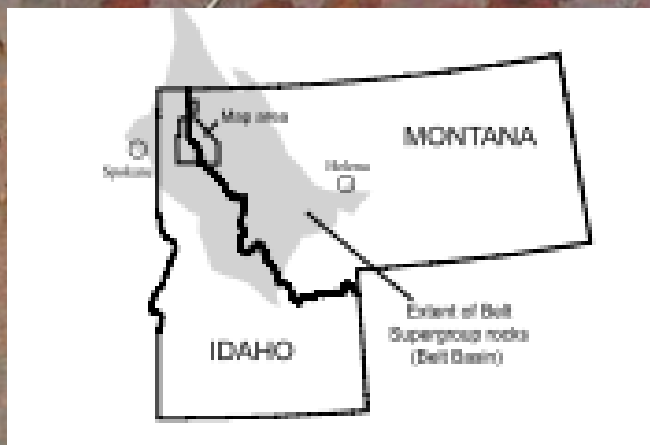


Environmental Geochemistry of Revett-style Cu-Ag Deposits, NW Montana



Lisa Bithell Kirk, Ph.D., P.G.
Principal Geochemist
Enviromin, Inc.



Environmental Geochemistry

- Evaluate potential
 - Acid rock drainage
 - Trace element mobility
 - Water quality impact
 - Cabinet Mtn Wilderness
- Operational Mines
 - Revett Troy
 - geological and geochemical analog
- Permitting
 - Revett Rock Creek Project
 - MMC Montanore Project

Underground mining of stratabound deposits via adits with conventional flotation and tailing deposition

Environmental Geochemistry Model

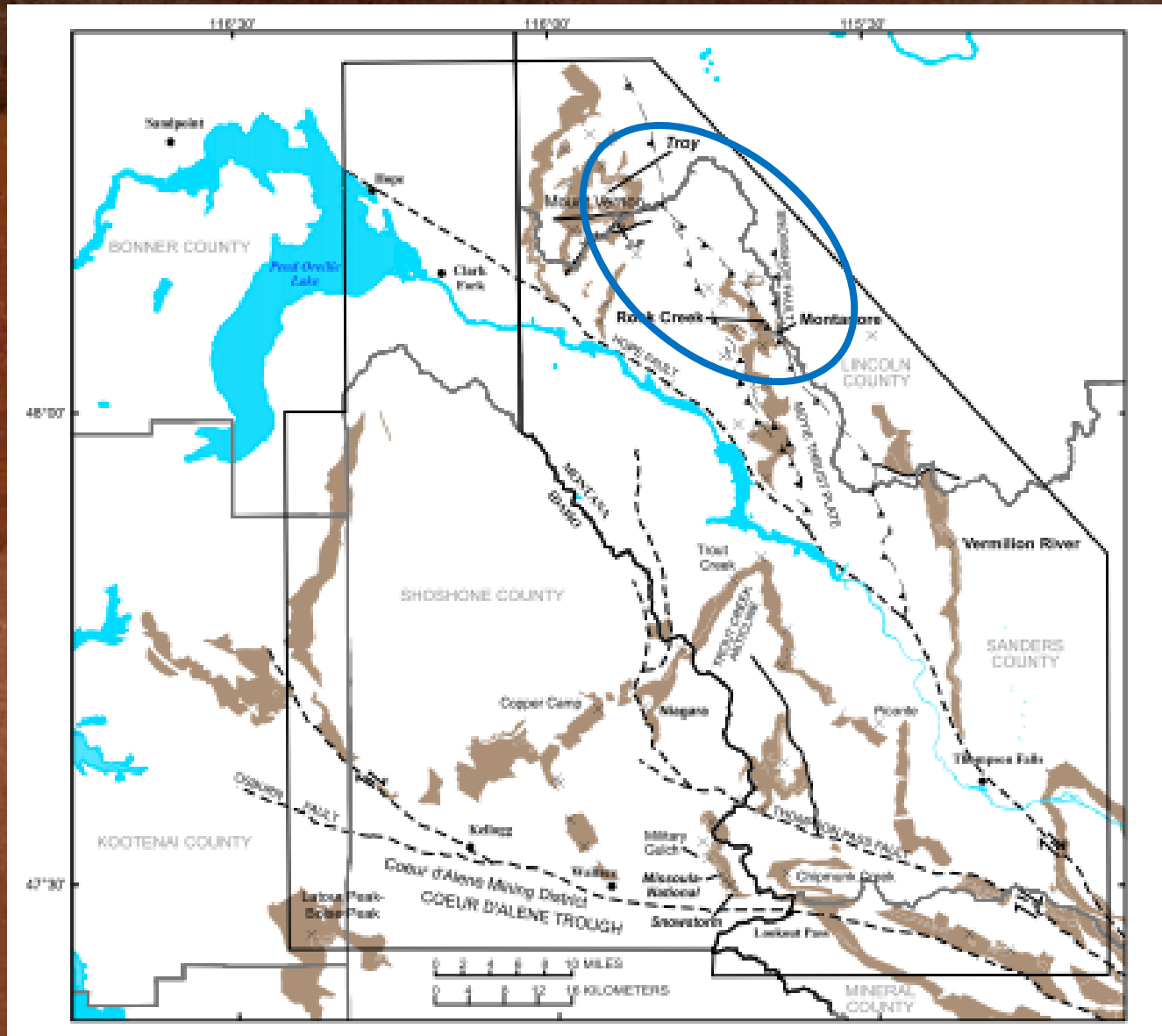
FACILITIES

- Ore
 - underground
- Tailing
- Waste Rock
 - underground
 - construction

DATA

- Lithology
- Mineralogy
- Geochemistry
 - Static
 - Kinetic
- *In Situ* Monitoring

Revett-style Cu-Ag deposits



From Boleneus et al, 2005



Revett Cu-Ag Stratigraphy

Age	Supergroup	Group	Formation	Members
Mesoproterozoic	Belt	Carbonate-bearing middle part of the Belt Supergroup	Wallace	
			Empire	
		Ravalli	St. Regis	
			Revett	
			Burke	
		Lower part of the Belt Supergroup	Prichard	Upper
	Lower			
		----- Base not exposed -----		
Paleo-proterozoic	Pre-Belt crystalline rocks			

Formation	Member	Bed	Presence of mineralization	Deposits	
Revett	Upper	Upper quartzite	—	Troy, Niagara	
		Upper siltite	—		
		Middle quartzite	—		
		Lower siltite	—		
		Lower quartzite	—		
	Middle			—	Troy, Snowstorm
				—	
	Lower	A		—	Rock Creek, Montanore, Missoula, National, Trout Creek, Vermilion River
		B		—	
		C		—	
D			—		
E			—	Troy, J-F	
F			—		
G			—		
H			—		

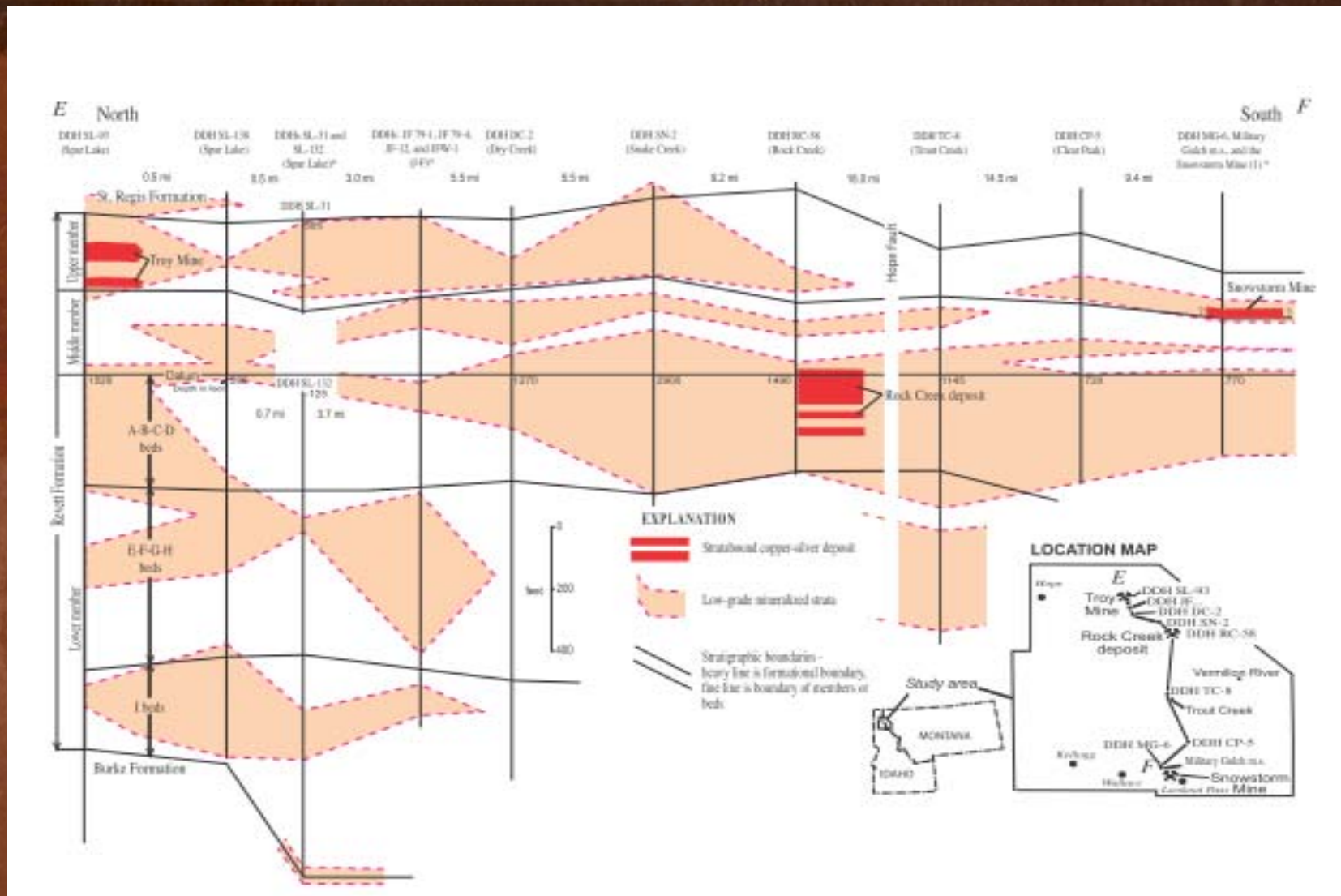
Presence of mineralization: Solid vertical line, deposit; dashed vertical line, low-grade mineralized strata

