



Exploration Geochemistry

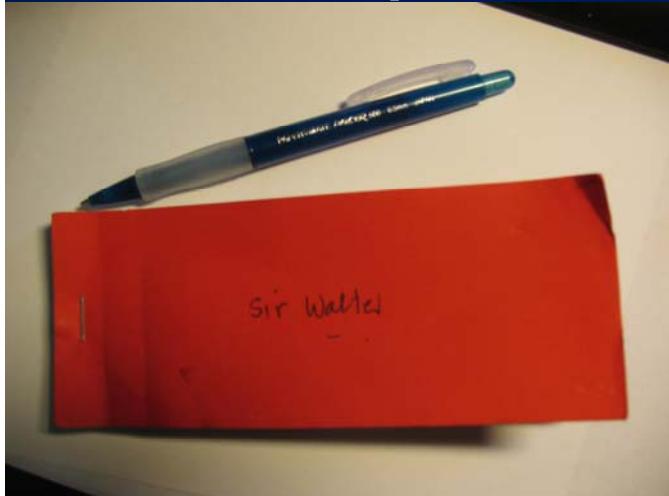
By
Richard Carver

Sample Numbering



- Basis of data management
- The sample numbers must be:
 - Unique
 - Consistent in format
 - Alpha Numeric eg TS000001
 - Note TS1 TS 1 TS000001 are not the same sample number
 - Best to start at TS100001 as this cannot be shortened
 - Do not proliferate prefixes
 - More prefixes = more management & more confusion
 - Don't use short runs eg TS0001-9999 as the prefix may quickly expire. If you then go to TS10001 you will have sorting problems.
 - Avoid characters that are confused.
 - Don't use I O in the prefixes as they are confused with 0 (zero) and 1 (one)

Sample Numbers- Ticket Books



WMC Resources Ltd.	AC 048801
EXPLORATION DIVISION	
Project.....	
Location.....	
Comments.....	
.....	
Analyse For.....	
Sampler.....	Date.....

AC 048801

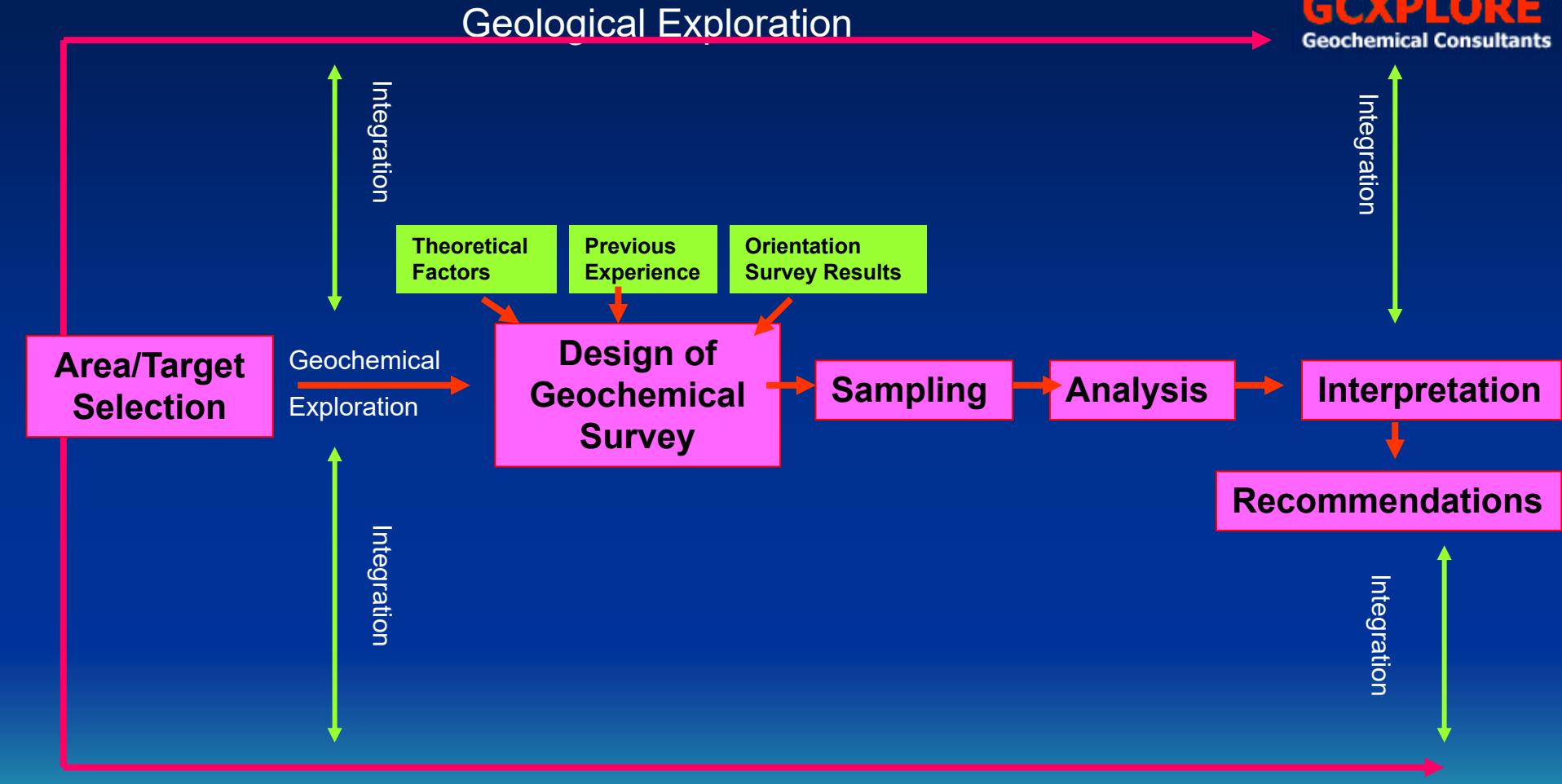
Advantages of Ticket Books

- Top down management all samples must have a sample number from a ticket book
- Fixed structure
- Lists are easy to check
- Lists are easy to describe
 - Eg KG100022-KG100157 , KG100196-201
- Errors in sample numbers reduced in for electronic data management
- The insertion of quality control samples is easy to manage.

