 Canto Rodado (Uno que es hermoso)
Py Shiny Nodule (No Matrix)
42.3 gr

B. Carrie
15 samples

J01 Py Band. 38 gr
Some matrix is at

J02 Py Nodule 20.4 gr
No matrix
Very shiny

J04 Py Nodule (Some yellow sulphur)
No matrix 33.1 gr

J05 Py Nodule (Some yellow sulphur)
No matrix
23.4 gr

J07 Py Nodule (Some yellow sulphur)
No matrix
21.9 gr

B-8

JO 11 A Aggregation of Py Nodules on white
fine grained sorted sandstone
21.2 gr

JO 11B (Same as 11A) It has Glycol 43.4 gr

JO 11C Orange Crust some laminae of py gray material (Pure Crust)
56.4 gr

JO 13 Orange Purple Dark gray crust
(No matrix pure crust) 55.6 gr

JO 13B Py Nodules on fracture (Some Getic matrix but just a
little)
Dark gray Where the picture 2 was taken
48.9 gr

JO 15 Crust with some matrix (carbonatic grey)
86 gr

JO 16 Orange crust (less matrix than JO 15) (Just little matrix)
28.4 gr

JO 17A Very fine ss. with oxidized surfaces Orange
28.1 gr

JO 18 Background Medium upper well sorted brownish (beige)
getic ss. 41.3 gr

B-9

JO 18B

Qtz fine grained sandstone
Whitish (Background)

23.7 gr

JO 22

Py Band (Almost or should I say A little sandy (white) matrix)
(Yellow sulphur grains)

43.6 gr

JO 24

Dark gray py mineralization in fl. grt ss
The whole rock looks dark

Orange crust at the surface of the sample.

(Well mixture of everything) Tiene de todo un poco!

41.6 gr

JO 20

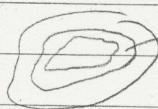
Py Band in white fine sandstone a lot of yellow
sulphur dust.

44.7 gr

JO 25

Py Nodule (Almost no matrix)

33 gr



Rim of
better developed Py crystals

JO 26

Py Nodule (No matrix)

48.9 gr

B-10

JO 27 Mixture of Nodule with crust
(Yellow Orange and Dark grey)
28.1 gr

JO 28 Medium/Dark grey homogeneous ss.
48.1 gr

JO 29 Crust (Purple Orange and Black Dark grey)
63.6 gr

23 samples Jorgensen

Seymour

SE 1A Background
Medium to very fine grained gytic sandstone (whitish)
23.2 gr

SE 1D More orange Background gytic, friable ss.
36.6 gr

SE 1E Pyritic with yellow sulphur dot Nodular level 76.3 gr

Appendix C
Description of Leonard Quarry thin sections

* 1st Appointment Microprobe

✓: candidates for microprobe
 ✓✓: good candidates

☺: Winners (Elected for microprobe)

C-1

Thin Sections

Grain-cement contacts

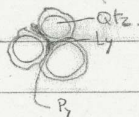
✓ (☺) { LE 1A : Qtz 100% Rounded moderately to well sorted
 (C) Type P_y } Cement.
 Limonite. → Areas where grains are more compacted

LE 1B : Qtz 100%

(C) Type Some qtz grain has some kind of brown coating (bioturbation)
 P_y not much (Not much cement as well)
 Limonite in the bioturbated areas

✓ LE 1Bb : Qtz 100%. Moderately to bad sorting

(B) Type Band of cement which is P_y and limonitic



A lot of ϕ between grains

✓ LE 2A : Dolomite with some quartz grains.

(A) Type Limonitic cement

Some sparse pyrite filling voids

☺ X ✓✓✓

LE 2B Well sorted, well rounded 100% Qtz

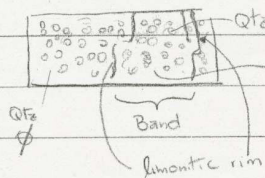
(D) Type Rounded tiny patches of cement (P_y)

☺ X

✓ LE 3A : 100% Qtz

(A) Type P_y Band The border is limonitic

☺



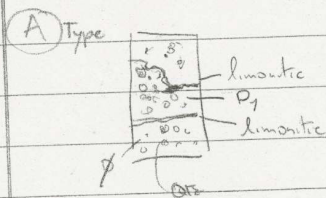
☺ ✓✓✓

C-2

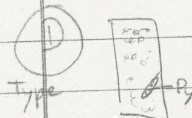
LE 3B Well rounded, well sorted 100% Qtz

(F) Type Tiny matrix of py cement
Bigger than LE 2B

✓ LE 4 Well rounded, well sorted 100% Qtz

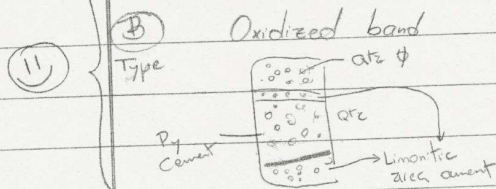


✓ LE 5 Well rounded, well sorted 100% Qtz



The yellowish mineralization that is
superficial is limonite

✓ LE 7 Well rounded well to very well sorted 100% Qtz

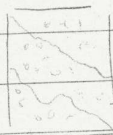


✓ Edge

✓ LE 9
(A) Type Qtz sandstone There is some kind of coating or
alteration with limonite (faint) rim on many grains

✓ LE 13 = LE 17

(A) 60% rounded
well sorted Qtz



Qtz Limonite
P1

C-3

In this case the distribution of the py and limonite seems to be irregular although there is a tendency for limonite to be at the rims of the grains and then it comes the py.

LE 14 100% Qtz well sorted well rounded
Altered grey grains (like coating)

LE 20 Altered grey qtz grains, moderately sorted, well rounded
(B) Type
Limonite and Py cementation in pseudo bands
Areas with opaque minerals even with reflected light diorite

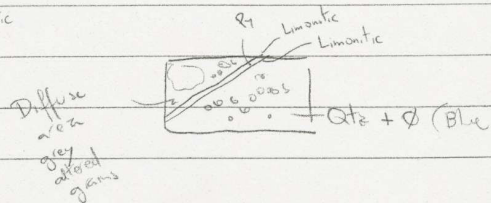
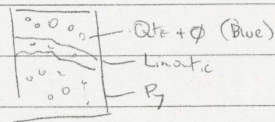
LE 15 Altered rounded well sorted grains
(B) Type
tiny mottles of limonite cement

LE 22 Beautiful well sorted, rounded, altered (grey) qtz 100%
(C) Type
Beautiful pyritic cement very shiny. Well developed py crystals.

LE 23 Just like LE 22 but the crystals are even better developed and it has limonite cement unevenly distributed near one border
(C) Type
LE 25 A

C-4

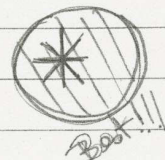
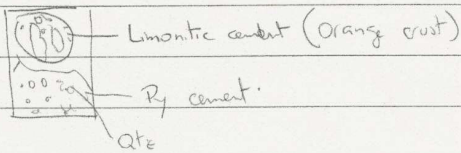
LE 25B Moderately to well sorted Qtz A lot of grey grains.



LE 25C Orange crust on top of dark gray nodule.

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③ Type



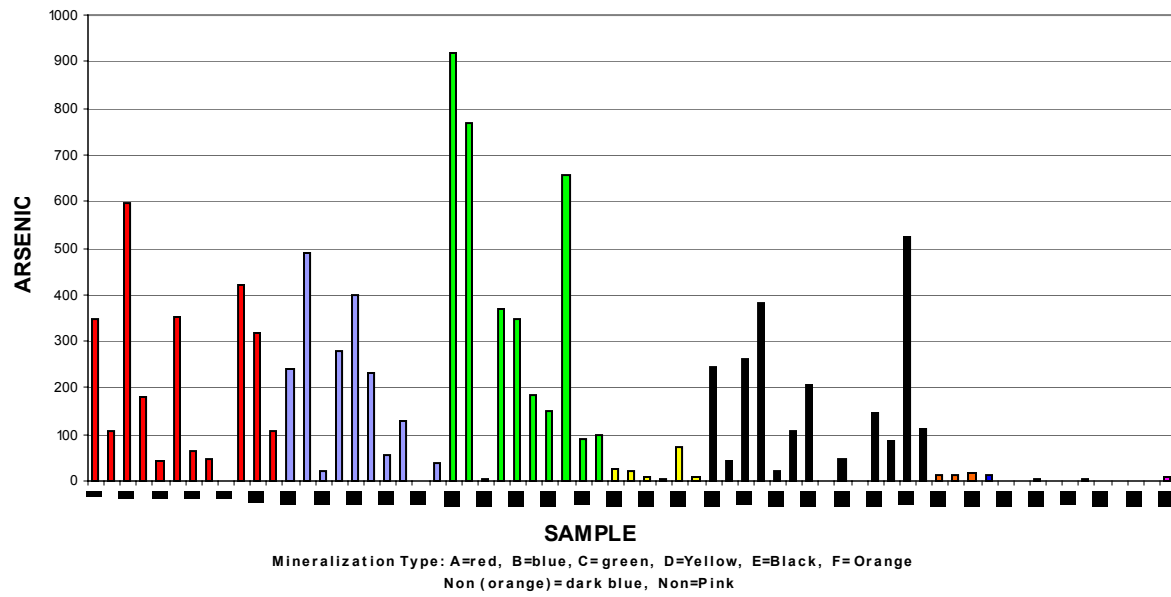
LE 31 Qtz (Medium grain (kind of bigger than the average))
Well to moderated. More compacted
Altered gray grains
R cement evenly distributed (sort of)