Deposits: (historical producers are italicized), production from veins

From Boleneus et al, 2005



Regional Revett Stratigraphy



From Boleneus et al, 2005

Deposit	Production			Remaining resource		
	Ore (10 ³ tons)	Copper (tons)	Silver (tons)	Ore (10 ³ tons)	Copper (tons)	Silver (tons)
Rock Creek -----	---	---	---	181,000	1,367,000	13,000
Montanore -----	---	---	---	150,000	1,170,000	10,300
Troy-----	33,742.5	194,652	1,516.3	12,000	78,000	580
Others -----	826.6	27,585	141.1	63,000	342,000	1,960
Total -----	34,569.1	222,237 (444.5 million lb)	1,657.4 (48.3 million troy oz)	406,000	2,957,000 (5,900 million lb)	25,840 (754 million troy oz)
Total (t)-----	31,361,600	201,610	1,503.6	368,000,000	2,682,545	23,442

From Boleneus et al, 2005

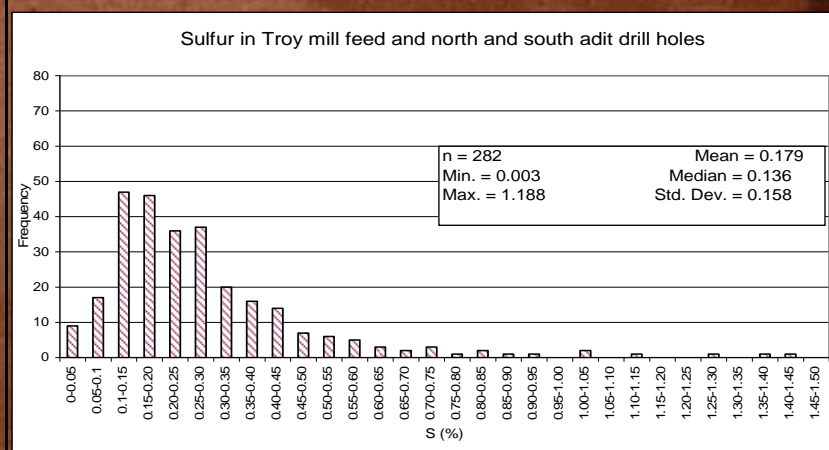
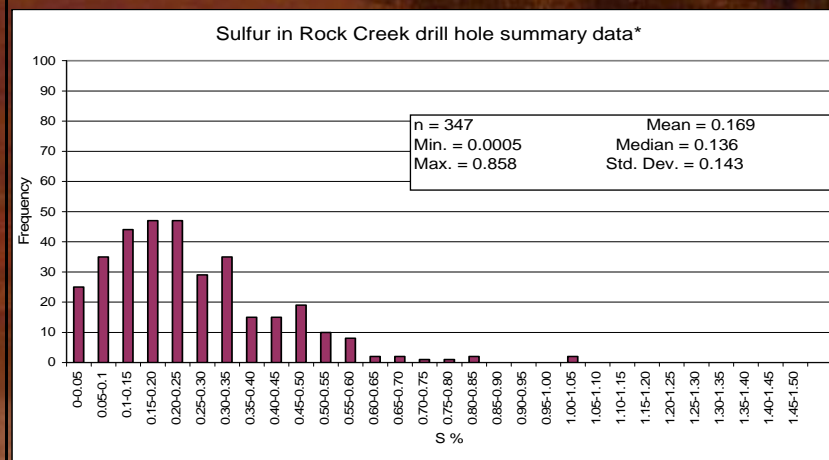
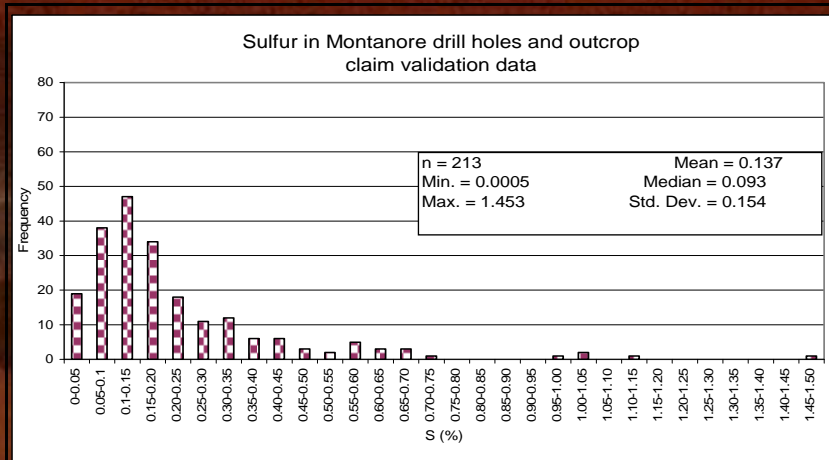
Troy
Rock Creek
Montanore

Revett Cu-Ag
Production in
NW Montana

Troy as an analog for Rock Creek/Montanore

- Assayed Cu
- Chalcocite, Cu_2S
Cu:S 2:1

Ore zones at Troy and Rock Creek cannot be distinguished from one another at >90% confidence interval based on assayed Ag



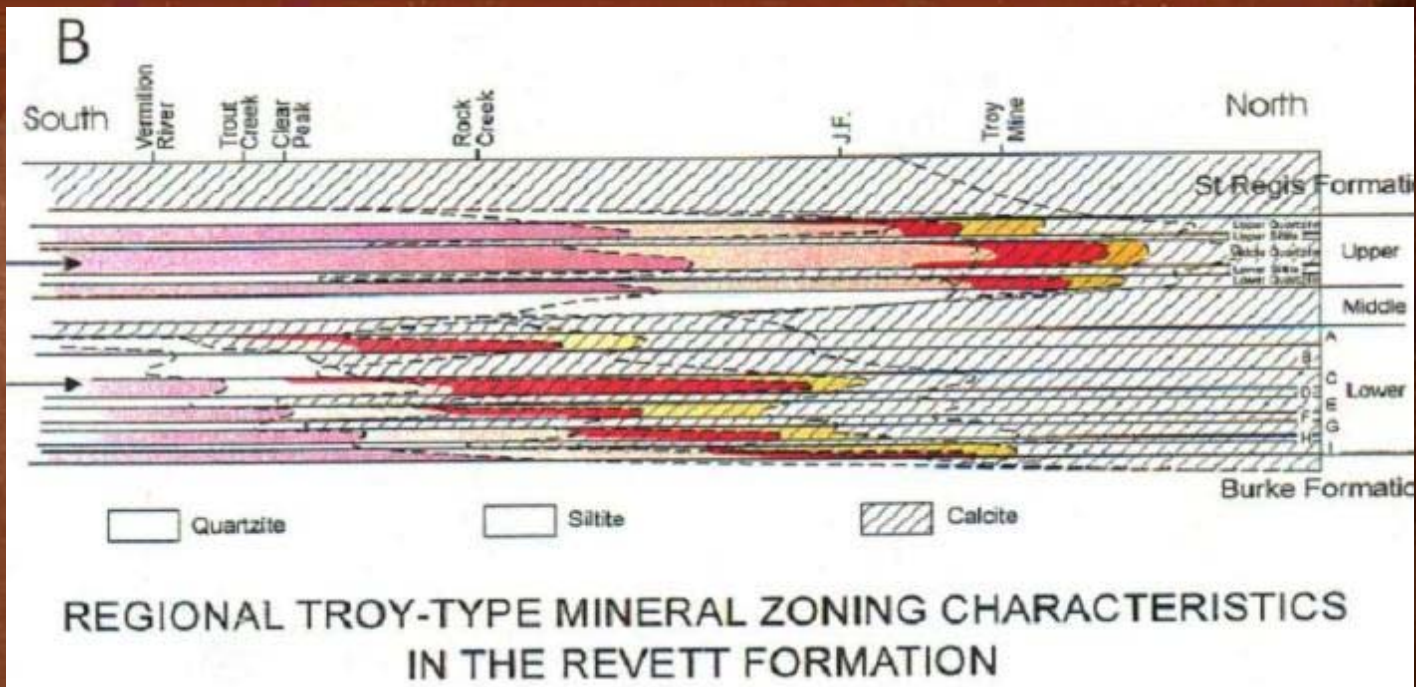
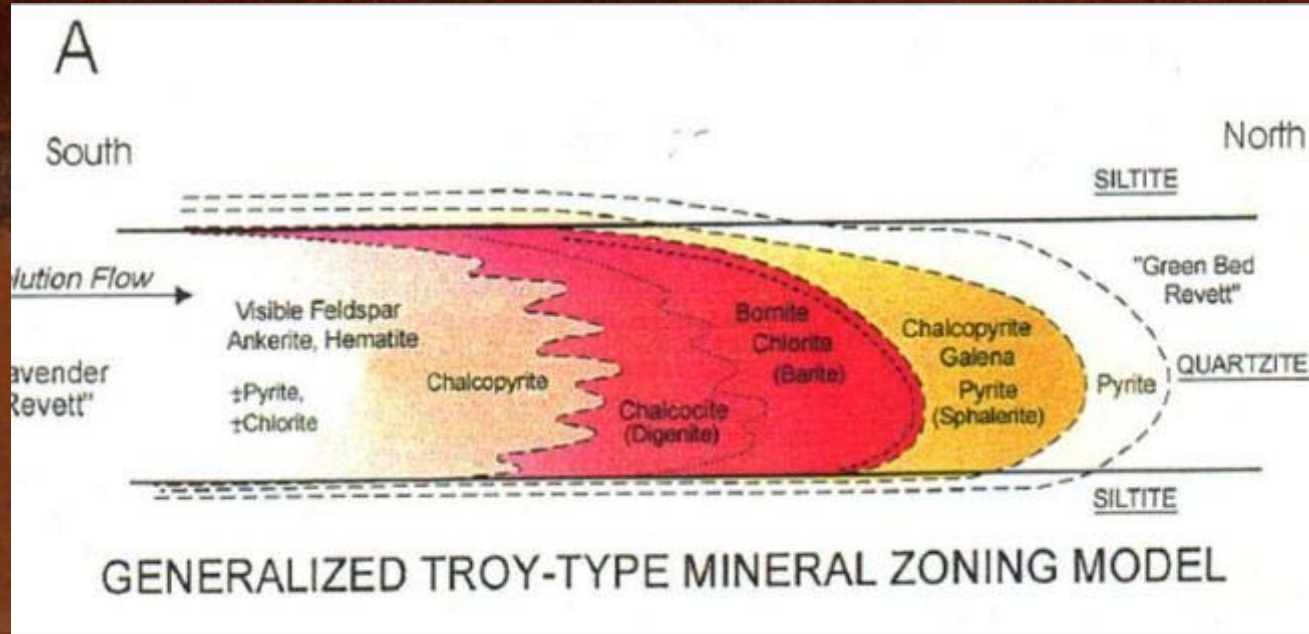
Revett Cu-Ag Sampling