Elements of a Geochemical Survey

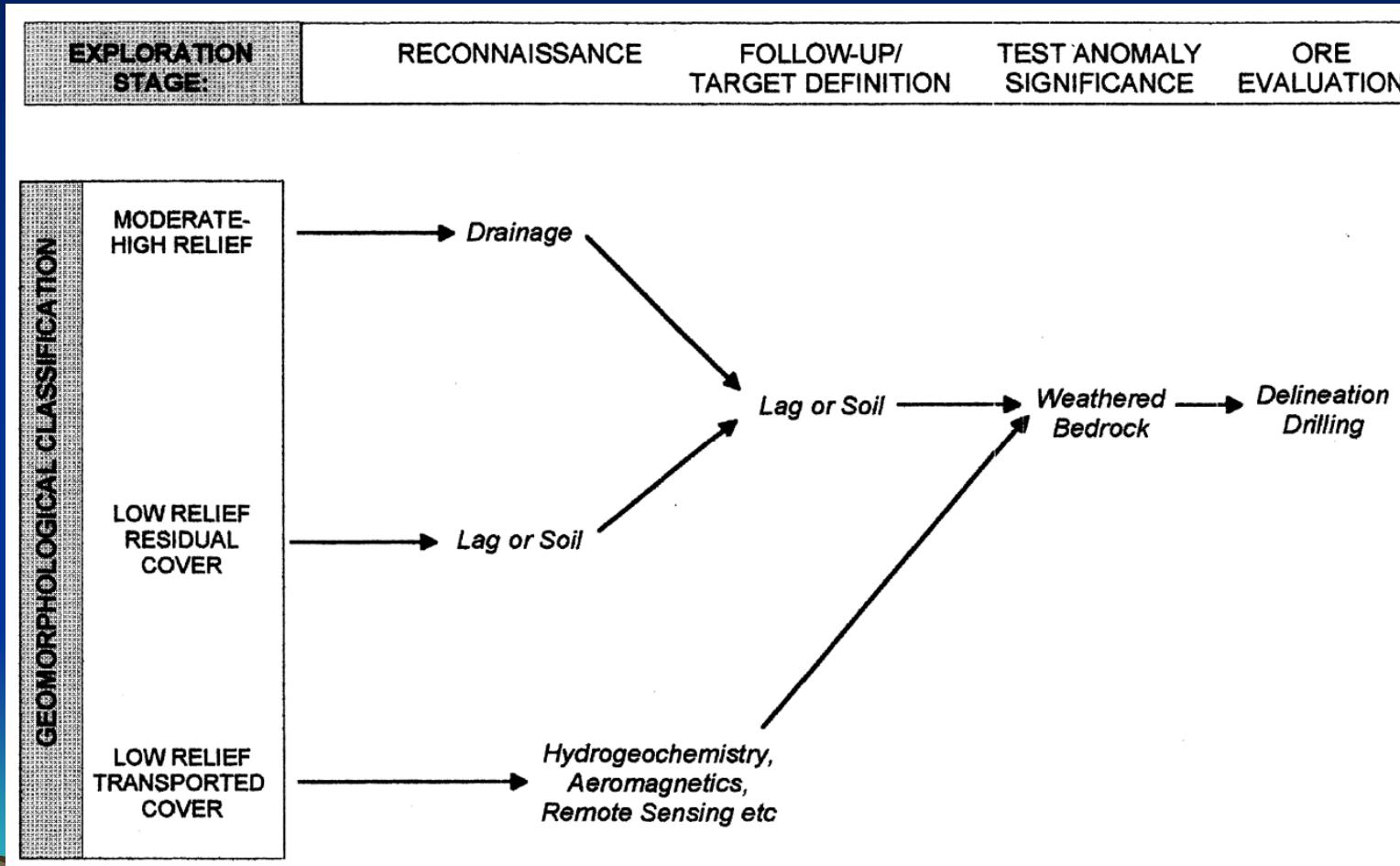


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After Mazzucchelli

The Process



Sample Media



- Stream Sediments
- Soils
- Deflation Lag [Coarse Fraction Surface Swept Soil]
- Vegetation
- Rock Chip
- Trenching
- Geochemical Drilling
 - Auger/Vacuum
 - Air Core



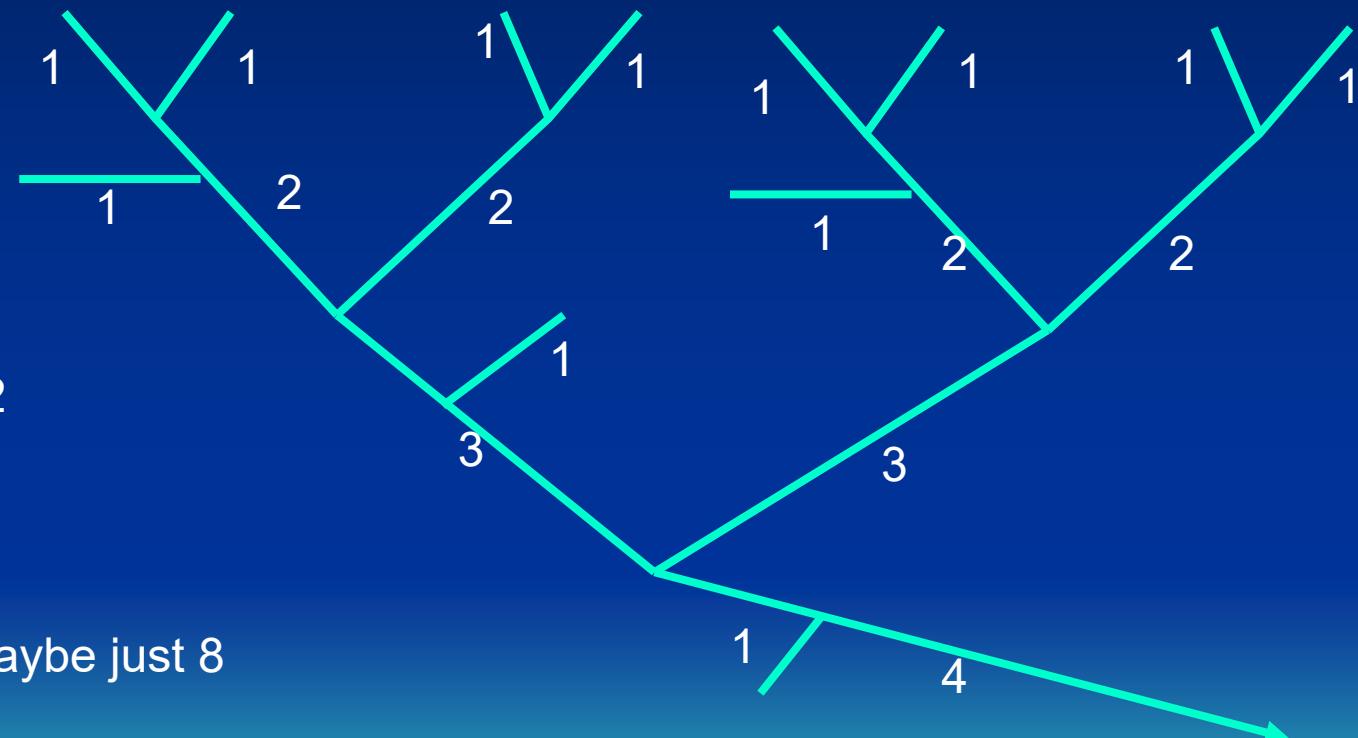
Stream Sediment Sampling



- Preferred reconnaissance technique in well drained terrains.
- Requires higher level of training than soil sampling
- Detailed (>5 samples / squ km) maybe more effective than recce soils in seeing beneath shallow dissected cover.
- A 'stream' maybe just a 'rill' or a depression containing transported material



Stream Sediments Stream Orders



Notes:

$$1+1=2$$

$$2+2=3$$

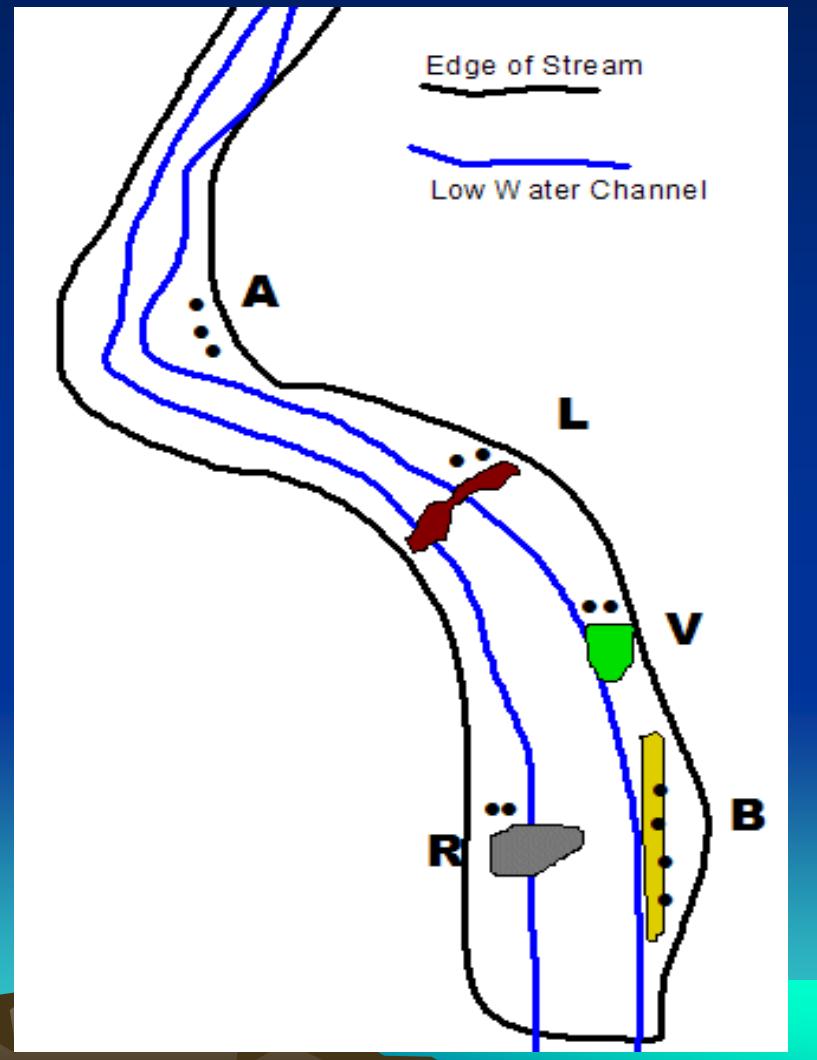
$$3+3=4$$

Nile maybe just 8

Stream Sediments

Fine Fractions Stream Samples - Target Locations

- **A** – Inside of a bend
- **L** – In the shadow of an obstruction such as a log
- **V** – Behind vegetation clumps or trees in the stream course.
- **R** – Behind rocks
- **B** – On beaches above the main water level. This material is deposited from the turbulent mud water when the stream is at higher levels. Care needs to be taken with this material that it is deposited from the stream and not an input from material coming in from the side of the stream. In very large streams this is your overbank sediment but it is found in streams of all sizes.
- Target finest material
- Avoid heavy mineral traps to avoid nugget anomalies of gold and detrital elements (Sn etc)
- In very small streams take the sample from 2 or 3 locations. In larger streams use 4 or 5.



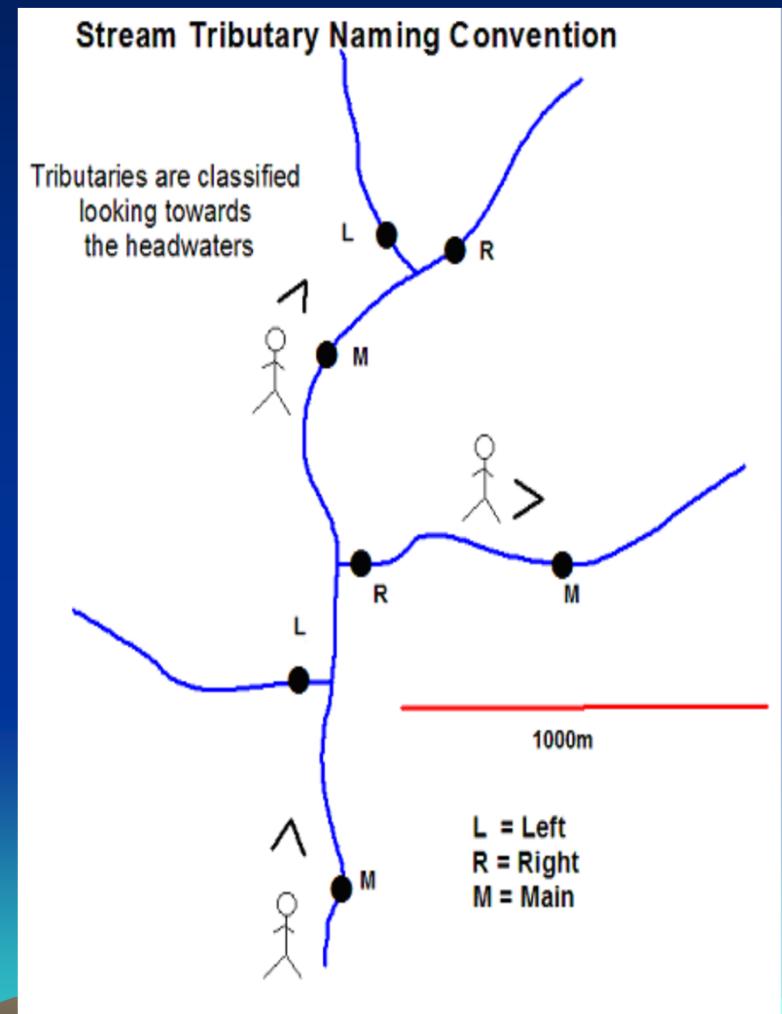
Stream Sediments



Tributary Naming Convention

Left-Right-Main stream convention
[L-R-M]

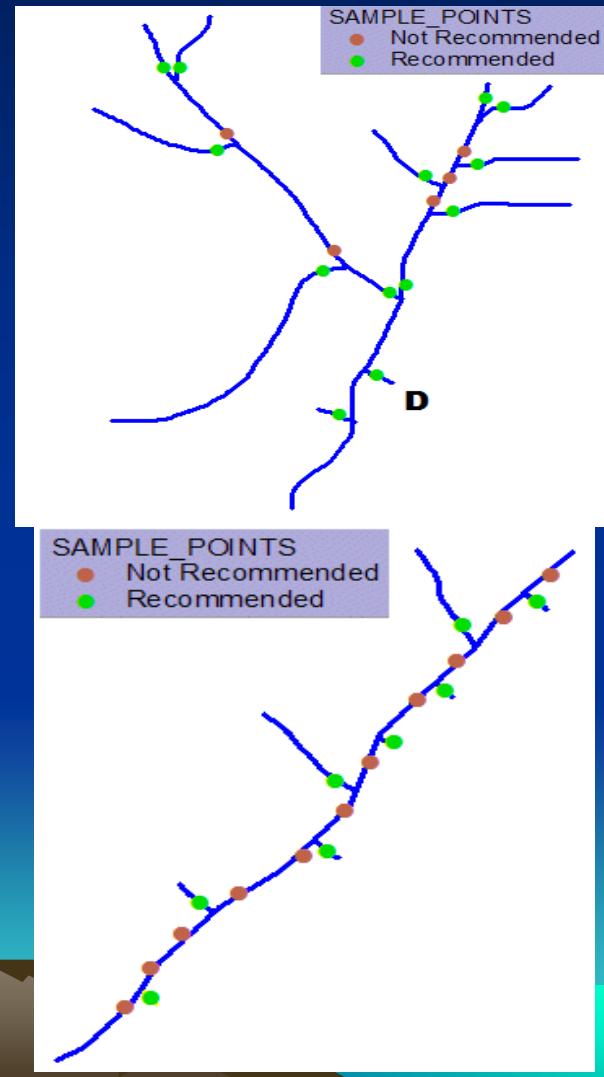
- This is necessary because the GPS data however accurate will not tell you which tributary the sample was taken from. The location of the sample can also be marked on a sampling map as the samples are collected but using this protocol keeps this information with the digital data.
- The classification is always made looking up stream in the major stream.



Stream Sediments

- Minimise the number of 'main stream' (brown dots in the above diagram) samples.
- Avoid collecting samples from larger streams as the dilution is too high and the signal is lost
- Once the main stream gets very large there are often long sections with out any significant tributaries. The area D is used in the above diagram to illustrate this situation

- In follow-up or more detailed work don't collect samples at small intervals down the main channel.
- Sampling down the channel is often shown in older text books but it is much better to find tributaries /rills or landslide material on the sides of the stream than to take multiple samples up the stream.