11

① Type

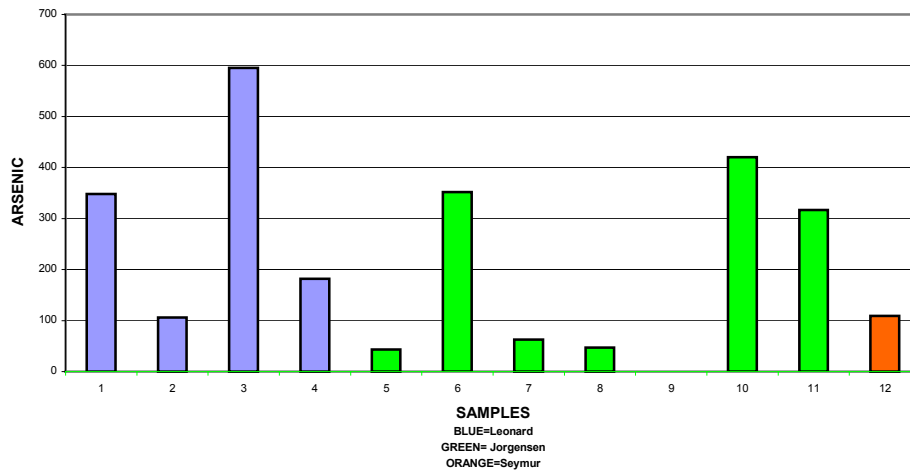
Appendix D1
Mineralization type vs As content

Mineralized type vs Arsenic Content

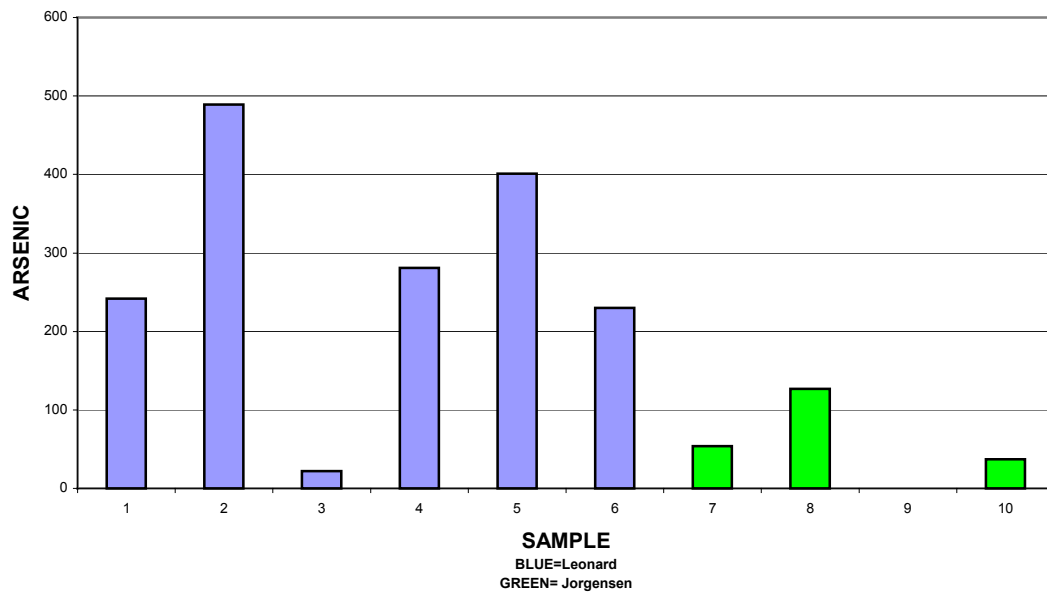


Appendix D2
As concentration by mineralization type

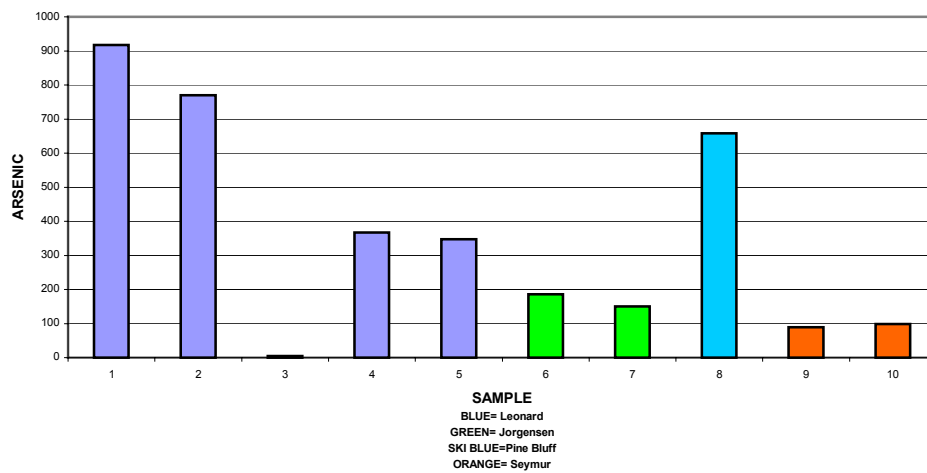
Mineralization A in different Quarries



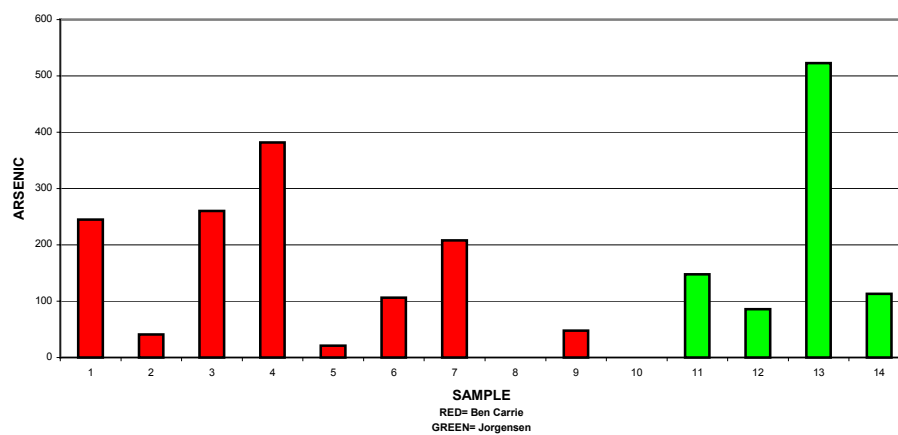
Mineralization B in different quarries



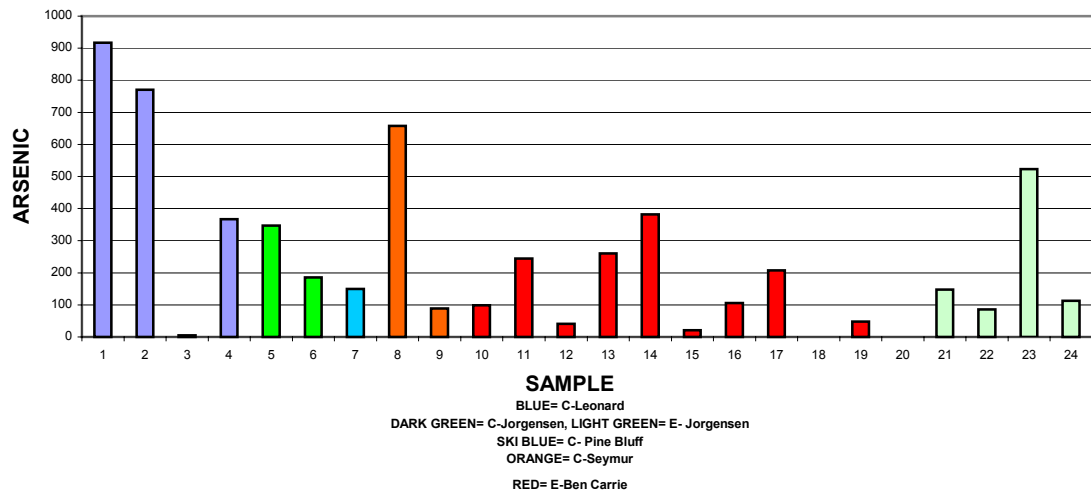
Mineralization C in different quarries



Mineralization E



Mineralization C and E



Appendix E1
Whole rock geochemistry of all samples

Element	Method	UNIT	Lower limit of detection	Upper limit of detection
Ag	ICP	PPM	0.2	400
Cu	ICP	PPM	1	20000
Pb	ICP	PPM	2	20000
Zn	ICP	PPM	1	20000
Mo	ICP	PPM	1	20000
Ni	ICP	PPM	1	20000
Co	ICP	PPM	1	20000
Cd	ICP	PPM	0.2	4000
Bi	ICP	PPM	5	4000
AsHY	AAHY	PPM	1	50
As	ICP	PPM	5	20000
Sb	ICP	PPM	5	4000
FeOL	AA	PCT	0.1	100
Fe	ICP	PCT	0.01	20
Mn	ICP	PPM	1	40000
Te	ICP	PPM	10	4000
Ba	ICP	PPM	1	10000
Cr	ICP	PPM	1	40000
V	ICP	PPM	1	20000
Sn	ICP	PPM	20	4000
W	ICP	PPM	20	4000
La	ICP	PPM	1	4000
Al	ICP	PCT	0.01	20
Mg	ICP	PCT	0.01	20
Ca	ICP	PCT	0.01	20
Na	ICP	PCT	0.01	20
K	ICP	PCT	0.01	20
Sr	ICP	PPM	1	4000
Y	ICP	PPM	1	4000
Ga	ICP	PPM	2	20000
Li	ICP	PPM	1	20000
Nb	ICP	PPM	1	20000
Sc	ICP	PPM	5	4000
Ta	ICP	PPM	10	2000
Ti	ICP	PCT	0.01	10
Zr	ICP	PPM	1	10000
S	ICP	PCT	0.01	20