	ROCK CREEK			TROY MINE			MONTANORE			TOTAL		
	Waste Rock	Tailing	Ore	Waste Rock	Tailing	Ore	Waste Rock	Tailing	Ore	Waste Rock	Tailing	Ore
Exploration												
Channel & Surface Samples						617						617
Feet drilled	4000		3000	45000	200	11429	12000		5000	61000	200	19429
Mineralogy Descriptions	3000		1500	22500		4798				25500		6298
Assays			7255			3799						11054
Assay Claim Validation			347			282			213			842
Operations												
Water quality monitoring					100	100	adit					100
Daily assay - Cu, Pb, Ag					12,000	12,000						12000
Pre-2002 Documents												
Static ABA	12	1 (1^)	23		4	16	121	1	35	133	6	74
Whole Rock/Total metals	13 (3^)	1 (1^)	24	1	4	16	60	1		74	5	40
EP Toxicity	3		1		1					3	1	
SPLP 1312			1		1						1	
Metallurgical Testing		1						1			2	
Kinetic Testing			1									
2003 Analyses												
ABA/Tot S	14	13	11							14	13	11
Whole Rk/Metals	14	13	11							14	13	11
SPLP select metals	14									14		
Mineralogy	2		11							2		11
2010-2012 Analyses												
ABA/Tot S				2		12				2		12
Whole Rk/Metals				2		12				2		12
SPLP select metals			1	2		2				2	1	2
Kinetic Testing			1			2					1	2
Mineralogy			3								3	

Collectively, good overall coverage in spite of lack of access for further sampling below wilderness



Ore



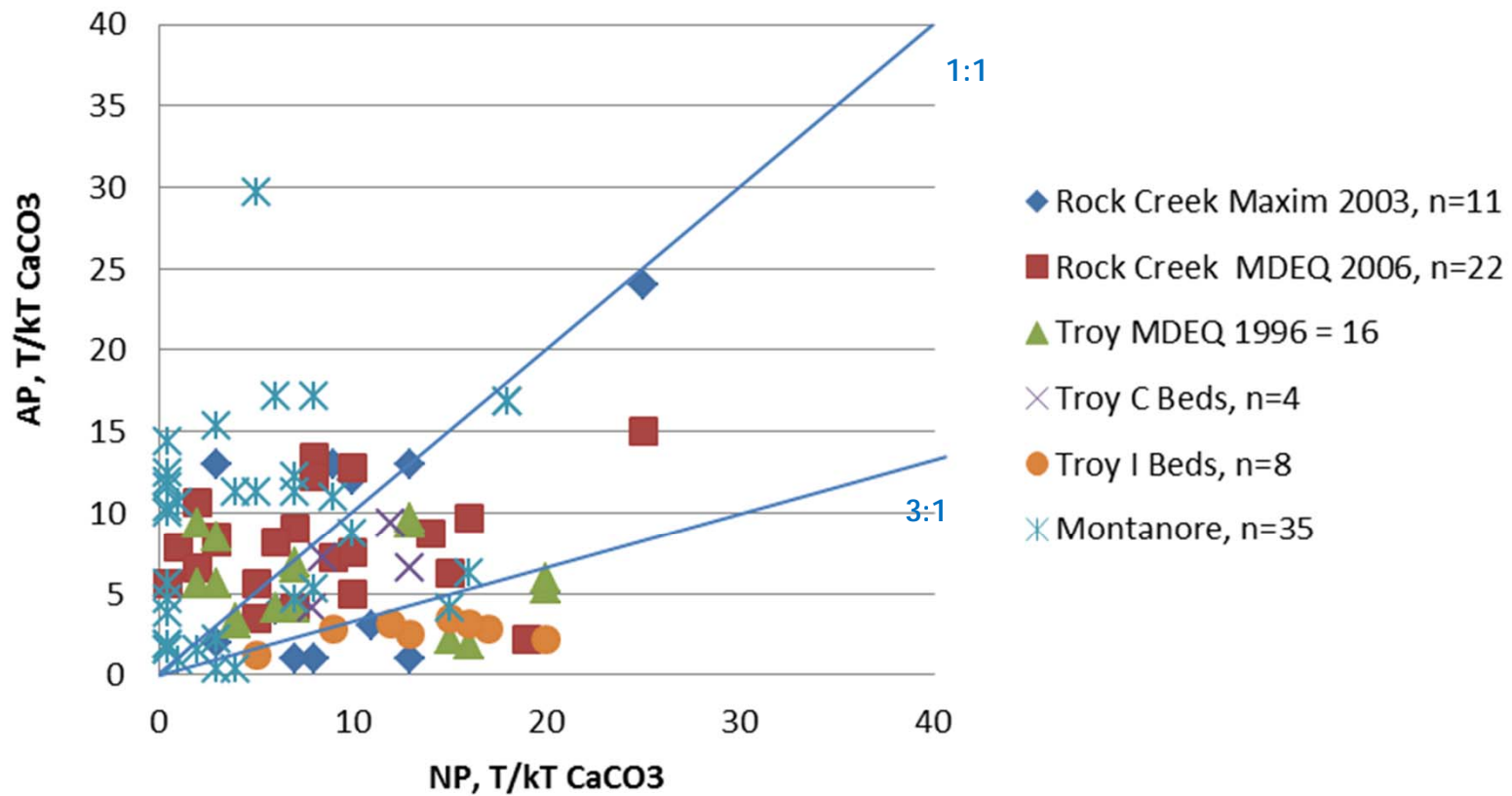






ORE - Acid Base Potential

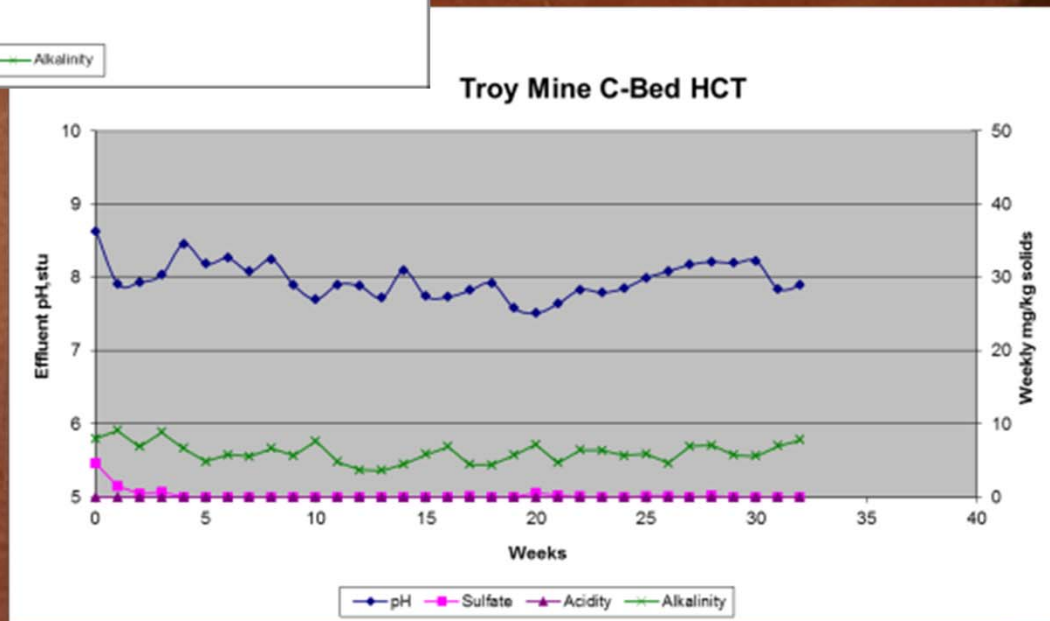
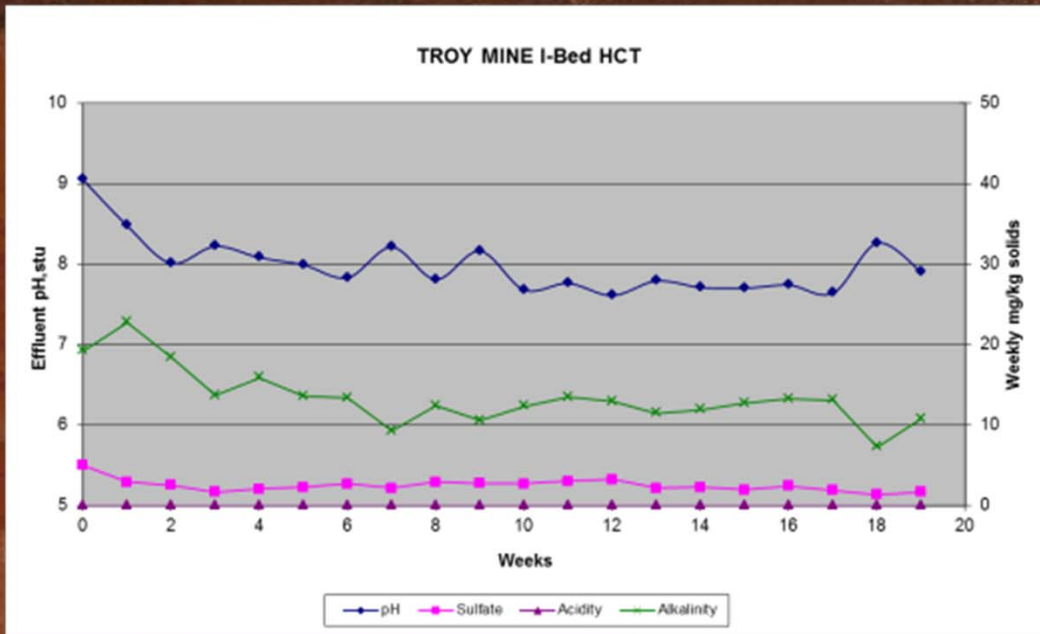
Revett Ore NP v. AP