Soil Sampling



- Sampling Grid
- Mesh Size
- Sample Depth
- Assays
 - Element List
 - Digestion Method(s)

Mesh Sizes



Fine Fractions

- -75u , -63u [Very Difficult to Sieve in Field]
- -125u
- -200u [Traditional Geochemistry Fine Fraction]

- Targeting clays
- No preparation required
 - Reduced Cost (-\$US 2-4)
 - No contamination from pulveriser.

Intermediate Fractions

- -400+200u [Sand]

- Targeting sand
 - Maybe OK for detrital minerals
 - Massive quartz dilution
 - Promotes 'gold' nuggets

Coarse Fractions

- -2mm + 400u
- -6+2mm Fraction [Deflation Lag]

- Targeting rock or laterite fragments
 - Fe collects Au and metals in lateritic samples
 - Removes Aeolian sand dilution

Bulk Fractions

- -2mm
- -6mm

- Lazy
 - Easy to collect
 - Have to pay for preparation
 - Difficult to interpret in complex environments as the proportion clay and iron collectors and quartz sand (dilution) is variable

Soil Sampling - Grids



Soil Sampling Grids					
Soil Grid	Samples		Cost Per Squ Km		
	per squ km	per Day	@ US\$15	@ US\$20	
1000x1000		1	10	15	20
500x500		4	25	60	80
400x400		7	30	105	140
400x200		13	60	195	260
400x100		25	90	375	500
200x200		25	65	375	500
400x50		50	110	750	1000
200x100		50	90	750	1000
200x50		100	120	1500	2000
100x100		100	100	1500	2000
100x50		200	130	3000	4000
100x40		250	140	3750	5000
100x25		400	150	6000	8000
100x20		500	150	7500	10000
50x50		400	140	6000	8000
50x20		1000	150	15000	20000
100x10		1000	150	15000	20000

- samples per day (per person) based on Yilgarn / low relief savannah.
- Grids will be determined by the style of the mineralisation.
- Often a two stage approach is used>
 - Eg 400 x100 recce
 - 200x50 or 100x50 follow-up
- Note that the subtle difference of 200x40 vs 200x50 will give a 25% assay cost difference.

Deflation Lags



- Size fraction (-6+2mm or similar)
- Sample is swept or scraped from surface so requires arid terrain with minimal grass coverage
- Targets lateritic iron rich material or rock chips.



Assaying



Steps in Process

- Preparation
 - Sieving
 - Crush/Pulverising
- Digestion
 - Hot Acid
 - Alkali Fusion
 - Cold Alkali/Acid
 - Solids
- Estimation
 - AAS (Atomic Absorption)
 - Colorimetry
 - ICPOES (Induced Coupled Plasma – Optical)
 - ICPMS (Induced Couple Plasma - Mass
 - XRF (Xray Fluorescence)
 - NA (Neutron Activation)

Requirements

- Sensitivity (Detection Limit)
- Precision
- Cost
- Portability [In Field]

Assaying



- Mixed Acid Digest [Including HF]
- Aqua Regia [Nitric + Hydrochloric Acid]
- Lead Fusion Fire Assay
- Cyanide Leach
- Neutron Activation
- XRF
- Partial Digests eg MMI



Fusion Fire Assay

84 Pot Oven – ALS Johannesburg



Loading Oven – 12 Pots at a time



Pouring 12 Pots

Aqua Regia – 40 gm Digest



Ultra Trace Perth

- 40 gm
- One use plastic orange juice containers
- Water bath
- Au + other elements by ICPOES/ICPMS

Selective Digestions



Cyanide

- Gold
- Large sample weights 500-2000gms
- Same digest as used in most gold processing
- Many variants including Leachwell which speeds up the leach time
- Solutions read on AAS (Graphite Furnace or ICPMS)



EXAMPLES OF ASSAY SUITES - ACME CANADA					
Limit	ID - ICPOES	1DX-ICPMS(15gms)	Max		
Ag	0.3 ppm	0.1 ppm	100 ppm	PATHFINDERS	
Al*	0.01 %	0.01 %	10 %	BASE METALS	
As	2 ppm	0.5 ppm	10000 ppm	LITHOLOGICAL	
Au	2 ppm	0.5 ppb	100 ppm	REGOLITH	
B*	3 ppm	1 ppm	2000 ppm		
Ba*	1 ppm	1 ppm	10000 ppm	Nickel Exploration	
Bi	3 ppm	0.1 ppm	2000 ppm	Ni-Cu-Zn-Co-Cr	
Ca*	0.01 %	0.01 %	40 %		
Cd	0.5 ppm	0.1 ppm	2000 ppm	Volc Massive Sulphides	
Co	1 ppm	0.1 ppm	2000 ppm	Cu-Pb-Zn-Bi	
Cr*	1 ppm	1 ppm	10000 ppm		
Cu	1 ppm	0.1 ppm	10000 ppm		
Fe*	0.01 %	0.01 %	40 %		
Ga*		1 ppm	1000 ppm		
K*	0.01 %	0.01 %	10 %		
La*	1 ppm	1 ppm	10000 ppm		
Mg*	0.01 %	0.01 %	30 %		
Mn*	2 ppm	1 ppm	10000 ppm		
Mo	1 ppm	0.1 ppm	2000 ppm		
Na*	0.01 %	0.001 %	10 %		
Ni	1 ppm	0.1 ppm	10000 ppm		
P*	0.001 %	0.001 %	5 %		
Pb	3 ppm	0.1 ppm	10000 ppm		
S	-	0.05 %	10 %		
Sb	3 ppm	0.1 ppm	2000 ppm		
Sc	-	0.1 ppm	100 ppm		
Se	-	0.5 ppm	100 ppm		
Sr*	1 ppm	1 ppm	10000 ppm		
Th*	2 ppm	0.1 ppm	2000 ppm		
Tl*	0.01 %	0.001 %	10 %		
Tl	5 ppm	0.1 ppm	1000 ppm		
U*	8 ppm	0.1 ppm	2000 ppm		
V*	1 ppm	2 ppm	10000 ppm		
W*	2 ppm	0.1 ppm	100 ppm		
Zn	1 ppm	1 ppm	10000 ppm		
	US\$7	\$US17			
Gold Only		\$US9			



Multi-Elements

- Pathfinders to characterise different styles of mineralisation
- Lithological elements to map geological units
- Other economic elements to find other styles of mineralisation in the area covered.

Interpretation



Percentile Statistics



PERCENTILE STATISTICS												
	SUM	MEAN	MAX	PERCENTILES					RATIOS			
				2.5	25	50	75	90	97.5	97.5/50	MAX/97.5	
Au	1509	7	434	-2	-2	2	4	13	54	27.2	8.0	
Au1	141	40	271	2	8	21	53	104	180	8.5	1.5	
As	1509	35	10600	-2	9	16	32	56	117	7.3	90.9	
Cu	1509	56	238	21	38	52	68	84	114	2.2	2.1	
Fe	1509	7	34	2	5	7	8	10	13	1.9	2.6	
Ni	1509	92	1660	26	53	76	103	142	245	3.2	6.8	
Co	1410	37	168	13	27	36	44	55	68	1.9	2.5	
Cr	1410	248	3800	89	169	212	267	339	618	2.9	6.2	
Mo	109	6	20	-5	5	7	10	12	14	2.0	1.4	

- Robust – Minor influence from ‘outliers’
- 97.5%ile is the statistical threshold – equivalent to Mean + 2SD for Normal Population
- The ratio of 97.5/50%ile is a measure of contrast of the variable