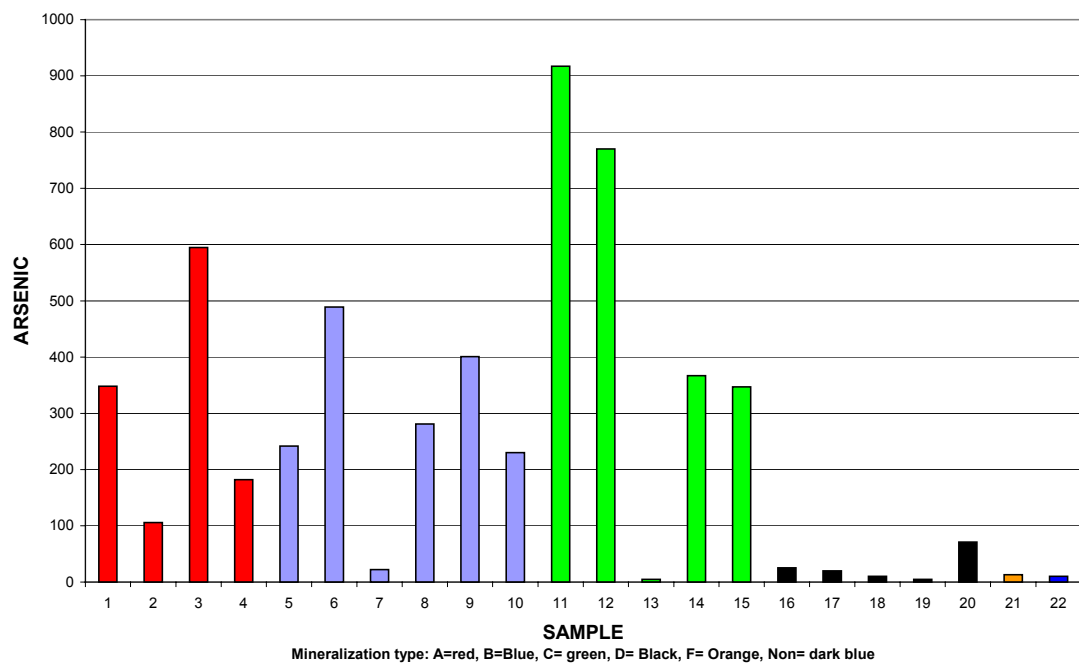
Appendix E2
Element concentration by mineralization type

Element	Method	UNIT	Lower limit of detection	Upper limit of detection
Ag	ICP	PPM	0.2	400
Cu	ICP	PPM	1	20000
Pb	ICP	PPM	2	20000
Zn	ICP	PPM	1	20000
Mo	ICP	PPM	1	20000
Ni	ICP	PPM	1	20000
Co	ICP	PPM	1	20000
Cd	ICP	PPM	0.2	4000
Bi	ICP	PPM	5	4000
AsHY	AAHY	PPM	1	50
As	ICP	PPM	5	20000
Sb	ICP	PPM	5	4000
FeOL	AA	PCT	0.1	100
Fe	ICP	PCT	0.01	20
Mn	ICP	PPM	1	40000
Te	ICP	PPM	10	4000
Ba	ICP	PPM	1	10000
Cr	ICP	PPM	1	40000
V	ICP	PPM	1	20000
Sn	ICP	PPM	20	4000
W	ICP	PPM	20	4000
La	ICP	PPM	1	4000
Al	ICP	PCT	0.01	20
Mg	ICP	PCT	0.01	20
Ca	ICP	PCT	0.01	20
Na	ICP	PCT	0.01	20
K	ICP	PCT	0.01	20
Sr	ICP	PPM	1	4000
Y	ICP	PPM	1	4000
Ga	ICP	PPM	2	20000
Li	ICP	PPM	1	20000
Nb	ICP	PPM	1	20000
Sc	ICP	PPM	5	4000
Ta	ICP	PPM	10	2000
Ti	ICP	PCT	0.01	10
Zr	ICP	PPM	1	10000
S	ICP	PCT	0.01	20

Appendix E3
Element concentration & mineralization type by quarry

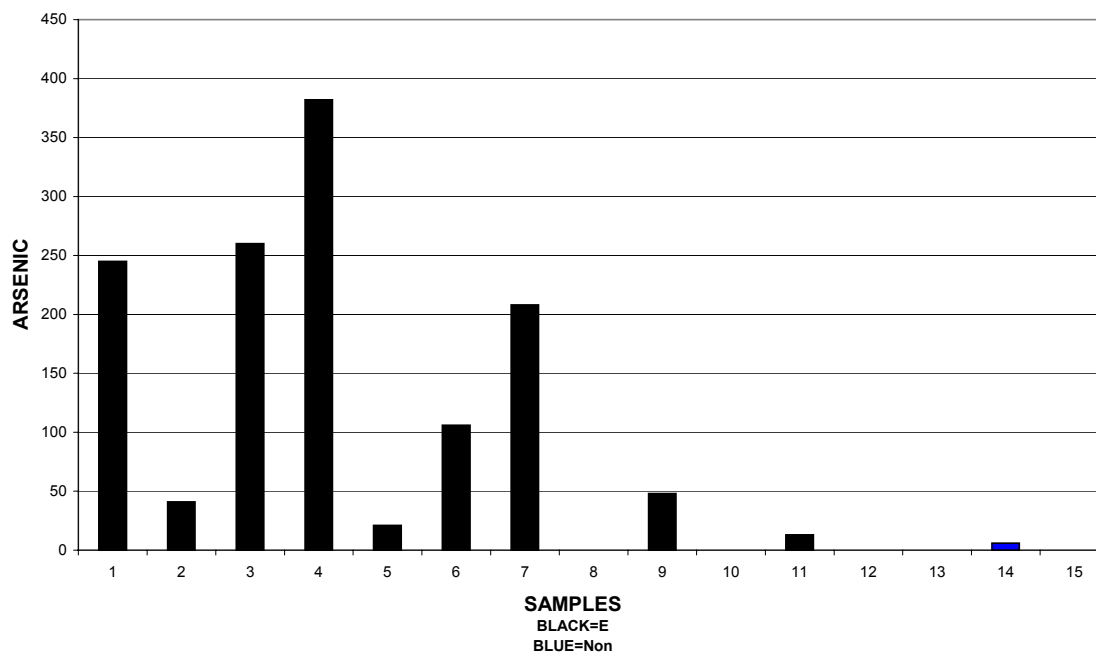
Sample Id	Mineralization Type	As	Ni	Fe	Zn	Mn
LE2A	A	348	397	17.95	53	318
LE3A	A	106	59	3.89	11	223
LE4	A	595	103	14.68	26	187
LE13	A	182	54	2.48	10	97
LE1BB	B1	242	69	4.95	16	94
LE7	B1	489	75	9.37	33	101
LE15	B1	22	76	1.73	32	196
LE20	B1	281	71	7.85	17	134
LE25C	B1	401	93	7.73	36	607
LE16	B	230	154	9.33	14	50
LE25B	C1	917	213	20	40	40
LE1A	C	770	111	20	34	88
LE1BA	C	5	56	2.89	6	197
LE22	C	367	60	20	27	91
LE23	C	347	87	20	35	36
LE2B	D	25	37	1.85	7	112
LE5	D	20	16	1.03	3	47
LE9	D	10	9	0.67	2	40
LE14	D	5	7	0.54	2	48
LE31	D	71	96	3.16	11	139
LE3B	F	13	12	1.99	4	126
LE25A	Non	10	9	1.26	9	1045

Mineralization type vs Arsenic Content for Leonard Quarry



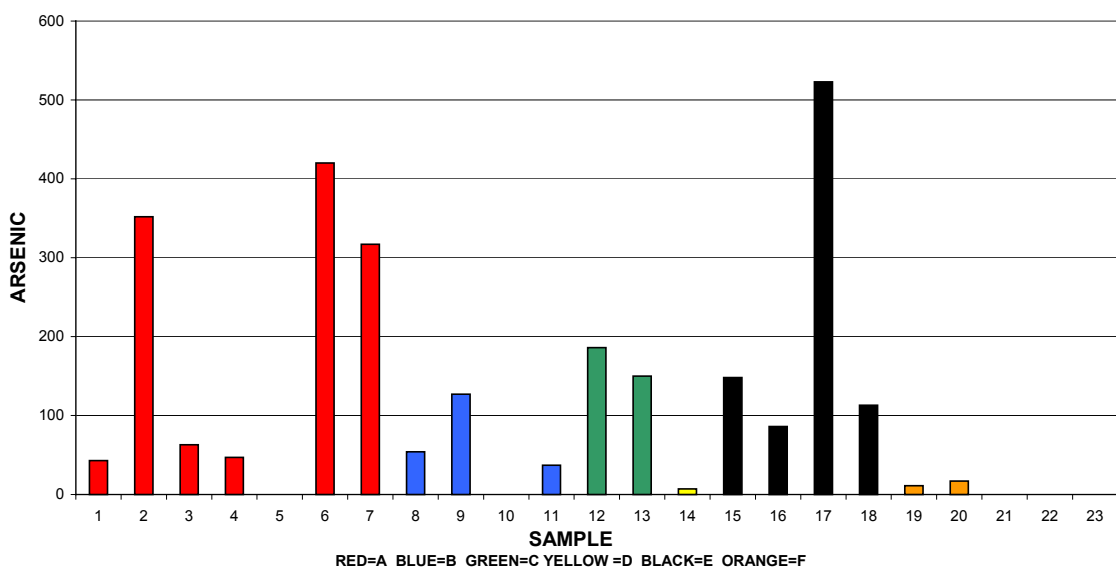
SAMPLE ID	Mineralization Type	ELEMENTS				
		As	Ni	Fe	Zn	Mn
BC3B	E	245	120	20	25	79
BC4B	E	41	85	19.88	18	61
BC16A	E	260	96	19.6	22	111
BC16B	E	382	58	20	23	69
BC22	E	21	66	20	17	70
BC30B	E	106	65	13.95	13	96
BC33	E	208	264	20	19	42
BC34	E	0	61	18.48	15	57
BC36B	E	48	30	6.5	6	67
BC37	E	0	19	20	17	33
BC5	Non (orange)	13	29	2.52	5	72
BC10A	Non (orange)	0	49	2.15	17	85
BC10B	Non (orange)	0	19	1.23	2	67
BC26	Non (orange)	6	48	0.72	7	38
BC30A	Non	0	12	0.39	0	33