Ore – Kinetic Data

Humidity Cell Test

$NNP = -14.5 \text{ T/KT CaCO}_3$
 Final pH 6.9
 Low SO_4
 Available alkalinity



Troy adit,
 underground pH
 between 7 and 8

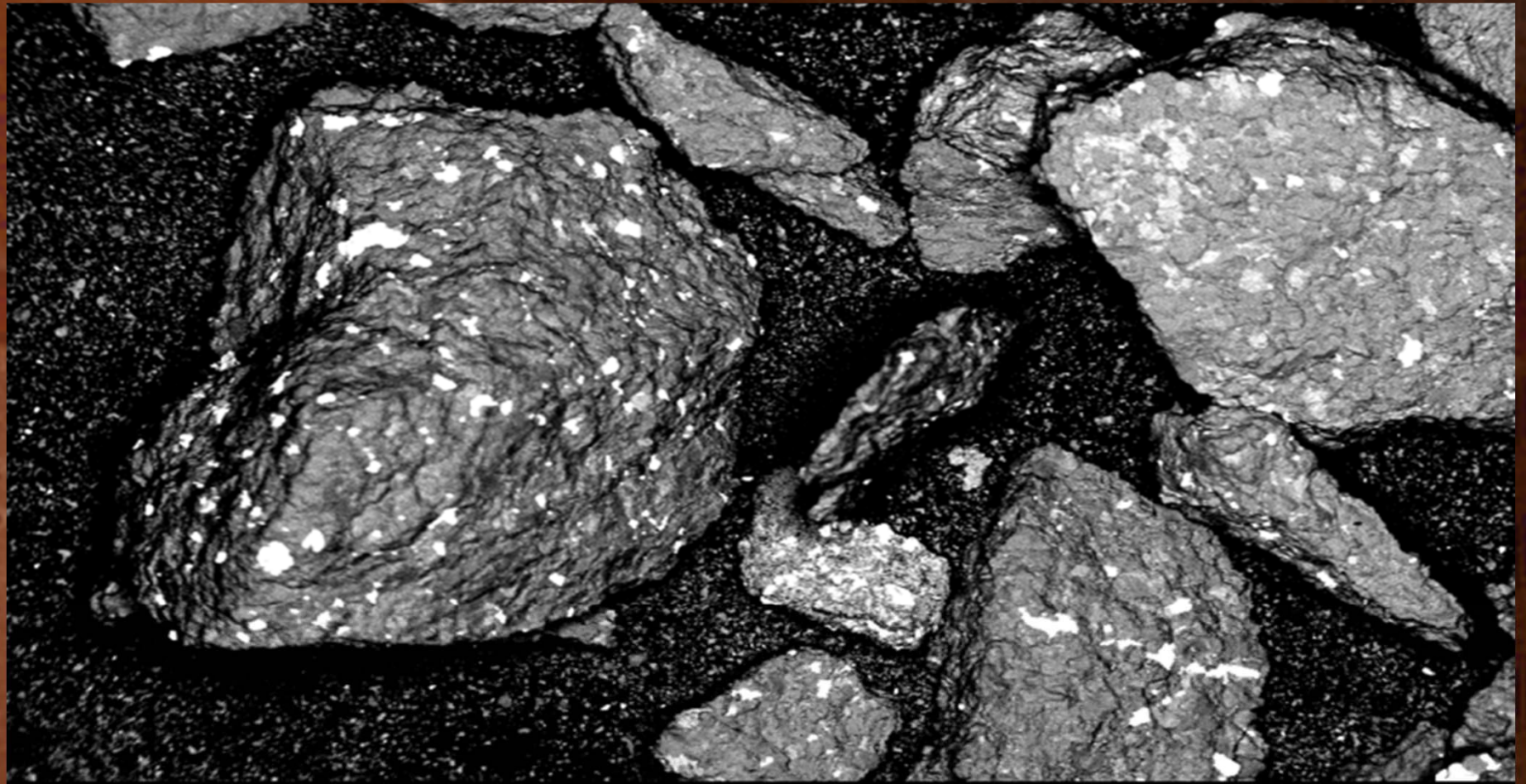


Why the difference between static and kinetic results

- ABA assumes all sulfide is pyrite, an acid generating sulfide
- Mineralogy indicates that Revett-style ore is non-acid generating chalcocite, bornite, and digenite
- Encapsulation of all sulfides



Static Test Data misrepresent Revelt-style Cu-Ag ore



1/31/03 x19 WD39 15kV

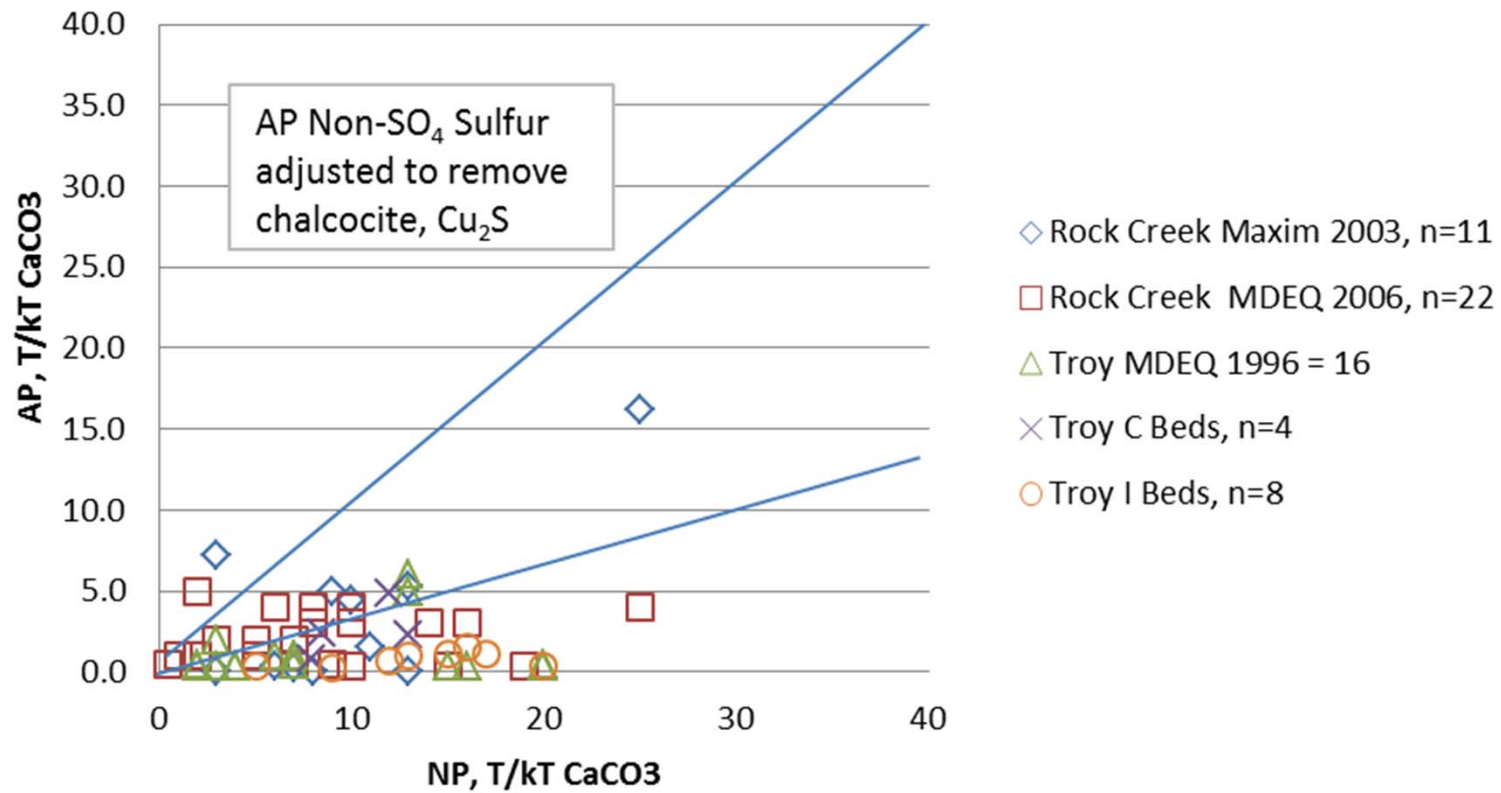
(s) +4H*

Maxim 24

— 1 mm —

Removing Cu Sulfide

Revett Ore NP v. AP Adjusted for Cu Sulfide



Metals - Troy C and I beds with monitoring from adit

Analyte	Troy Mine I-Bed Extract			Troy Mine C-Bed Extract				Reporting Limit mg/L	MT WQ Standard (groundwater) mg/L	MT WQ Standard (surface water aquatic life) ** mg/L	MT WQ Standard (surface water human health) mg/L	Troy Adit	Troy Adit	Troy Adit	Troy Adit total
	Week 0	Week 20	Week 22	Week 20	Week 24	Week 28	Week 32					Oct 2008	Pipe May 2009	Ditch May 2009	
Aluminum	0.07	0.05	0.06	<0.03	<0.03	<0.03	0.11	0.03	none	0.087		<0.05	0.09	0.06	0.7
Antimony	0.006	0.04	0.029	0.024	0.017	0.017	0.018	0.003	0.006	0.0056		0.012	0.015	0.008	0.014
Arsenic	0.007	0.003	0.002	<0.003	<0.003	<0.003	<0.003	0.003	0.01	0.15	0.01	0.001	0.002	0.001	0.004
Barium	0.034	0.106	0.129	<0.005	<0.005	<0.005	<0.005	0.005	2	2		0.095	0.07	0.065	0.4
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.004	0.004		nd	<0.001	<0.001	<0.001
Cadmium	<0.00008	<0.00008	<0.00008	<0.00008	0.00194	0.00106	<0.00008	0.00008	0.005	0.000097		nd	0.0022	0.00087	<0.0001
Chromium	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.1	0.011		nd	<0.001	<0.001	0.001
Copper	0.026	0.021	0.024	0.765	2.30	1.40	1.72	0.003	1.3	0.00285		0.045	0.041	0.084	0.64
Fluoride	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4	4		nd	<0.1	<0.1	nd
Iron	<0.05	<0.03	<0.03	<0.05	<0.05	<0.05	0.08	0.05	0.3*	1		<0.03	0.05	<0.05	1.11
Lead	<0.0005	<0.0005	<0.0005	0.0007	<0.005	<0.0005	0.0032	0.0005	0.015	0.000545		<0.002	0.0021	0.008	0.045
Manganese	0.013	0.066	0.07	0.038	0.047	0.062	0.075	0.005	0.05*	none		0.3	0.163	0.312	0.34
Mercury	0.00028	0.00002	<0.00001	<0.00002	<0.00001	0.00009	0.00011	0.00002	0.002	0.00091	0.00005	<0.0001	<0.000005	0.000005	<0.0001
Nickel	<0.01	<0.005	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.1	0.016		nd	<0.01	<0.01	<0.01
Phosphorus	0.041	<0.005	<0.005	<0.005	<0.005	<0.005	0.008	0.02	none	none		0.03	0.096	0.051	0.03
Selenium	<0.001	<0.001	<0.001	<0.001	0.004	0.002	<0.001	0.001	0.05	0.005		nd	0.003	0.001	nd
Silver	<0.0005	<0.0005	<0.0005	0.0005	0.0023	0.0009	0.0023	0.0005	0.1	0.00037		nd	<0.0005	<0.0005	0.0035
Sulfate	10	5	5	2	<1	<1	<1		250	none		18	17	17	18
Thallium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	0.002	0.00024		nd	<0.0002	<0.0002	<0.001
Uranium	0.00051	0.00009	0.00009	0.00008	0.00014	0.00011	0.00015	0.00003	0.03	0.03		nd	0.0013	<0.0003	0.0015
Zinc	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	2	0.037		<0.01	<0.01	<0.01	0.02
Energy Labs#	B11101323	B12030164		B09091055	B09102104	B09112058	B09121714	dissolved concentrations in mg/L							