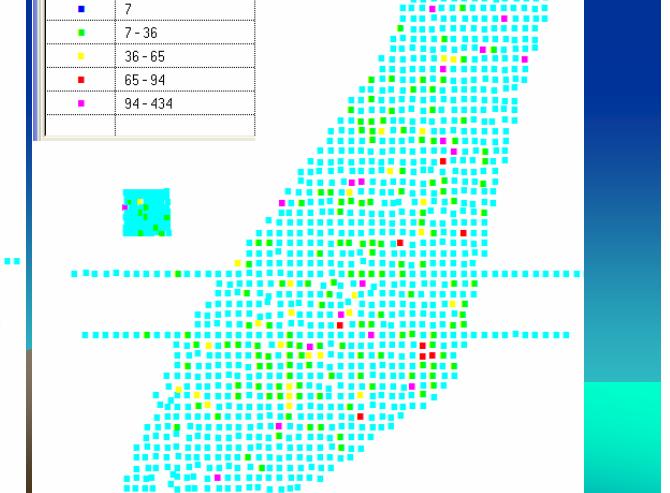
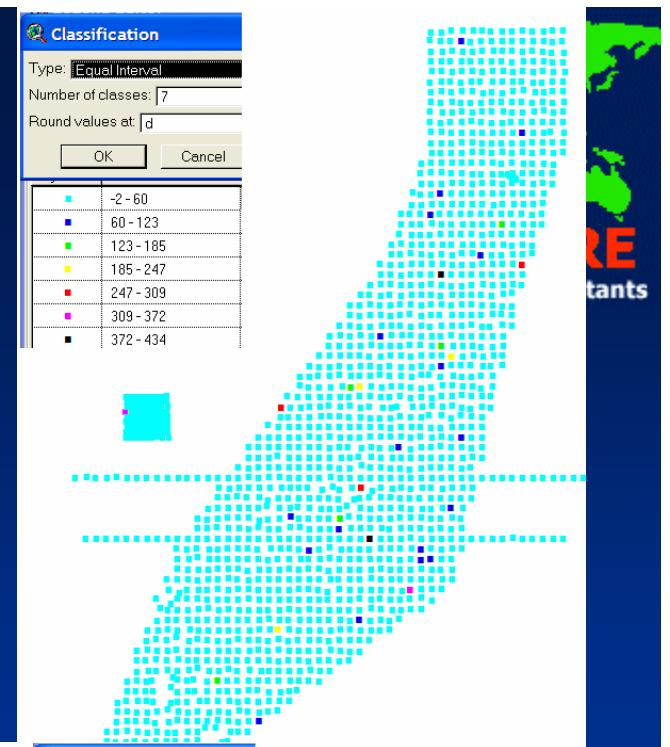
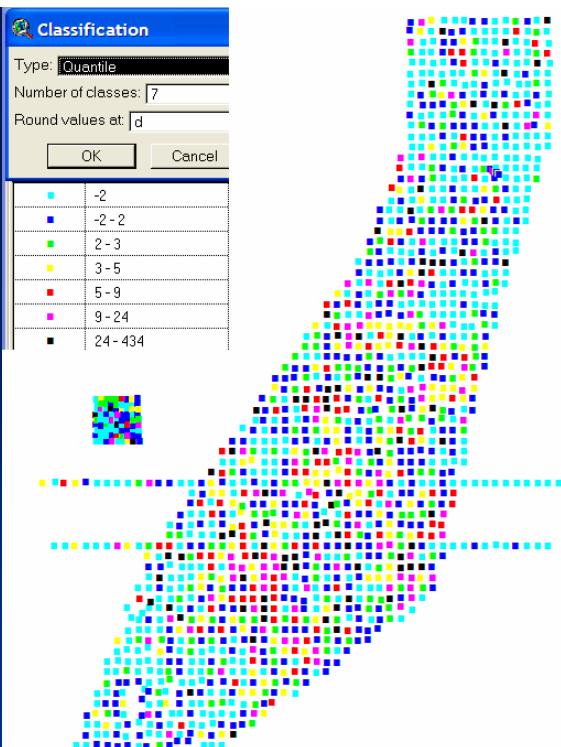


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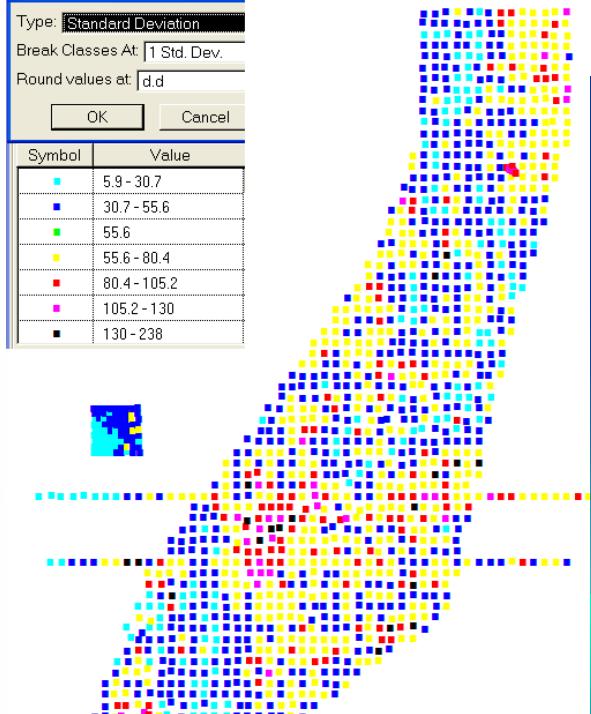
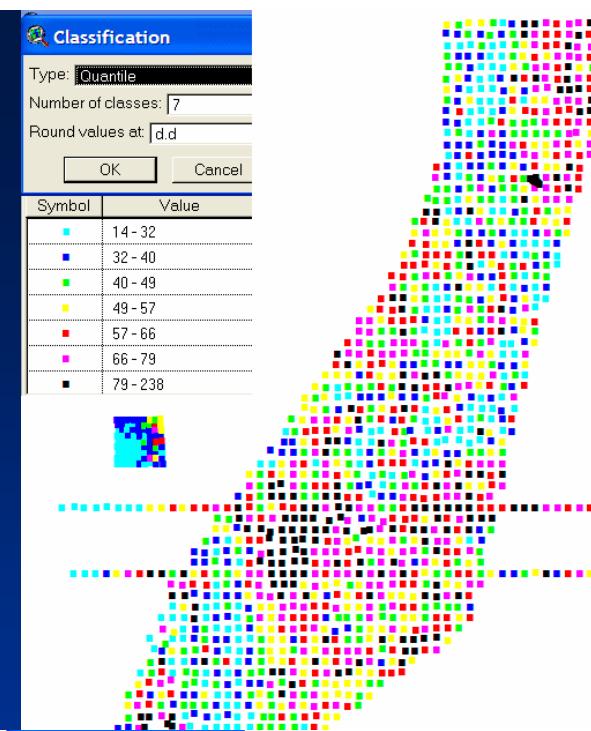
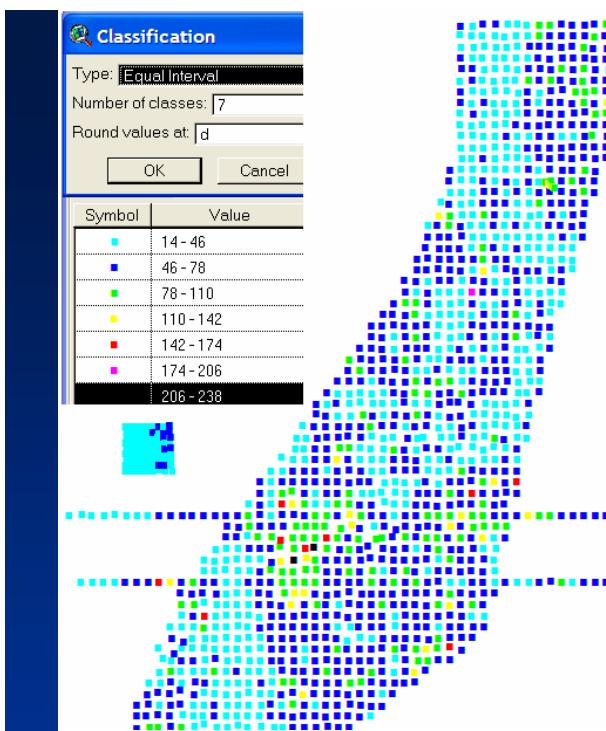
GEOMETRIC LEGENDS