Ben Carrie Quarry



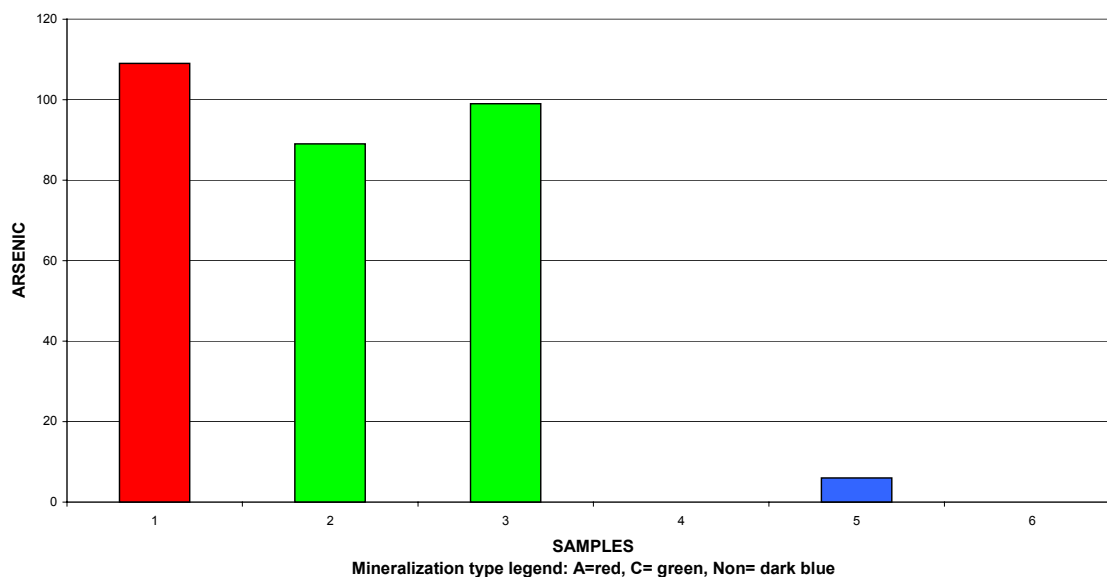
SAMPLE ID	Mineralization Type	ELEMENTS				
		As	Ni	Fe	Zn	Mn
JO11C	A	43	94	4.67	9	79
JO13	A	352	113	12.82	16	415
JO15	A	63	42	3.15	5	429
JO16	A	47	28	4.43	5	373
JO24	A	0	17	2.45	3	68
JO27	A	420	233	10.19	762	405
JO29	A	317	389	20	45	303
JO1	B	54	78	15.87	15	346
JO13B	B	127	42	17.73	14	53
JO20	B	0	23	5.62	15	209
JO22	B	37	75	18.35	46	647
JO25	C	186	99	20	20	218
JO26	C	150	363	16.94	259	711
JO28	D	7	19	1.78	96	132
JO2	E	148	35	20	33	54
JO4	E	86	44	20	22	566
JO5	E	523	193	16.27	94	34
JO7	E	113	67	18.25	43	31
JO11A	F	11	65	13.27	14	80
JO11B	F	17	24	6.17	5	40
JO17A	Non (orange)	0	3	0.39	2	23
JO18	Non	0	5	0.34	6	24
JO18B	Non	0	7	0.43	4	33

Jorgensen Quarry



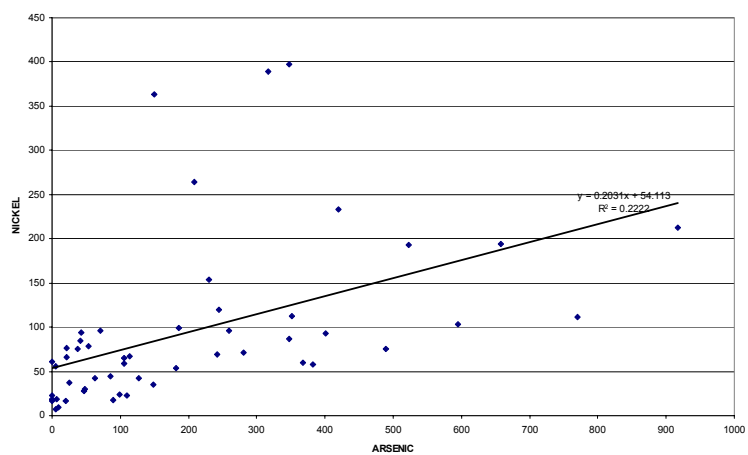
SAMPLE ID	Mineralization Type	ELEMENTS				
		As	Ni	Fe	Zn	Mn
SE1B1	A	109	23	8.98	180	179
SE1B2	C	89	18	17.04	39	31
SE1E	C	99	24	19.06	112	22
SE1C	Non (orange)	0	4	0.43	1	27
SE1D	Non (orange)	6	2	0.31	6	16
SE1A	Non	0	8	0.45	2	27

Mineralization type vs Arsenic content for Seymour Quarry

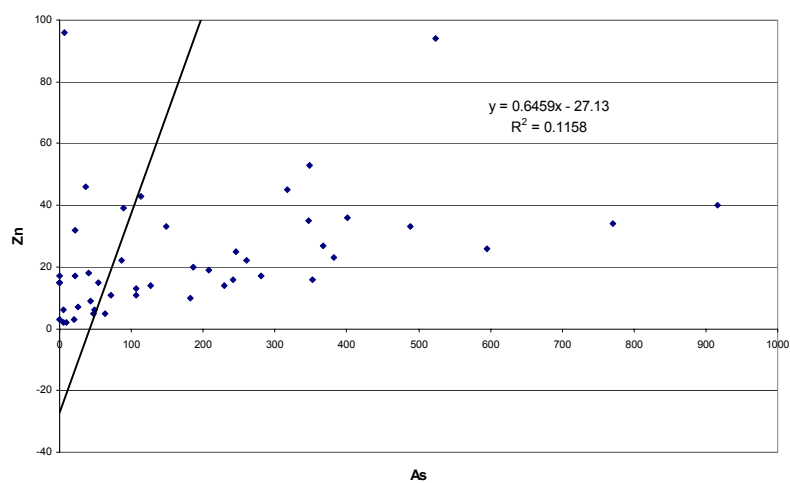


Appendix F
Linear correlations of whole rock geochemistry

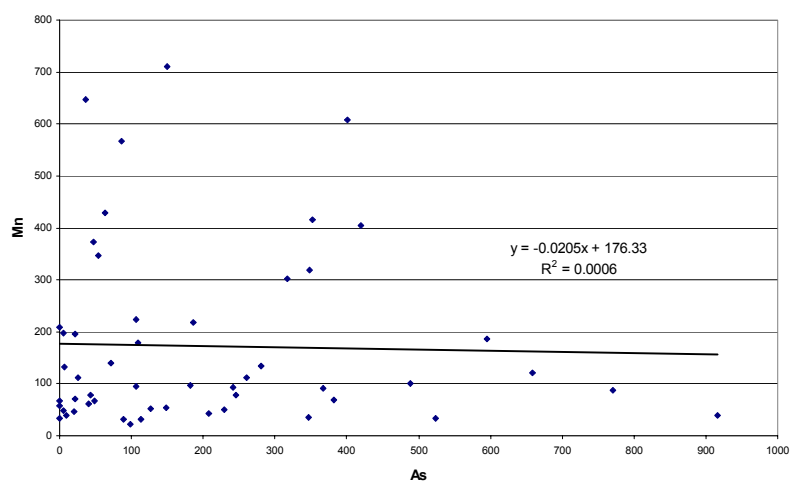
Arsenic vs Nickel



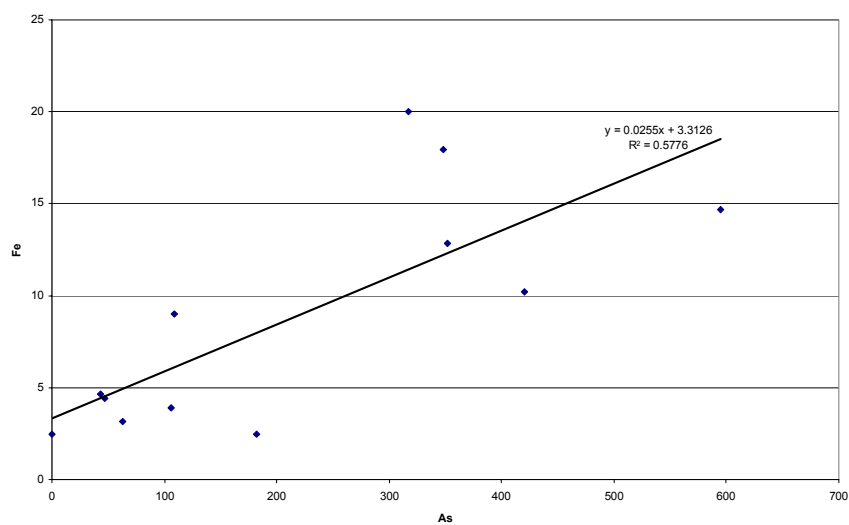
As vs Zn



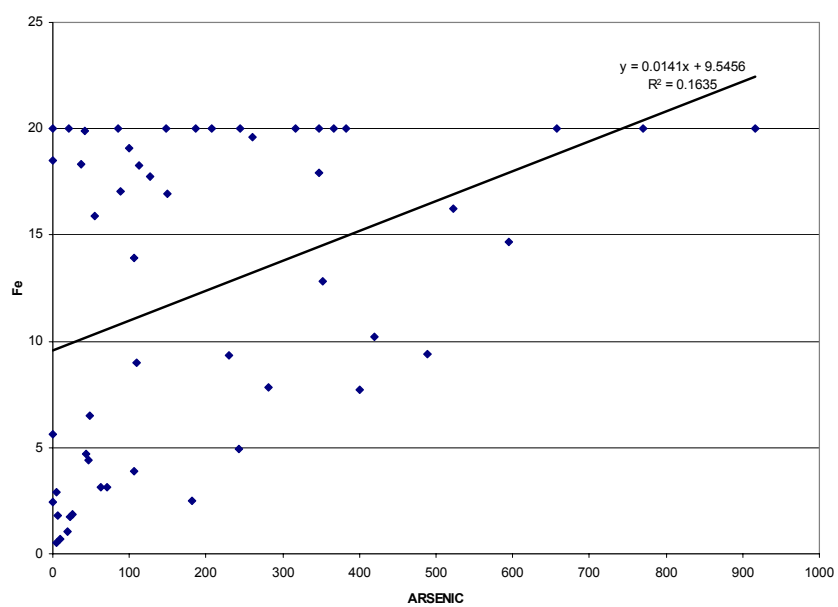
As vs Mn



As vs Fe (Mineralization A)