At Troy, Cu, Ag, Pb, Mn
Zn, Al, As, Ba sediment

Ba, Cu, Pb in TCLP



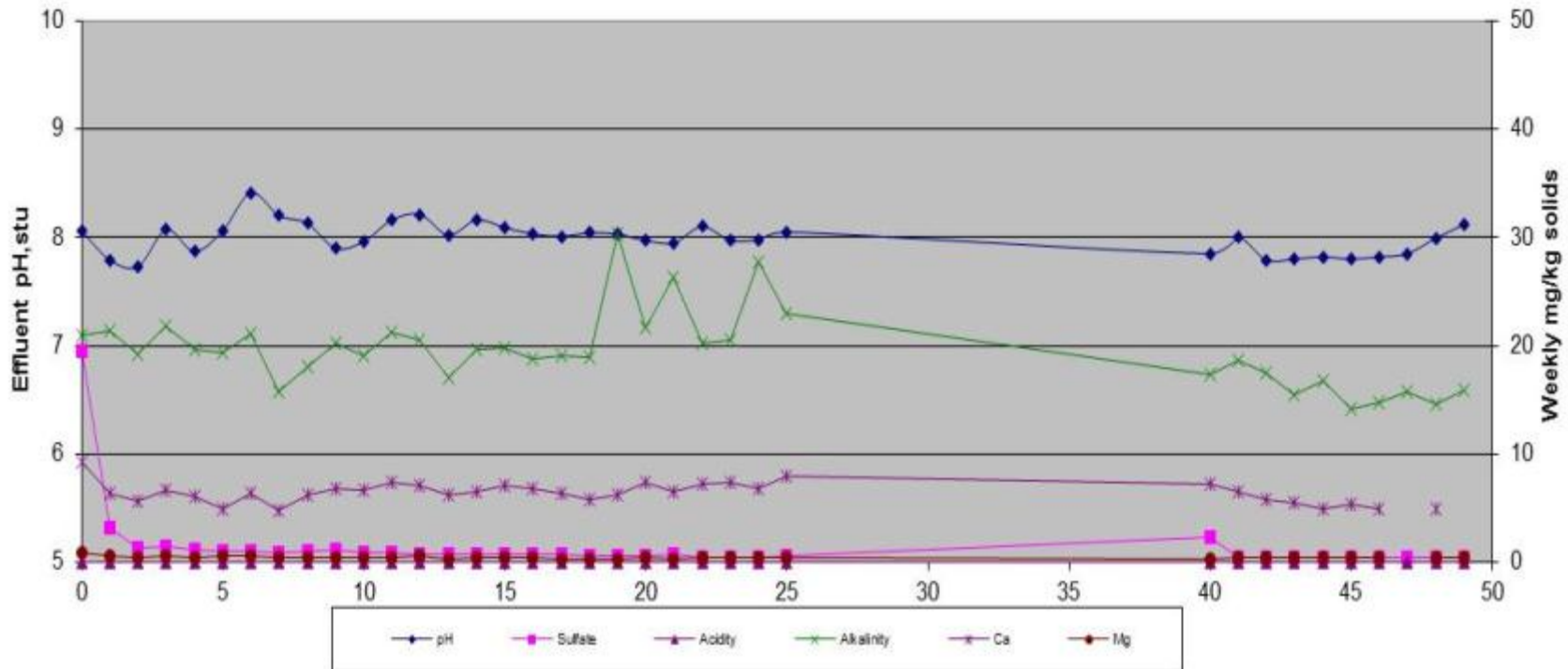
Tailing

- 88-94% removal = no reactive sulfide
- Non-acid generating NP/AP ratio
- 0.01% avg S
 - alkaline pH of 8.9 in historic kinetic test
 - Troy Tailing pond pH 7.5
- Some residual metal mobility is possible
 - HCT data Cd, As, Sb, Cu, Pb, Mn, Ag
 - SPLP tests Ba, Cr Cu, Fe, Pb, Mn, Zn
 - Troy pond Cd, Cu, Fe, Pb, Mn, Ag, Zn
- Non-degradation standards



Rock Creek Tailing HCT

Figure 1a.- Weekly Humidity Cell Analytical Results
RC Tailings Comp

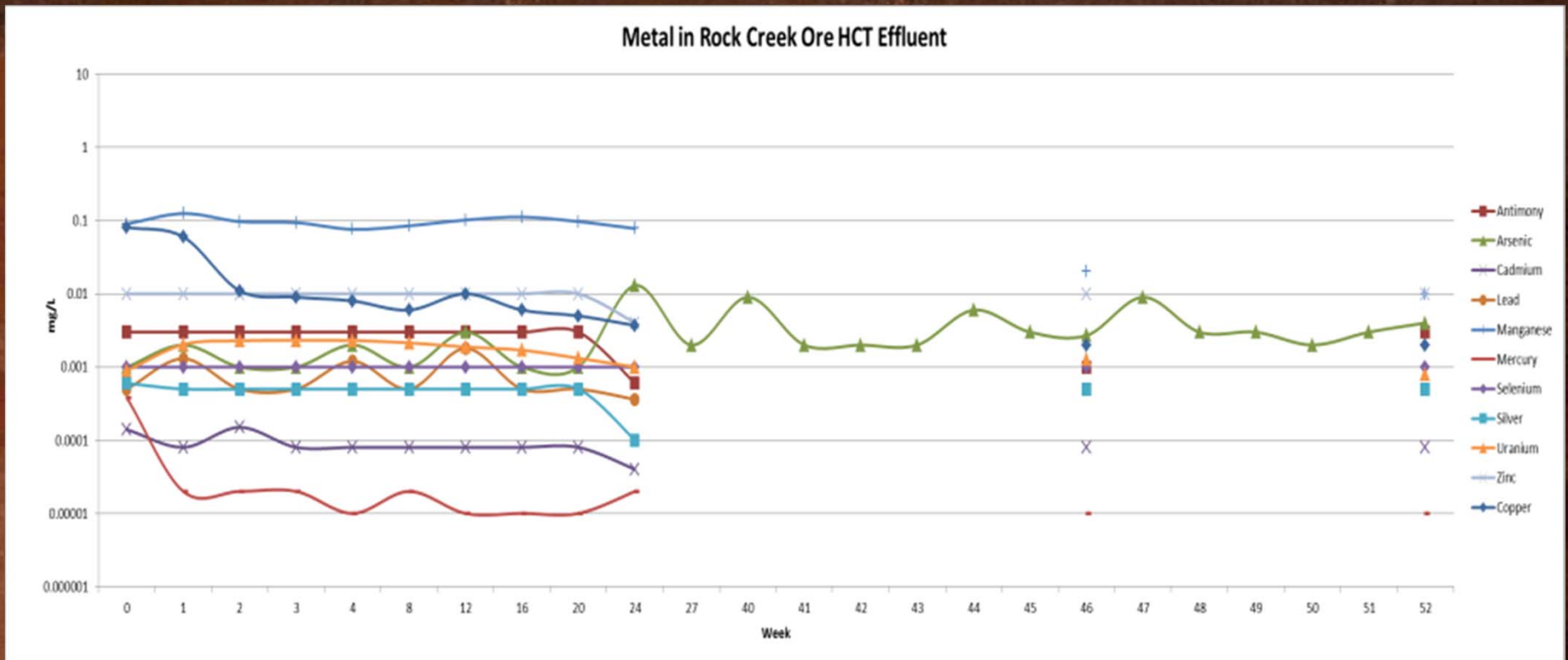


Rock Creek Tailing HCT

Analysis, mg/L	Week 0	Week 1	Week 2	Week 3	Week 4	Week 8	Week 12	Week 16	Week 20
Aluminum	<0.03	0.06	<0.03	0.04	0.03	0.05	0.08	0.06	0.06
Antimony	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Arsenic	0.001	0.002	0.001	<0.001	0.002	0.001	0.003	0.001	<0.001
Barium	0.032	0.052	0.087	0.098	0.100	0.145	0.190	0.238	0.294
Beryllium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	0.00014	<0.00008	0.00015	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008	<0.00008
Calcium	20	11	12	13	12	14	13	15	17
Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	0.081	0.060	0.011	0.009	0.008	0.006	0.010	0.006	0.005
Fluoride	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead	0.0005	0.0013	<0.0005	0.0005	0.0012	<0.0005	0.0018	<0.0005	<0.0005
Magnesium	2	1	1	1	1	<1	<1	<1	<1
Manganese	0.090	0.125	0.097	0.094	0.076	0.085	0.102	0.112	0.097
Mercury	0.00038	0.00002	<0.00002	<0.00002	<0.00001	<0.00002	<0.00001	<0.00001	<0.00001
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus	0.05	0.021	0.09	<0.005	0.006	<0.005	<0.005	<0.005	<0.005
Selenium	0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001
Silicon	3.0	3.5	2.6	3.0	2.3	2.6	2.1	2.1	2.1
Silver	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Strontium	0.064	0.052	0.061	0.067	0.074	0.076	0.069	0.073	0.074
Sulfate	39	5	3	3	3	2	2	1	<1
Thallium	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Uranium	0.00089	0.00203	0.00228	0.00232	0.00230	0.00214	0.00188	0.00170	0.00132
Zinc	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Energy Labs Report #	B11041060	B11041616	B11042148	B11050384	B11050990	B11060981	B11070407	B11080343	B11082952