0	0	0	0	0	0	0	0	0	0	0	cyan
0.01	0.02	0.025	0.04	0.05	0.1	0.2	0.25	0.4	0.5	0.5	blue
0.02	0.04	0.05	0.08	0.1	0.2	0.4	0.5	0.8	1.0	1.0	green
0.04	0.08	0.1	0.16	0.2	0.4	0.8	1.0	1.6	2.0	2.0	yellow
0.08	0.16	0.2	0.32	0.4	0.8	1.6	2.0	3.2	4.0	4.0	red
0.16	0.32	0.4	0.64	0.8	1.6	3.2	4.0	6.4	8.0	8.0	magenta
0.32	0.64	0.8	1.25	1.6	3.2	6.5	8.0	12.5	16	16	Black
0	0	0	0	0	0	0	0	0	0	0	cyan
1	2	4	5	8	10	16	20	25	40	40	blue
2	4	8	10	16	20	32	40	50	80	80	green
4	8	16	20	32	40	64	80	100	160	160	yellow
8	16	32	40	64	80	125	160	200	320	320	red
16	32	64	80	128	160	250	320	400	640	640	magenta
32	64	125	160	250	320	500	640	800	1250	1250	Black
									Gold		
0	0	0	0	0	0	0	0	0	0	0	cyan
50	80	100	160	200	250	400	500	1000	3	3	blue
100	160	200	320	400	500	800	1000	2000	8	8	green
200	320	400	640	800	1000	1600	2000	4000	25	25	yellow
400	640	800	1250	1600	2000	3200	4000	8000	75	75	red
800	1250	1600	2500	3200	4000	6400	8000	16000	250	250	magenta
1600	2500	3200	2500	6400	8000	1250	16000	32000	1000	1000	Black

Au Legends



Cu Legends



Regolith

“Everything between fresh rock
and the fresh air”



- Important for the context of geochemical results.
- Residual
 - Different Soil Types / Thickness
 - Variations in Dispersion Patterns
- Colluvial – Mixed Residual/Transported – Complete continuum
- Transported – Usually Avoided
 - Alluvium
 - Sand Dunes
 - Younger Sediments
- Lateritic – Complex deep weathering profiles in tropical – savannah climates

Laterite



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- Profile ex CSIRO
- Most work by BRGM & CSIRO
- This is an idealised complete intact profile.
- Usually the profiles are truncated

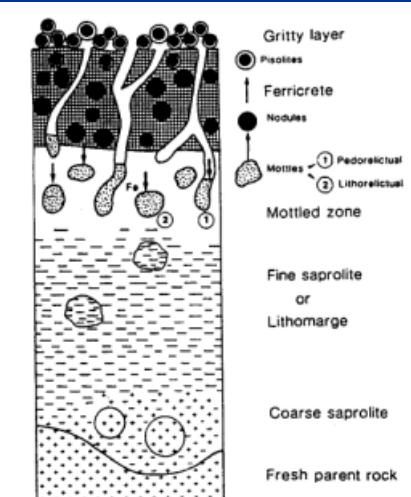
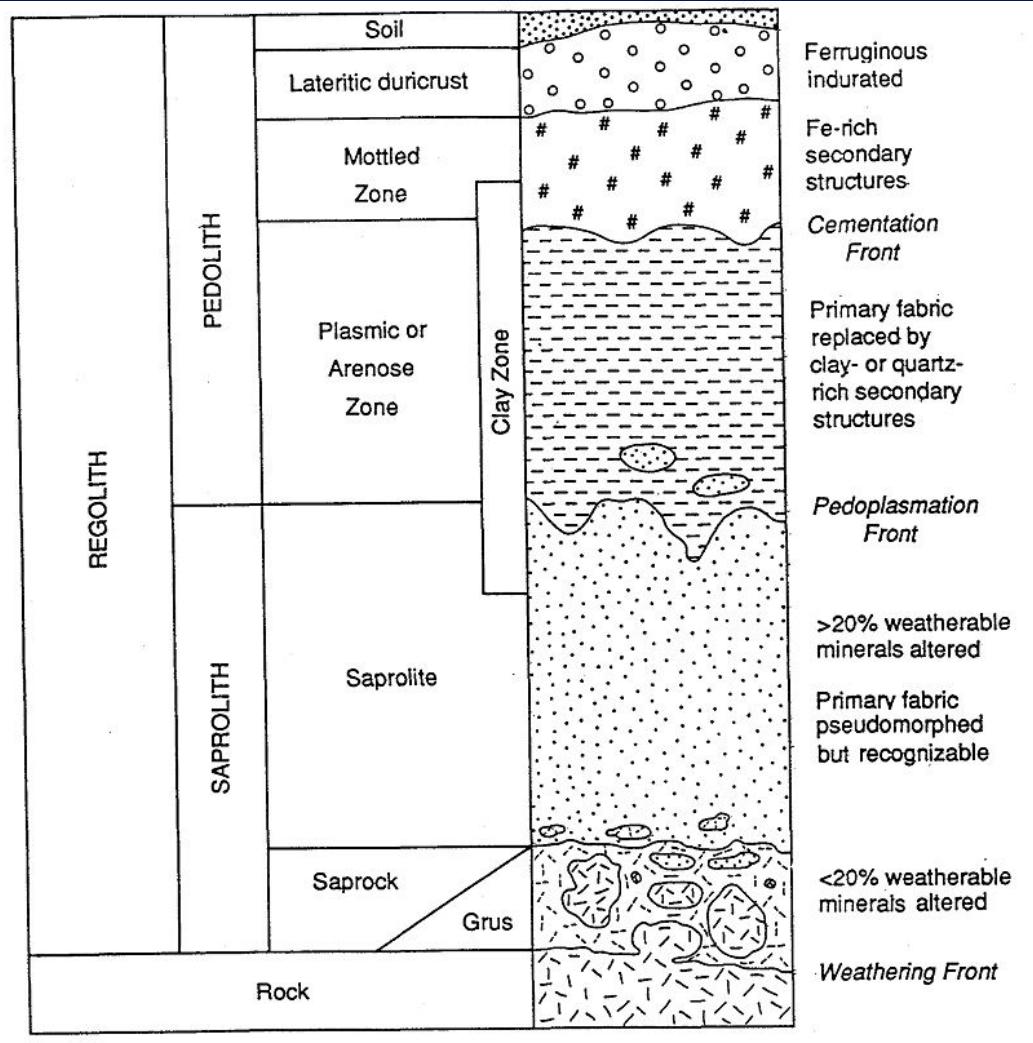
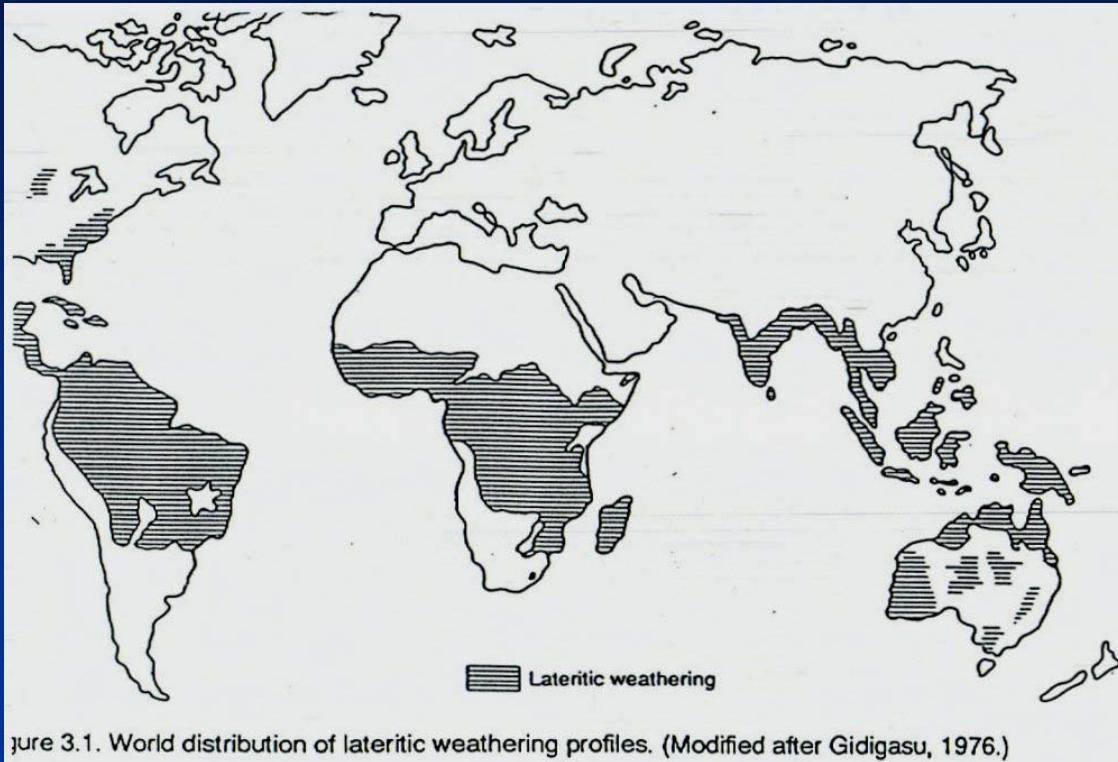
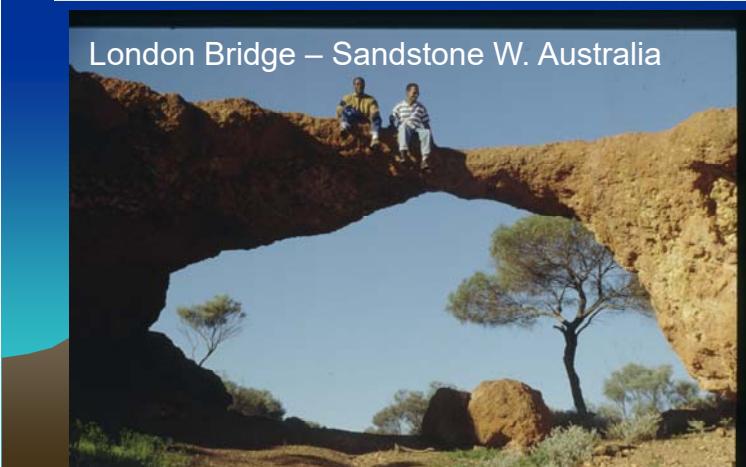