Arsenic vs Fe



Appendix G
S-Fe-As-O-Si on peak counts data from microprobe

G1

S On Peak Counts"	Fe On Peak Counts	As On Peak Counts	O On Peak Counts	Si On Peak Counts
Un 32 LE7 grid 1				
3578.817627	4894.183105	62.736156	5512.587402	20536.63281
10956.38477	14260.35938	113.584053	134.033325	115.900841
11037.6416	14367.63281	113.069023	127.371696	97.357643
9184.787109	13386.27539	103.709412	633.93042	656.160461
154.681427	14120.1123	83.868767	10594.89063	1463.184692
446.884857	683.561462	19.632681	1760.444092	789.937439
11044.69336	14410.67969	94.966125	117.733765	102.722893
11079.24902	14418.8457	92.032494	121.545937	94.751938
38.962948	16888.4043	88.913193	10305.38672	628.840881
151.165329	16772.87695	91.327454	12380.65723	698.149292
11072.70508	14437.43652	106.623154	120.421661	95.947723
11051.05957	14305.33008	170.661423	125.13472	97.945465
10778.69434	14247.12598	99.237839	151.497177	100.345291
6218.657715	11735.3584	103.653778	1805.774048	184.810089
3888.033203	14472.09082	99.647232	4871.70752	1533.45874
6217.507324	14172.01855	103.573944	4240.220215	234.416138
5347.165527	15011.6709	101.449341	4180.465332	1628.067261
3138.706055	16120.69531	103.768356	8327.567383	449.656647
2409.414307	4868.674316	56.867844	7365.825195	17349.61133
5672.280762	13268.5166	85.753456	1674.976685	1438.131104
11361.63281	14417.12305	96.116898	121.388176	106.587402
8979.430664	13916.47363	100.76828	229.711105	186.987793
102.560211	245.081085	39.043987	9327.443359	33235.45313
1606.948853	9862.932617	70.655205	2756.193604	2492.983887
328.613434	705.554138	41.859135	9188.979492	34868.86719
7464.179199	13005.65332	107.400055	2779.32373	4556.95752
4447.878418	14991.83301	96.811867	6411.327148	815.08429
496.45932	8057.451172	67.914368	5470.774414	17262.35938
5502.939941	15344.32422	102.862236	7062.539063	486.58551
10551.44238	14310.9502	103.952286	395.019257	169.999985
1455.539795	16440.86328	103.771835	10422.08008	687.640137
1611.006348	5011.250488	62.798946	9225.207031	20269.69336
6944.480469	13094.0332	96.029099	2307.68335	2943.192627
57.167934	251.160736	38.847916	8571.952148	38301.10547
396.4021	468.750336	43.483898	7943.773926	34958.26953
5385.756348	7637.819824	74.586372	4689.425781	15543.4707
2568.195557	11454.24805	84.360985	8365.035156	4443.732422
10914.46094	14196.79102	113.162155	164.130188	247.364288
2139.506592	5224.852539	65.53212	4152.217285	17315.16016
10532.37891	13959.02246	111.957375	365.849792	490.971924
8708.911133	13700.0752	91.519684	1560.13147	1242.742554
8.656199	119.817322	40.869232	9754.974609	36697.19141
73.383163	256.729675	38.751163	9763.59668	35236.85938
10453.4209	14289.67578	106.799507	149.195923	137.009644
11273.42773	14395.41699	118.661598	122.688919	103.862053
10242.45996	13907.05566	108.507637	714.945557	185.149475
9780.211914	13712.46191	157.253464	1166.799561	939.770813
284.100464	2555.213379	50.822754	15909.36035	31502.85742
11408.40137	14132.13672	112.434547	268.478088	372.82312
380.966461	890.407471	40.956169	8141.201172	32201.23438
1879.247559	15544.8584	95.119713	8579.609375	1709.390015
10944.88477	14299.68262	113.336967	132.066071	115.552139
11093.57715	14286.90918	99.227844	124.39637	101.241188
11199.69727	14397.48145	126.019974	124.912361	100.244614
11112.82227	14100.04785	152.398453	173.447159	144.644318
1475.892822	3466.175781	60.079185	9567.674805	30169.37695
1720.067749	3740.89209	55.139851	9675.532227	30011.58789

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10593.48926	14323.06836	103.966232	625.473755	408.687714
10949.8623	14388.79199	117.449478	126.107971	102.952553
11063.37891	14337.31543	126.842529	122.210083	100.459442
11023.14453	14334.69238	120.175873	127.727486	98.831818
11011.08398	14368.91699	102.338242	134.149292	104.552742
11557.95703	13946.75	91.26619	552.784973	663.338928
Un 34 LE7 grid 2 between qtz grains				
253.36824	572.712524	94.980797	2625.37085	25229.26758
5421.201172	10496.51367	647.562683	3716.137695	1108.881836
11138.40234	14479.12305	134.323624	144.792297	95.172508
10704.23438	14429.3584	107.353241	147.61586	91.854713
11157.75391	14362.93359	149.634262	129.903488	96.889801
11170.93555	14394.60645	103.9244	126.468292	95.672478
11104.47266	14322.87109	119.33036	125.671539	94.169342
11386.5	14421.93848	94.458588	126.359184	95.263573
11100.93262	14303.93164	98.892685	133.413239	107.446678
10067.96875	14206.91406	102.813957	194.212372	93.052979
11268.52051	14298.17578	130.813797	118.835052	96.893036
10996.00684	14221.01855	96.691742	126.887894	118.0298
11316.91699	14436.93262	122.773125	143.210495	106.767265
11971.21777	14479.88477	106.29248	137.307144	114.750465
6675.912598	9583.25	97.760475	2413.289795	8251.766602
11049.92773	14385.56543	134.606171	124.9375	112.953156
10671.45996	14215.64648	192.441284	183.876938	222.470337
72.867516	142.141113	40.053082	9164.908203	39141.52344
6.742612	65.626198	42.170944	8962.456055	37975.20313
Un 35 LE2A grid 1 grungy area				
10428.06348	13709.7334	89.395805	337.396332	145.896774
1715.821655	6109.217773	67.442863	4074.408936	2125.57251
241.594864	586.614197	26.972078	2065.613525	2815.827881
9283.487305	14187.25	83.639282	1740.950806	169.133362
287.042786	691.953247	33.211395	1346.498291	1067.662231
31.497171	150.797287	37.233719	4430.806152	64.208168
179.804581	484.381775	40.353672	4645.753418	67.731277
694.37085	1720.111572	42.257431	3610.576416	115.528893
348.229736	1530.565063	31.297993	1830.001587	972.661804
9230.691406	14013.55664	97.445282	653.401672	205.224503
8999.823242	14267.20898	91.403641	1438.730225	129.368912
171.645767	377.852936	32.805489	199.145554	772.934753
2797.441895	9292.112305	69.140526	5206.082031	2558.397217
11001.8125	13898.4082	93.89576	392.33609	99.633858
1659.935303	5072.60498	44.380997	290.047455	146.673096
9656.682617	13697.01074	86.555962	902.880066	239.345642
5509.791992	12402.22949	89.359833	820.314148	187.932266
10407.0293	14163.25195	91.986191	608.407288	154.714691
8363.140625	14464.73633	87.062241	1015.75	109.313141
10763.3457	13795.3457	84.237686	474.174103	145.052002
9722.536133	14184.15137	87.387711	683.704163	216.9422
6852.270508	12749.35449	83.253342	1653.052734	284.359283
8125.616699	13462.34766	85.160843	1423.606567	228.300262
9853.366211	14036.80176	83.451935	687.374268	144.884598
9251.18457	14198.62109	92.825775	918.737244	171.596817
8435.563477	14731.24805	93.933563	1634.15625	150.540588
987.87384	4011.300781	54.763012	15195.44238	8824.459961
4697.305176	11114.82129	81.851883	2923.807373	1201.881958
7780.460449	13822.55957	80.534622	1548.394165	159.999802
828.267517	3238.670898	40.168549	1397.243408	5947.54248
384.777618	605.076477	20.637468	476.516815	2005.813599
9086.172852	14329.80566	95.437775	776.756104	154.257706