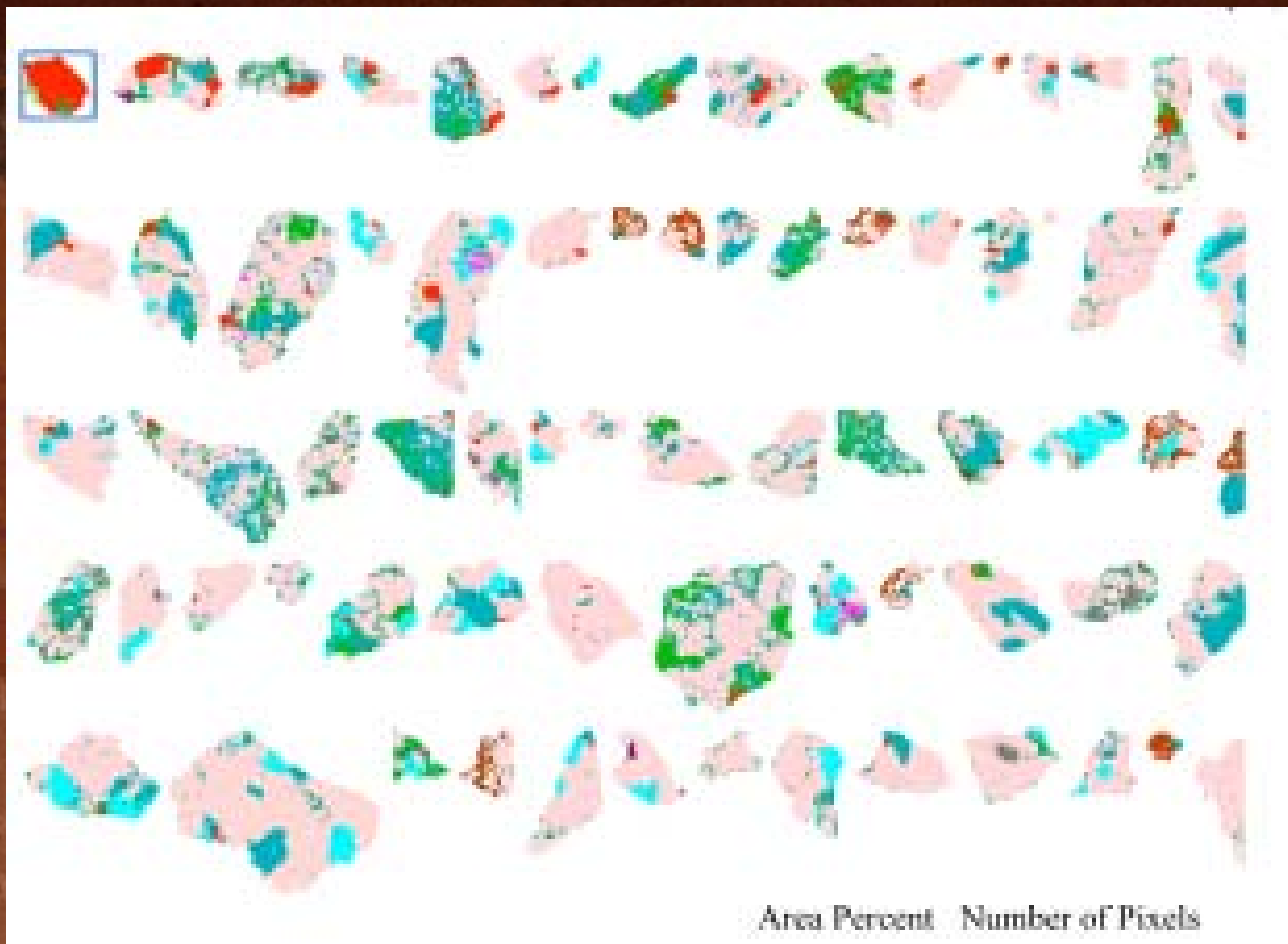
Rock Creek Tailing HCT



Later weathering of tetrahedrite – As release

Extending test,
mineralogy confirmation of As, Sb residence



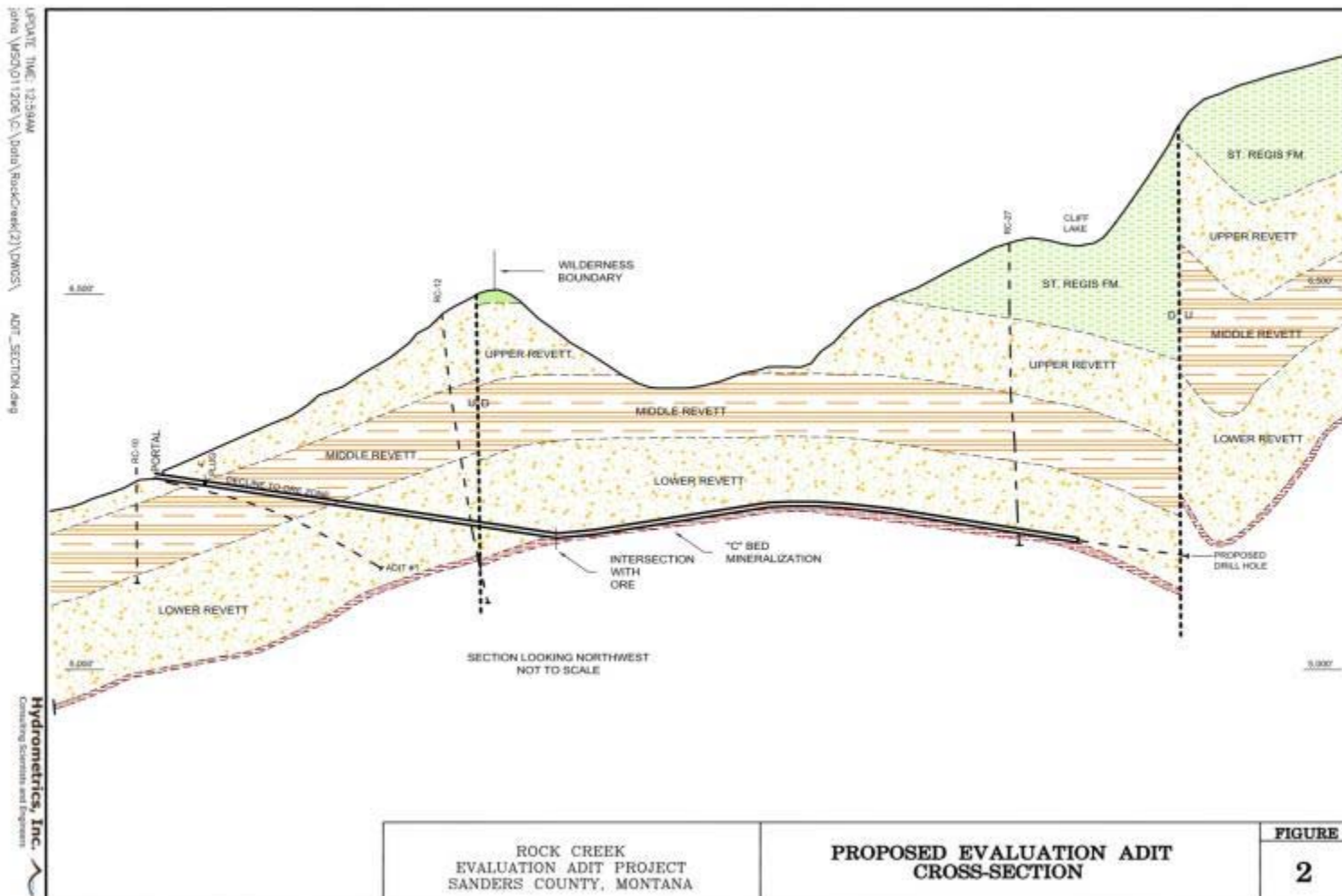


QEM Scan of Tailing from Troy

Carol Russell, EPA

Mineral Name	Area Percent	Number of Pixels
Quartz	42.2	278773
α-FeOOH	15.7	10306
Fe-silicate_Alnite	6.8	4448
Muscovite	6.2	4072
Iron_sulfide_hydroxide_sulf	2.1	1397
Others	1.8	1197
Accessory minerals	1.2	787
Background	1.2	787
Sulfides	0.8	526
Selenite	0.8	526
Cu trap	0.6	394
Chalcopyrite	0.2	136
Cu-sulfide malachite border	0.0	0
Covellite	0.0	0
Pyrite	0.0	0
Chalcocite/Digenite	0.0	0
Selenite	0.0	0
Complex Ag-sulfide trap	0.0	0
HSR	0.0	0
Cu-sulfide trap	0.0	0
Selenite	0.0	0
Selenite (Fe flux)	0.7	459
Selenite and other selenates	0.8	526
Trace phases (misc silic, silic)	0.2	136
Sr-bearing minerals	0.1	63
Copper oxides, sulfates, silic	0.1	63
Baite	0.1	63
Chlorite	0.0	0
Selenite and other selenates	0.0	0