FIG. 1. Schematic representation of a common lateritic profile and its overlying ferricrete (after TARDY and NAHON, 1985).

Laterite Distribution



Distribution of
'laterites'
Not all are
currently forming
eg Yilgarn W.
Australia &
Mauritania



Gold Dispersion – W Africa

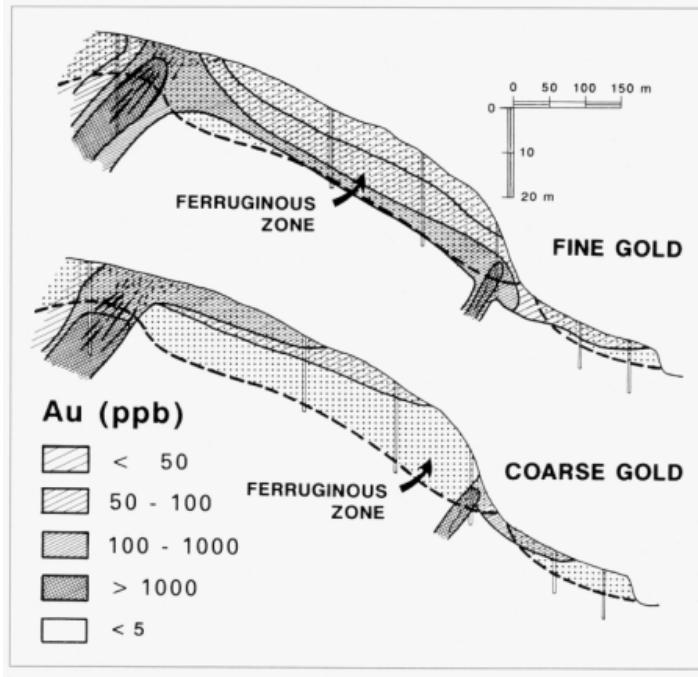


Fig. 9. – Distribution of fine and coarse gold concentrations in the axis of the surface anomaly.
Fig. 9. – Distribution des teneurs en or fin et grossier dans l'axe de l'anomalie de surface.

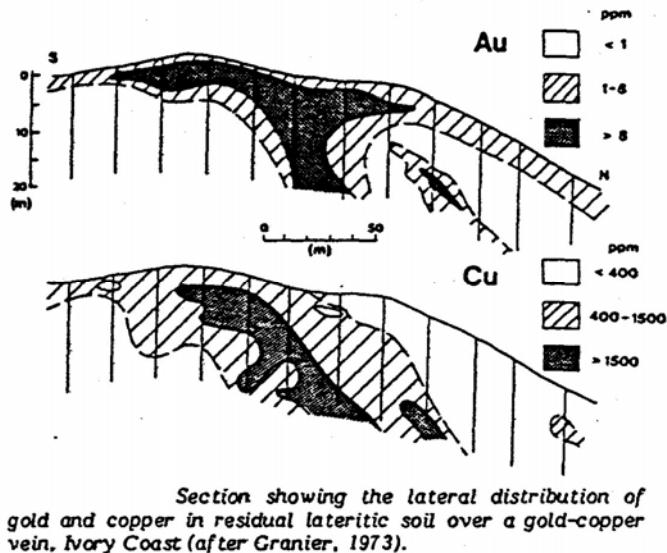
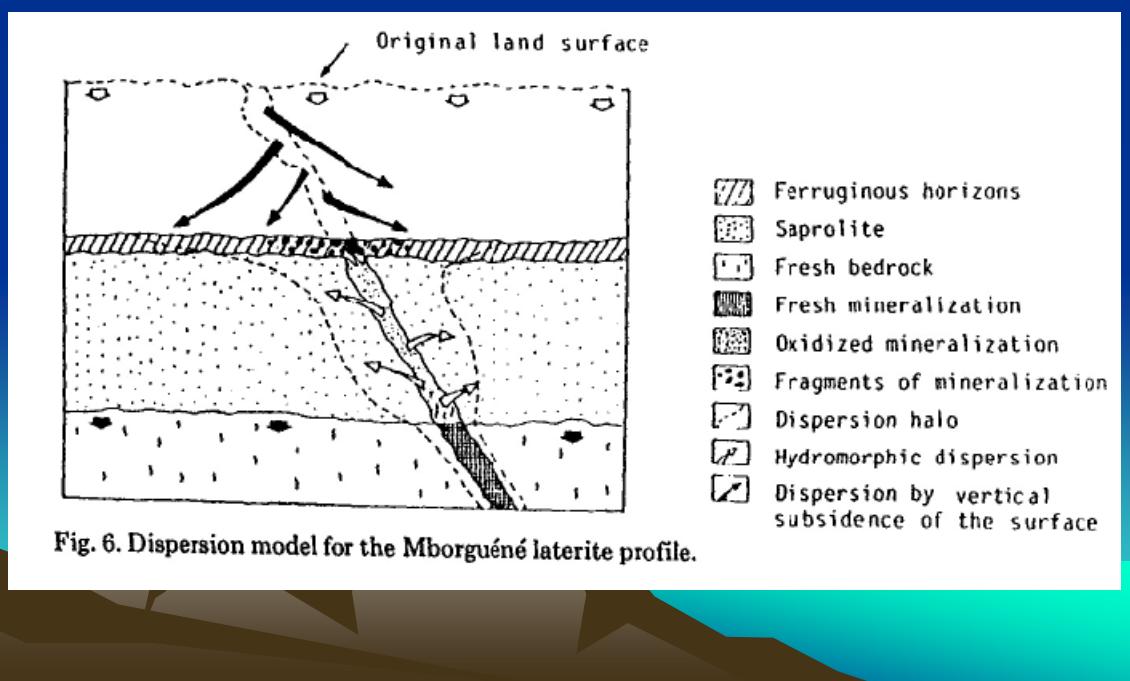