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	8997.754883	14151.34473	108.835243	932.065552	192.145447
	9756.930664	13990.08301	96.366707	585.194641	136.359543
	10457.36621	13819.73438	88.214066	427.30304	126.797119
Un 36	LE2A grid 2 grungy area				
	9904.196289	13800.78418	89.721977	1181.400269	142.913208
	3486.977539	12016.9209	87.310448	5140.204102	1317.904541
	107.00428	179.790054	24.075054	1264.523926	4848.616699
	223.948853	393.191742	25.271208	2977.370117	2495.381592
	168.731598	364.874908	26.884956	405.039459	1592.922974
	24.563908	226.950317	38.961643	4598.623535	62.927044
	1311.058228	2930.059326	51.440479	6295.350586	206.360519
	9851.042969	13382.77637	85.100113	734.185791	204.816864
	7819.94043	13625.60449	86.306038	610.63446	534.158203
	6895.29834	13997.26563	99.620056	2345.276367	287.235474
	6267.247559	10446.21973	68.472649	1768.990356	593.417297
	4543.586426	10003.76465	73.400398	3298.829834	2174.301025
	2975.015869	9427.552734	67.26181	3302.336914	547.132935
	9928.745117	14122.15723	88.608055	651.555908	134.843781
	11279.47363	13458.80469	82.151222	406.316101	159.506775
	2842.397217	7476.854004	61.309643	4839.086914	4971.13916
	93.521324	203.316864	30.396261	38.751163	167.146912
	9143.173828	14410.03906	91.907104	763.05542	113.557388
	9731.473633	13274.44043	92.108482	1065.911011	622.489197
	10518.45605	13893.27637	85.06015	637.23761	116.07505
	9600.629883	14177.6123	88.800552	727.797485	168.17688
	51.645313	158.812225	32.616245	55.270145	278.851959
	981.528503	2484.867188	39.159077	1417.856201	1528.233521
	10473.29004	13989.65918	90.839088	526.583191	118.342216
	10198.07617	13956.95605	87.396507	339.369324	129.500015
	9436.513672	14233.12402	89.810638	1011.533752	155.789658
	8833.223633	14262.51172	92.529877	686.782166	168.887833
	7413.944824	13919.62305	90.305107	2231.656982	273.682434
	8493.412109	14044.75195	94.736038	672.565186	230.338913
	8461.142578	12177.57813	89.890244	869.514648	197.25795
	8722.955078	13517.66309	85.560715	1237.727417	403.927765
	8489.242188	13642.5127	88.990028	730.429016	195.961349
	9261.521484	13820.5918	88.288132	740.663147	193.247345
	9613.208984	13771.98145	88.495461	703.109192	187.919769
	9940.407227	13853.04785	82.445038	660.698181	193.543167
	10901.58789	13932.44824	86.469795	270.53009	127.858185
	10428.29883	13605.22656	84.050438	633.579529	150.011719
	5078.376465	11664.05664	98.240952	2336.787354	251.958557
	10328.10938	14175.89063	87.870605	342.885468	109.014732
	9835.225586	13668.42773	79.930481	349.700104	293.634521
	10258.41992	14123.07129	85.580811	559.986328	119.321716
	10623.70605	13962.11523	85.6959	479.795532	172.846497
	10978.11621	13653.55957	87.511909	301.801605	287.278503
	11186.37695	13941.81055	81.168724	329.046814	115.420425
	10205.00977	14182.51855	89.337059	323.934662	231.346893
	9784.297852	14013.02051	91.849533	422.500946	241.414032
	9898.544922	13873.78223	89.221344	444.159454	160.249664
	10459.04102	14024.7002	87.997849	384.550018	180.475525
	10512.41016	13911.80957	84.783676	323.959442	131.120651
	10520.25488	13935.56934	86.708969	342.565094	139.803833
	9821.332031	13689.51953	86.403885	537.069275	121.360748
	10326.32031	14007.77832	85.897354	453.244385	140.499771
	10164.76563	13877.2041	92.25869	354.102295	121.578568
	7733.4375	14059.39258	90.44223	1105.869751	361.658173
	3579.246582	12392.36816	80.970001	719.624329	237.68335

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	397.066315	583.373169	24.669554	951.444946	2408.890625
	8167.916992	13305.21387	83.79055	1075.02478	120.663597
	8980.125977	14172.72363	99.811531	1234.63916	200.589752
	10494.29004	13318.17969	93.993484	1209.607788	184.409851
	10174.18359	12123.97949	79.162117	626.461853	527.646301
	9419.958008	13620.59082	82.595596	526.285278	159.08313
	10193.96973	13927.86523	88.246597	492.352112	158.473587
	8861.231445	13674.42871	89.707161	990.843201	167.243011
Un 38	LE2A grid 3 grungy area				
	11262.63379	14208.42383	86.886848	207.755417	113.739021
	10414.08789	13907.42383	88.902679	1065.278687	279.278198
	7115.881836	11747.36133	70.53775	2443.927002	2724.145508
	2496.87915	13156.20703	100.00956	2366.063477	234.727936
	10079.86133	14210.83887	87.189667	783.299255	172.202774
	10408.96094	14181.94727	85.776512	711.856323	128.580215
	1970.138428	5184.220215	50.456566	2631.342529	766.957397
	8511.393555	12990.25488	84.498413	1007.351685	271.21167
	9856.461914	13724.28418	87.590492	405.034088	113.129494
	10400.78516	13849.0166	90.459885	892.405579	228.007843
	4073.435059	9647.09668	76.239777	2859.479736	2380.914063
	11347.73145	13845.56543	90.453812	528.487	146.646408
	11000.91504	14002.30469	84.37352	212.880112	112.507446
	2594.385986	12103.57031	94.633057	3137.891846	1724.543335
	10491.11719	13174.69727	89.473854	960.402161	493.404694
	10775.13477	14065.125	87.965019	294.708008	106.107864
	11179.5332	14179.74121	87.328033	167.645462	98.713234
	9290.600586	13025.37305	82.676918	764.980896	197.344009
	10604.17383	14262.83105	87.618515	290.424408	111.696457
	9502.339844	13480.47949	88.851219	515.326477	98.625717
	8850.374023	13894.77344	89.141556	1724.939697	561.82843
	10156.94141	14239.86035	92.038666	1963.773804	202.067978
	5680.394043	12495.6582	91.446579	4579.163086	975.039612
	9442.027344	12412.20313	79.461678	2238.474121	320.796509
	9709.392578	13378.03809	89.749084	1391.002808	324.976288
	3539.595215	14077.21289	101.531067	6433.247559	691.181213
	3982.608643	13469.31152	95.473	906.765869	676.328796
	10950.39453	14154.45117	83.880028	226.562317	114.401421
	9277.639648	14429.10059	92.942085	633.994263	161.649612
	6040.814453	13457.66602	97.975052	5684.041992	353.301147
	1087.132324	11185.63281	94.245171	6055.015137	4134.649902
	3884.468506	14115.14746	111.96489	1917.214966	1091.821045
	3074.447998	6040.998535	54.072742	1037.364868	512.426941
	112.513802	469.693176	42.095703	5111.371582	252.934479
	1861.852051	6799.250488	66.467262	3436.344238	8644.801758
	4199.975586	10040.41504	76.016273	2972.974121	4028.305176
Un 39	LE25C grid 1				
	10335.37988	14193.39844	92.426064	247.792404	117.706116
	10697.3252	14172.24316	85.376534	176.53978	106.123154
	11132.5127	14333.45898	85.082985	129.605103	101.802574
	11163.14063	14422.11523	86.685707	129.793533	95.447388
	11004.36816	14200.44727	132.705887	144.088455	141.872299
	11251.25781	14460.93164	93.732147	118.407204	97.760475
	11221.05469	14335.28125	101.496994	123.455811	95.957382
	10723.65332	13952.45605	105.813889	237.293274	406.605133
	31.605232	97.653221	40.262478	8966.969727	35964.33594
	4341.751953	5501.399902	400.941864	3482.211182	11162.87793
	11139.65723	14288.01855	93.298019	119.575768	125.013054
	1491.828735	2627.975342	57.969364	7918.959961	26860.85742
	5.736235	52.639839	39.855793	9393.407227	35818.41406

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5.535147	43.380318	39.655815	9277.817383	35883.875
41.775314	99.06971	41.372608	9037.685547	34868.85938
10559.38965	13173.57715	106.025986	369.316498	796.075256
11119.34082	14402.02734	100.785179	132.916275	128.786224
11133.4873	14423.47656	105.723824	127.98465	109.651993
11227.46094	14388.70215	95.444176	116.795654	101.386055
11444.49023	14466.15137	90.930687	127.195869	96.470688
11170.56738	14379.19824	84.268776	117.303215	103.70594
11207.59766	14487.99121	96.857353	129.894272	98.065903
10535.2832	13259.70605	94.959763	163.972748	478.567963
11090.05762	14058.20508	90.021126	126.58712	92.539192
11100.71777	14050.36035	94.849472	162.84787	109.857117
10737.61523	13808.55469	86.789322	528.781982	862.029297
10037.625	12845.93457	91.947189	424.707275	770.265991
9690.160156	13065.8877	102.430992	718.8396	755.752625
11144.00684	13998.95508	89.538551	154.632553	166.827896
11074.25	14046.67285	90.350571	152.526321	178.632904
11188.09375	14402.86621	94.585419	122.296242	101.739403
10900.94727	14251.81348	89.218353	192.694519	150.77243
11260.47656	14465.94238	90.744453	121.977531	97.897324
11162.9043	14397.08984	90.44223	121.876778	99.912277
9512.683594	13425.63867	105.37043	340.930176	151.830994
10232.07715	13600.3916	140.643005	254.77536	376.050446
522.266235	579.565247	60.949821	2812.234863	5547.164551
5.943293	46.94767	39.995365	9167.520508	35722.10156
4.230228	38.881828	38.075897	9291.789063	35881.50781
4.431671	45.933899	37.572189	9221.735352	35820.58594
1178.286865	2476.491699	60.939594	4637.071777	23107.45117
11109.24512	14386.83496	112.603218	134.064819	126.608368
11143.84863	14454.08105	103.740746	118.753212	103.136246
8632.90332	12562.87793	82.475471	156.727982	79.755844
11216.95996	14249.81934	93.464523	143.642624	113.110779
11155.41309	14407.87207	106.874786	121.485954	101.232185
11092.0166	13836.38574	87.926636	146.066116	111.200157
11257.29785	14189.89844	85.704521	129.228165	103.938744
11286.54297	13900.86914	92.954552	156.632462	118.745224
10481.17871	13651.3291	103.236992	300.621552	421.303833
10665.80957	13754.02539	88.720673	277.294586	325.505188
11027.49219	14242.40625	91.058914	143.359543	126.024963
10727.43652	13516.9502	95.58017	242.934647	398.391754
10176.30469	13305.55176	108.37532	382.042328	325.739746
8648.384766	13197.91602	100.808853	456.288147	373.729584
11097.87891	14230.15234	103.243919	149.49765	187.396912
10018.73145	13216.46875	95.781654	641.90448	713.78363
11423.57227	14047.80371	96.802109	272.114716	263.238861
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11250.88574	14365.16602	86.910446	118.64447	101.819649
10943.30664	14054.79297	141.324814	167.527802	148.782181
11034.90332	14128.10059	110.110306	165.142136	208.595795
11199.56445	14350.7832	101.433701	131.462585	108.789284
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11216.85059	14324.61816	97.803146	128.132675	108.987152
11018.35254	14089.68457	104.428467	172.437592	205.293365
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10273.58301	14040.75586	100.62764	201.315643	153.937378
11176.88281	14295.53418	88.960953	140.565811	124.739975
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11064.2168	14442.81641	97.049232	124.874306	96.948425
11042.41211	14300.51563	128.810822	141.213318	106.629768
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10998.89453	14019.81543	98.554733	134.847122	87.265366
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67.783562	207.869034	46.529007	10631.35449	36125.28516
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G7