Waste Rock



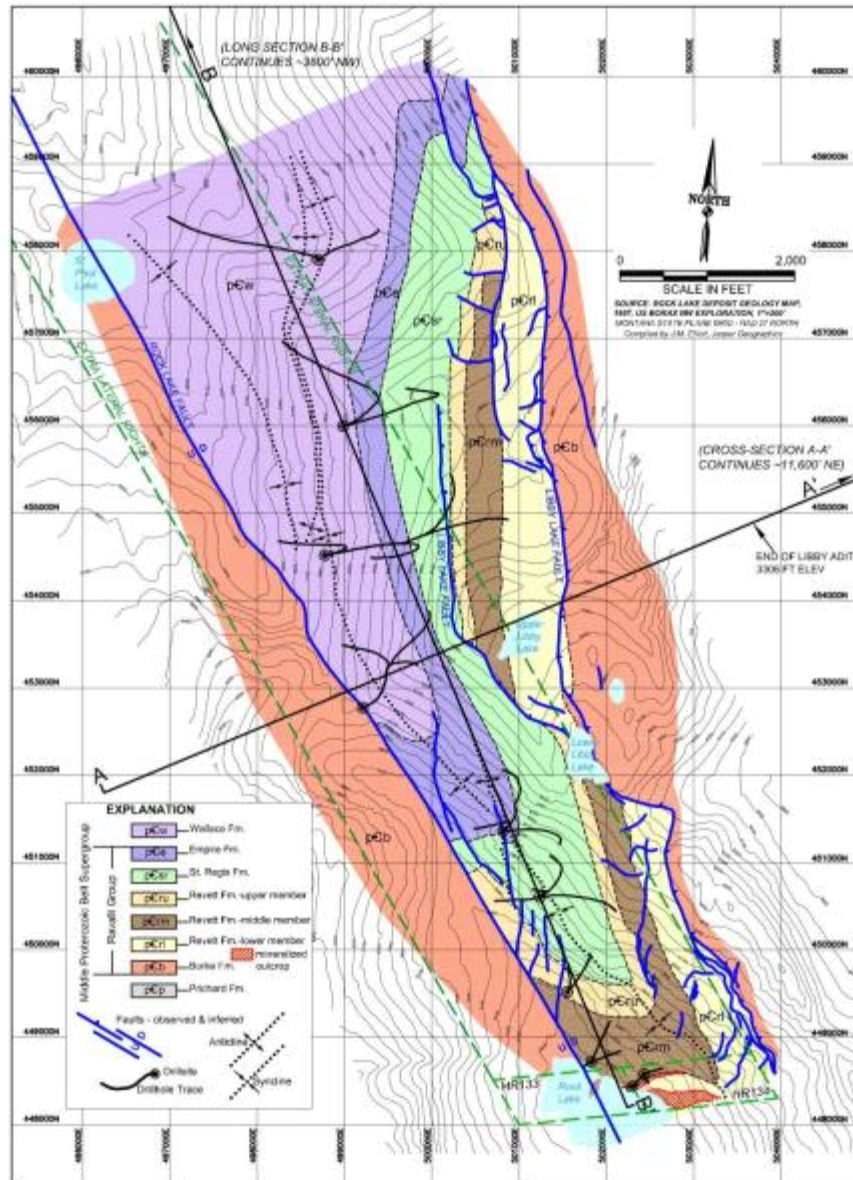


Figure 61. Bedrock Geology of the Rock Creek-Montanore Deposit

Rock Creek Montanore Deposit

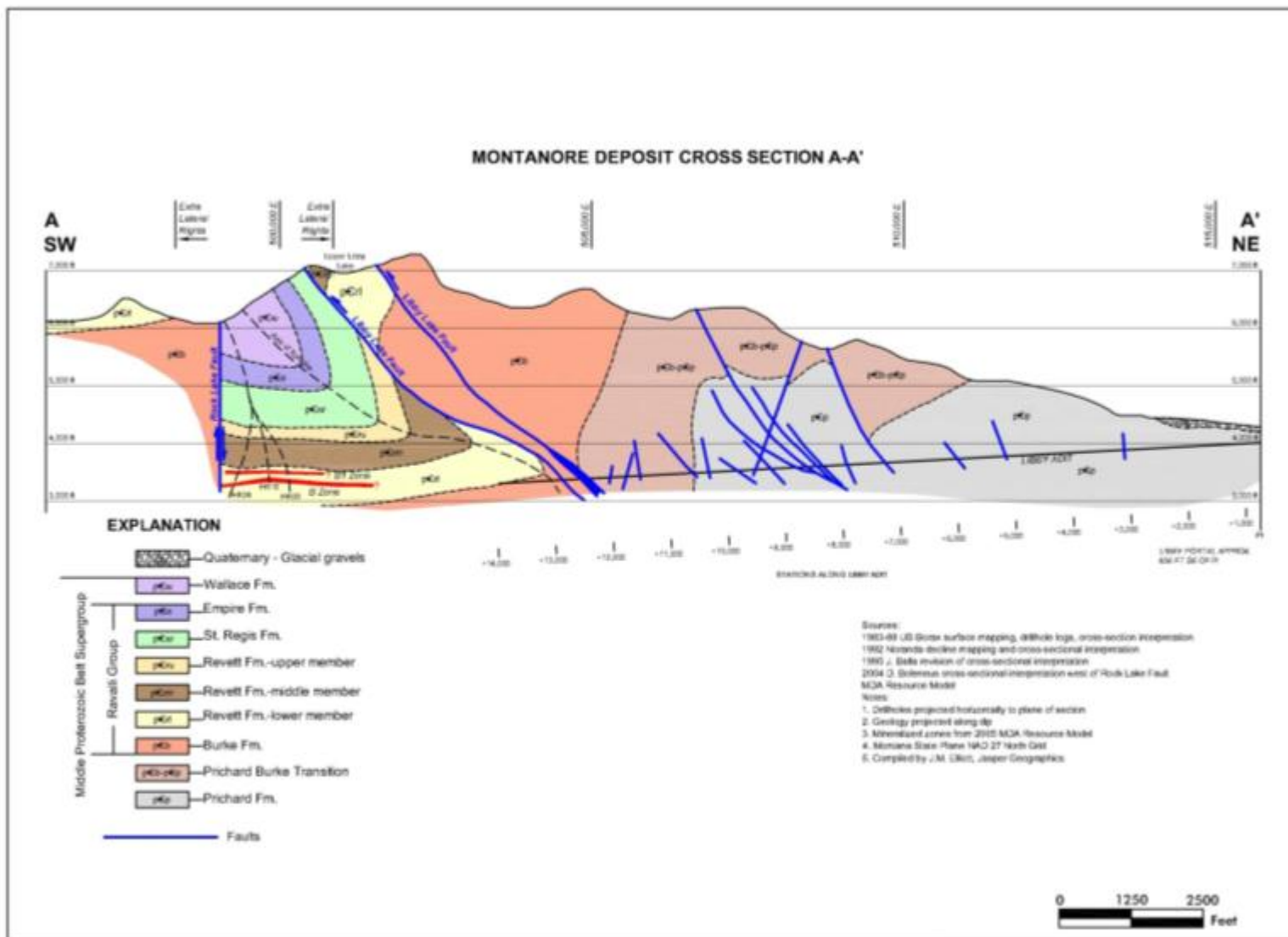


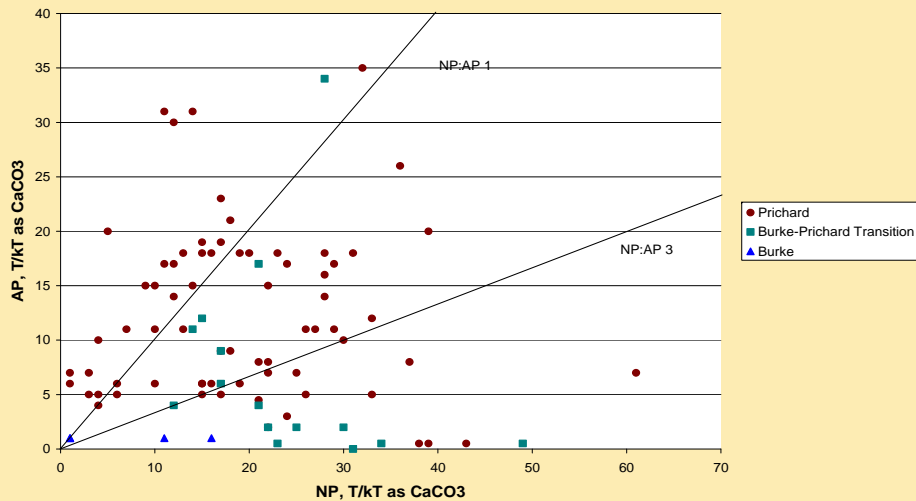
Figure 62. Geologic Cross Section-Libby Adit

Waste Backfilled Stopes



Waste Rock

ABP for Libby Adit Samples by Lithology



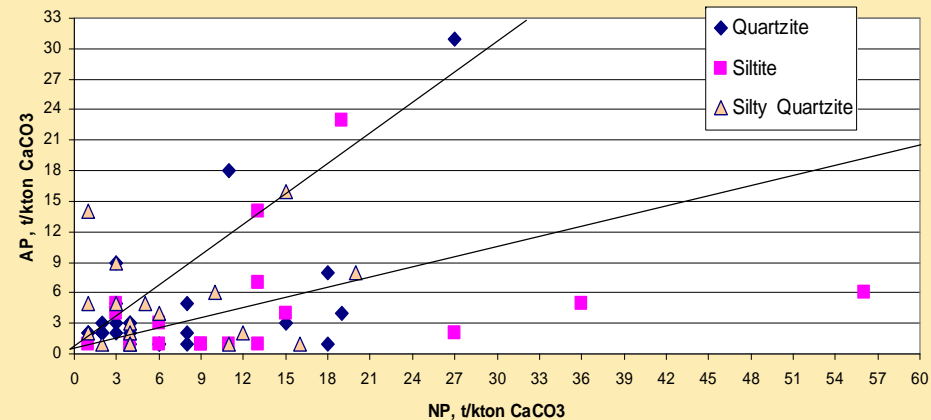
Montanore Kinetic tests

Prichard	pH 8.9	As, Fe, Mn, Zn
Revett	pH 8	Ba, Cu, Pb, Mn
Barren Pb	pH 6	Pb, Mn, Zn