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8075.40625	11242.27246	95.593002	1297.510254	2741.952393
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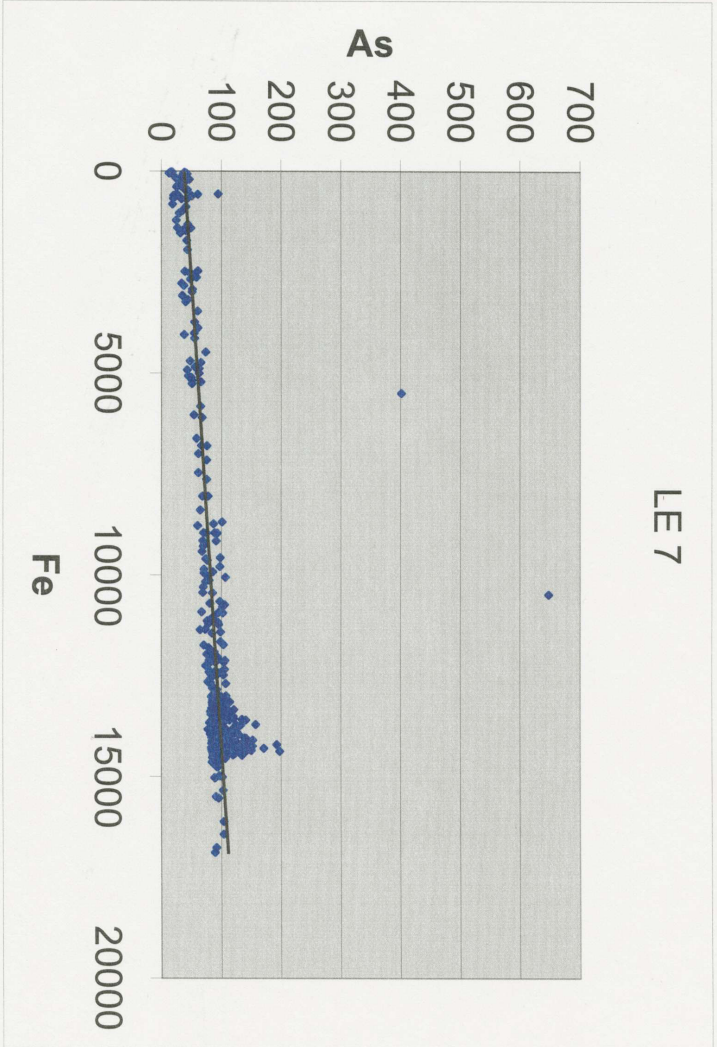
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Un 45 LE25C grid 2				
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956.970093	4929.919922	42.734455	2484.90625	762.081726
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1396.822144	5117.246582	49.359299	2670.761719	4273.960938
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8900.738281	14089.3291	89.455818	1075.82019	170.389938
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7540.805664	14670.04297	93.049049	2481.484619	595.943176
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Appendix H
Linear Correlations using microprobe data

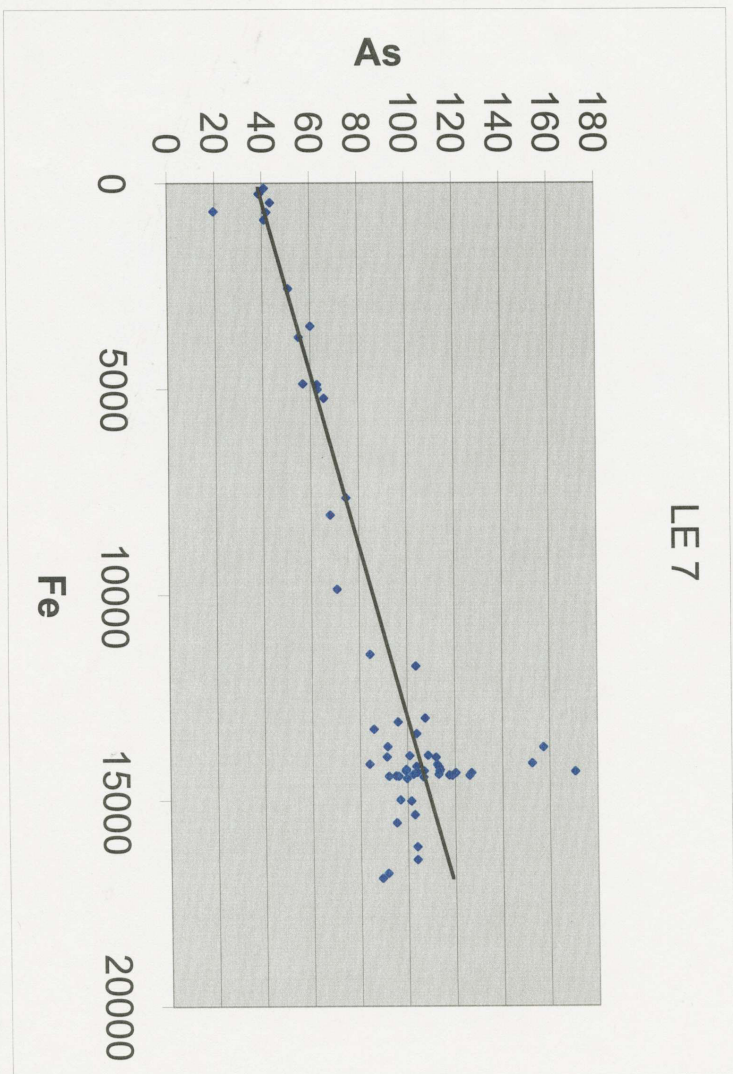
H 1

LE 7

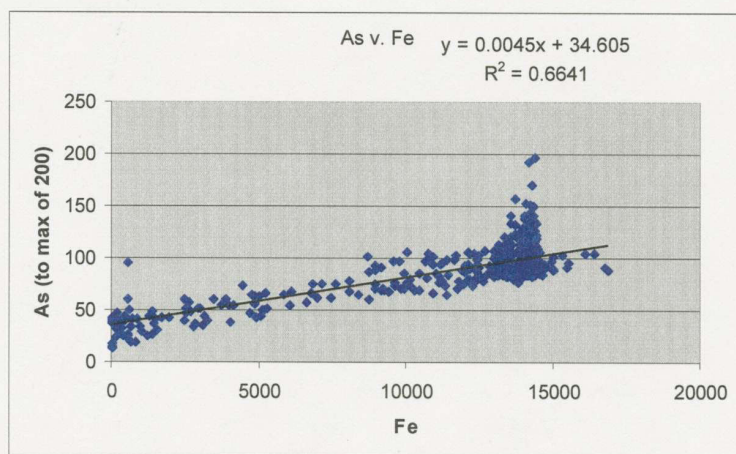
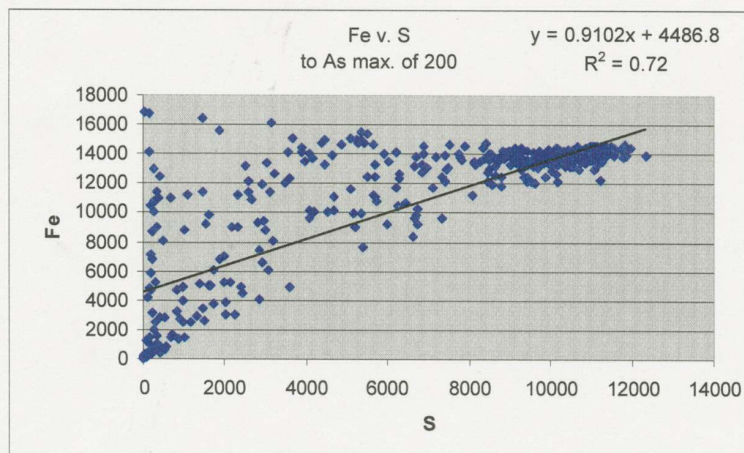


H2

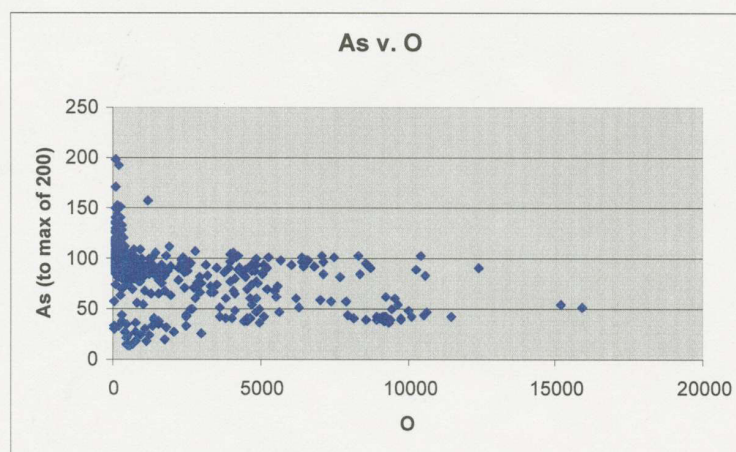
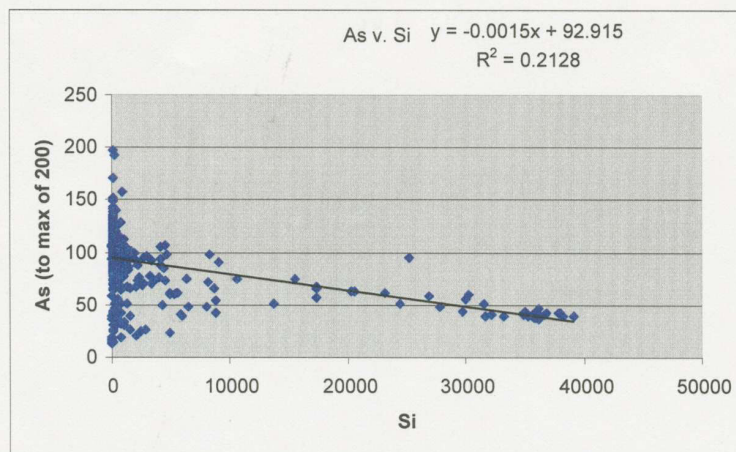
LE 7