Libby Adit
pH 8.0 to 8.4, avg. 8.2
As 1 ppb

Waste Rock Sump
As – 6 to 58 ppb
Median 15 ppb

Montanore
Revett Waste Rock ABP



Conclusions

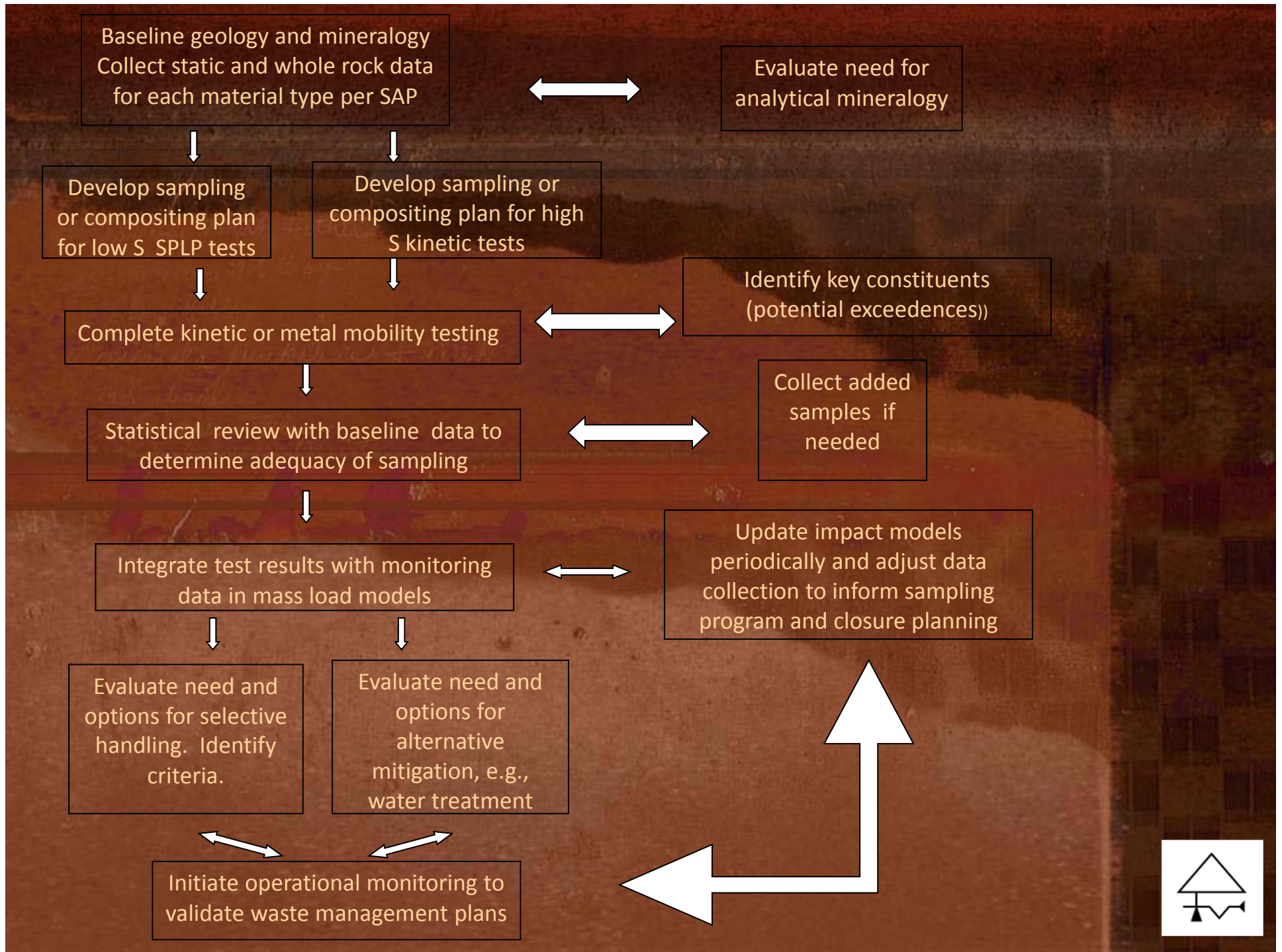
- A lot is known, more can be learned
- Negligible ARD risk
- Low levels of metal release
 - Sensitive water resources
 - Must meet non-degradation standards
 - Plans for collection and water treatment
- Sufficient data for NEPA analysis with additional data collection
 - Evaluation audit and operations



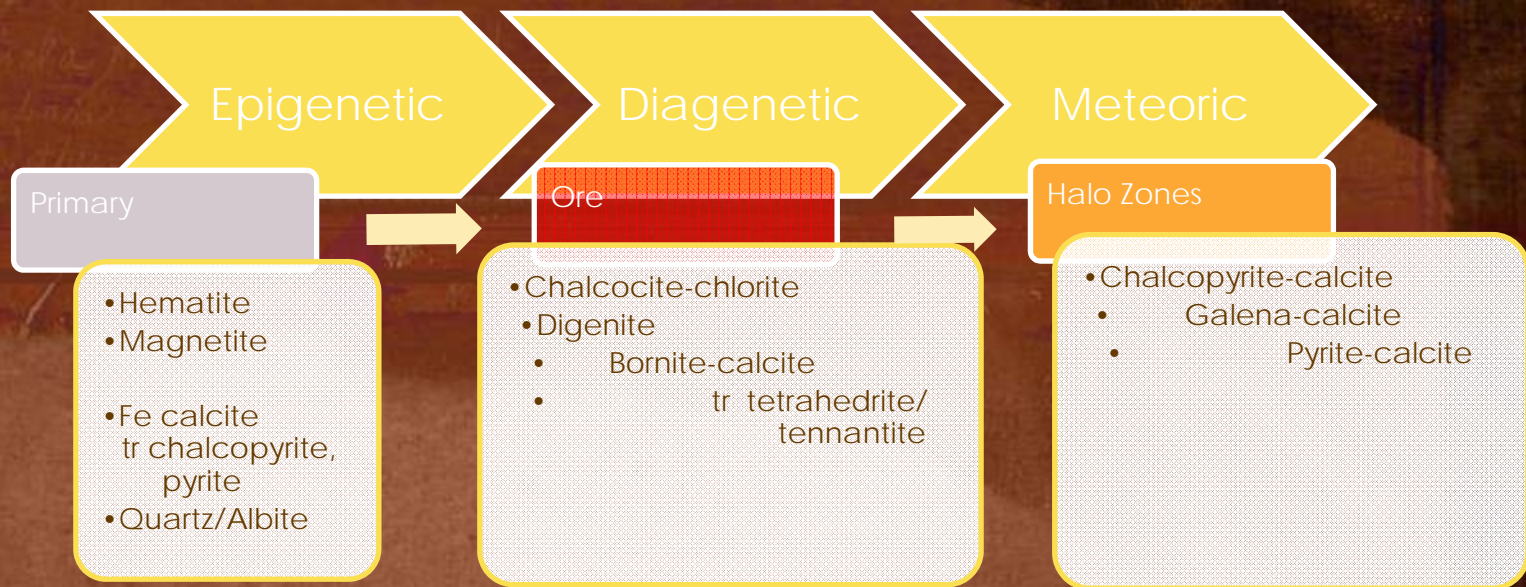
Sampling and Analysis Plans Rock Creek and Montanore

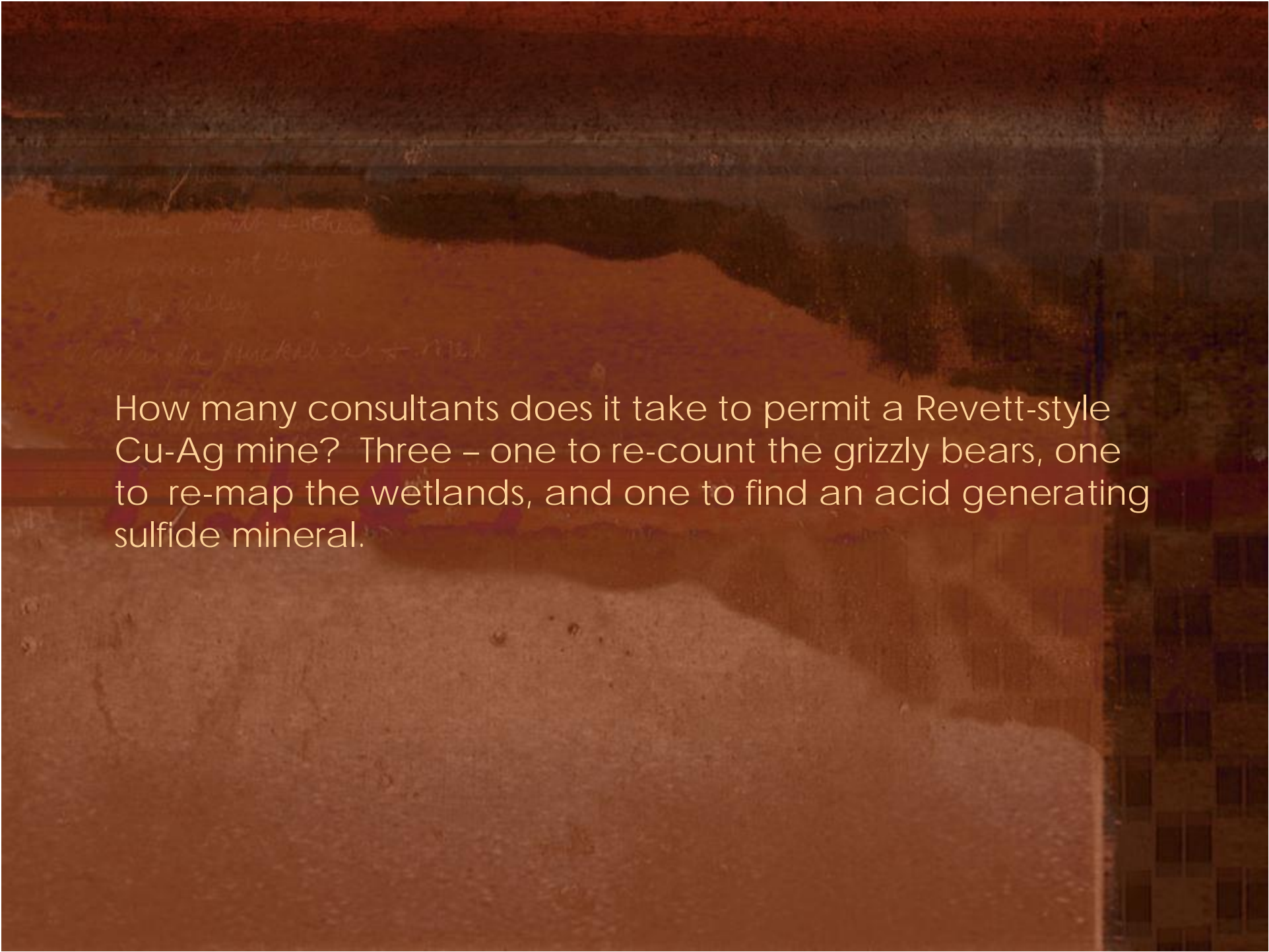
- tonnage, mineralogy, kinetic and metal mobility tests of galena, chalcopyrite and pyrite calcite waste rock halos
- Kinetic test for Revett ore and tailing when representative bulk composite is available
- Confirmation testing of Prichard, Burke, St. Regis, Wallace Fm





Revelt Mineralogy





How many consultants does it take to permit a Revett-style Cu-Ag mine? Three – one to re-count the grizzly bears, one to re-map the wetlands, and one to find an acid generating sulfide mineral.