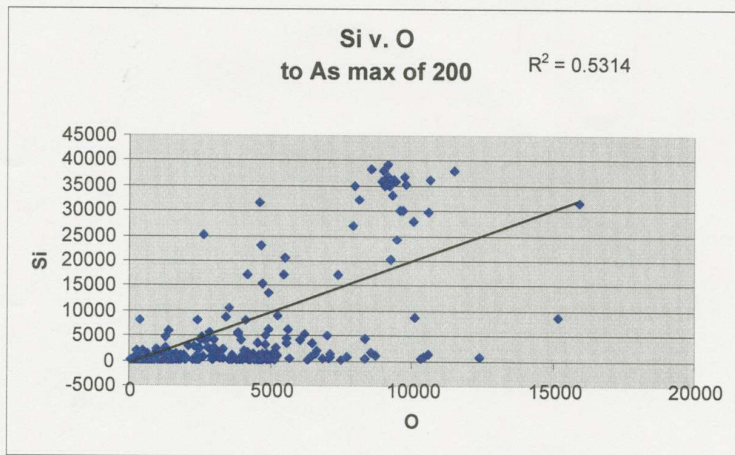
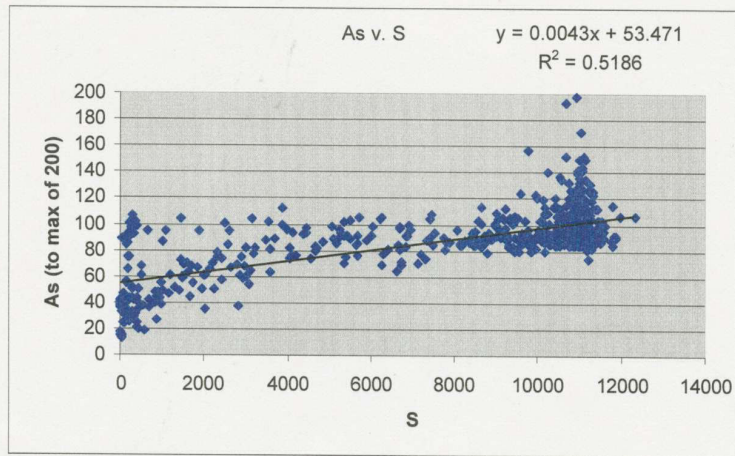
H3



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H5



Appendix I
Whole rock geochemistry results of samples from Honey Creek field site

Sample ID	Location	Depth (ft, bgs)	(m, bgs)	Description	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	Ni ppm	Co ppm	Cd ppm	Bi ppm	AsHY ppm	As ppm	Fe %	FeOL %	Sb ppm						
SB-1,71'	SB-1	71.0	21.64	dolomite, mineralized veins	1.5	145	21	13	6	81	46	0.9	<5	NA	73	4.45	NA	<5						
MW-1,73'	MW-1	73.0	22.25	dolomite, mineralized veins	<0.2	11	3	7	3	24	9	0.4	<5	NA	23	1.71	NA	<5						
well1-1	MW-1	76.0**	23.16	mineralized zone, purple	0.8	109	53	32	37	154	113	1.4	<5	NA	161	12.67	<9	9						
well1-2	MW-1	77.0**	23.47	sandstone, white to gray-brown	<0.2	7	7	6	38	14	6	<0.2	<5	1.8	<5	2.27	<9	<5						
well1-3	MW-1	78.5**	23.93	mineralized nodule, purple	3.9	83	585	56	53	234	196	4.8	<5	NA	510	20	21.4	<5						
well2-1	MW-2	78.7	23.99	sandstone, white	<0.2	7	12	7	32	23	10	<0.2	<5	NA	16	1.54	<9	<5						
well2-2	MW-2	78.8	24.02	sandstone, orange	<0.2	10	12	55	47	35	10	<0.2	<5	NA	13	2.55	<9	6						
well2-3	MW-2	79.2	24.14	sandstone, white	<0.2	8	7	5	31	12	3	<0.2	<5	2.8	<5	0.72	<9	6						
well2-4	MW-2	80.4	24.51	sand, light gray	0.8	149	10	61	10	16	6	<0.2	<5	NA	8	1.11	<9	<5						
WELL 2 crust	MW-2	78.6	23.96	SCH	4.9	129	442	85	29	378	241	3.6	<5	NA	585	20	NA	9						
WELL 2 85'	MW-2	83-87*	2.0	sandstone, white	<0.2	16	4	10	15	6	2	<0.2	<5	1.8	<5	0.57	NA	<5						
WELL 2 95'	MW-2	93-97*		sandstone	<0.2	3	<2	<1	15	4	2	<0.2	<5	<1	<5	0.45	NA	<5						
WELL 2 100'	MW-2	98-102*		sandstone	0.3	28	2	15	14	7	3	<0.2	<5	1.9	<5	0.53	NA	<5						
WELL 2 105'	MW-2	103-107*		sandstone	0.3	13	<2	<1	15	5	3	<0.2	<5	4	<5	0.68	NA	<5						
WELL 2 110'	MW-2	108-112*		sandstone	0.2	11	<2	<1	16	7	3	<0.2	<5	<1	<5	0.47	NA	<5						
WELL 2 113'	MW-2	112-114*		shale	0.4	67	8	3	17	66	38	<0.2	<5	NA	12	1.37	NA	<5						
Sample ID		Mn ppm	Te ppm	Ba ppm	Cr ppm	V ppm	Sn ppm	W ppm	La ppm	Al %	Mg %	Ca %	Na %	K %	Sr ppm	Y ppm	Ga ppm	Li ppm	Nb ppm	Sc ppm	Ta ppm	Ti %	Zr ppm	S %
SB-1,71'		715	<10	8	26	4	<20	<20	<1	0.08	8.39	13.93	0.04	0.06	39	2	<2	<1	5	<5	<10	<0.01	3	3.95
MW-1,73'		1009	<10	7	20	5	<20	<20	<1	0.08	10.05	16.59	0.03	0.07	67	1	<2	1	3	<5	<10	<0.01	2	1.05
well1-1		387	<10	7	434	25	<20	<20	2	0.04	0.04	0.04	0.01	0.01	5	2	<2	<1	<1	<5	<10	<0.01	2	0.02
well1-2		153	<10	3	628	3	<20	<20	3	0.02	0.02	0.16	<0.01	0.01	5	2	<2	<1	<1	<5	<10	<0.01	1	<0.01
well1-3		168	<10	5	632	20	<20	<20	3	<0.01	0.06	0.04	<0.01	<0.01	9	4	<2	<1	<1	<5	13	<0.01	1	0.5
well2-1		206	<10	4	513	6	<20	<20	3	0.03	2.07	3.43	0.01	0.01	18	8	<2	<1	<1	<5	<10	<0.01	2	0.03
well2-2		138	<10	6	764	4	<20	<20	2	0.02	0.11	0.18	<0.01	0.01	5	1	<2	<1	<1	<5	<10	<0.01	1	<0.01
well2-3		56	<10	2	502	2	<20	<20	2	0.02	<0.01	0.02	<0.01	0.01	3	<1	<2	<1	<1	<5	<10	<0.01	1	<0.01
well2-4		412	<10	7	107	8	<20	229	5	0.15	7.85	11.62	0.03	0.05	32	2	<2	2	<1	<5	<10	<0.01	2	0.24
WELL 2 crust		681	<10	9	241	24	<20	<20	2	0.11	0.25	0.77	0.01	0.02	20	10	<2	<1	<1	<5	<10	<0.01	<1	17.9
WELL 2 85'		135	<10	3	232	3	<20	32	1	0.04	1.8	3.27	0.01	0.02	9	<1	<2	<1	<1	<5	<10	<0.01	<1	0.1
WELL 2 95'		48	<10	2	218	2	<20	<20	<1	0.02	0.38	0.75	0.01	<0.01	3	<1	<2	<1	<1	<5	<10	<0.01	<1	0.04
WELL 2 100'		48	<10	3	208	2	<20	79	<1	0.02	0.25	0.5	<0.01	0.01	6	<1	<2	<1	<1	<5	<10	<0.01	<1	0.03
WELL 2 105'		34	<10	3	214	2	<20	<20	<1	0.03	0.1	0.19	0.01	0.04	4	<1	<2	<1	<1	<5	<10	<0.01	<1	0.16
WELL 2 110'		33	<10	2	243	2	<20	<20	<1	0.02	0.04	0.07	0.01	0.02	2	<1	<2	<1	<1	<5	<10	<0.01	<1	0.11
WELL 2 113'		134	<10	22	237	11	<20	91	11	1.32	1.37	2.53	0.02	0.85	47	10	4	15	<1	<5	<10	<0.01	9	0.58

NA indicates sample not analyzed for this parameter.

“<” indicates analytical result was less than this value, which is the method detection limit.

** indicates core recovery was less than 100% and depth of sample is estimated to nearest 0.5-feet.

* indicates material analyzed was cill cutting from the indicated depth interval.