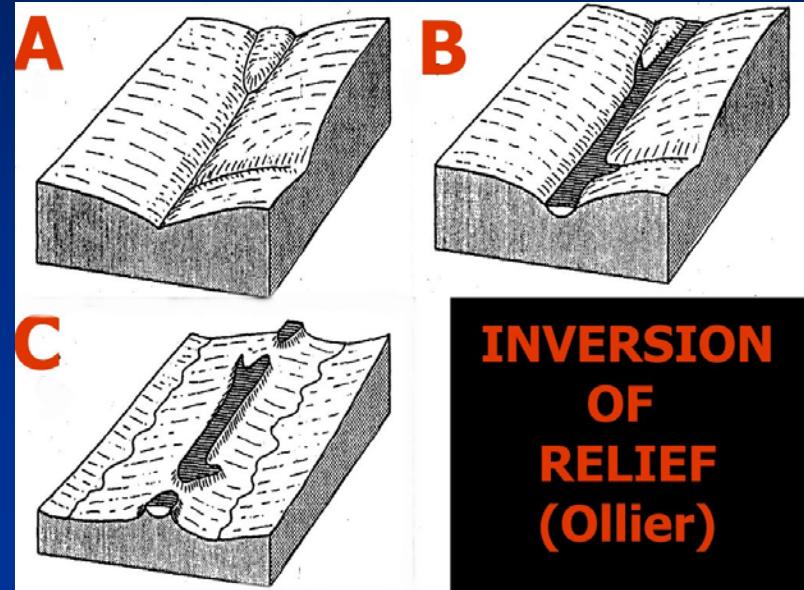
FIGURE A16 SECONDARY DISPERSION



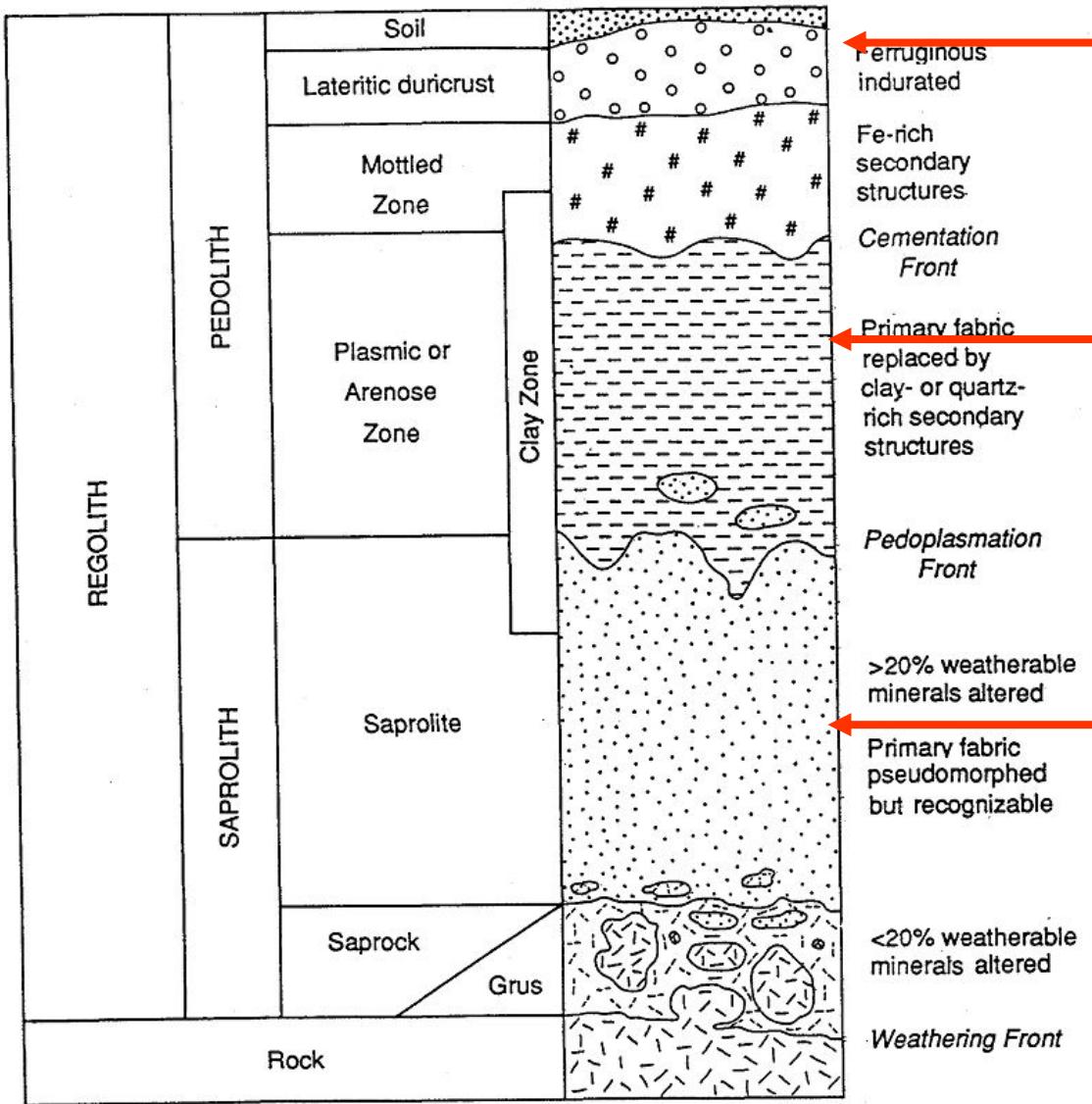
Relief Inversion



- During tropical weathering Fe may migrate (Fe^{2+}) and is deposited in drainage areas as iron oxides.
- In time these channel deposits are more resistant to erosion than the clay rich parts of the laterite profile
- This can lead to topographic inversion.



Lateritic Terrain – Sample Media



Duricrust – Cuirasse

- Direct Sampling
- Deflation Lags

Clay Zone

- Soils (May be leached)

Saprolite

- Soils



QA/QC

By Richard Carver
August 2008

Introduction



- Accuracy & Precision
- Errors
- Bias
- QA/QC
- QC Samples
 - Standards
 - Blanks
 - Duplicates



Accuracy

Accuracy

The closeness of the agreement between the result of a measurement and a *true value*

- "Accuracy" is a qualitative concept

True Value

This is a value that would be obtained by a perfect measurement

- "True values are by nature indeterminate"



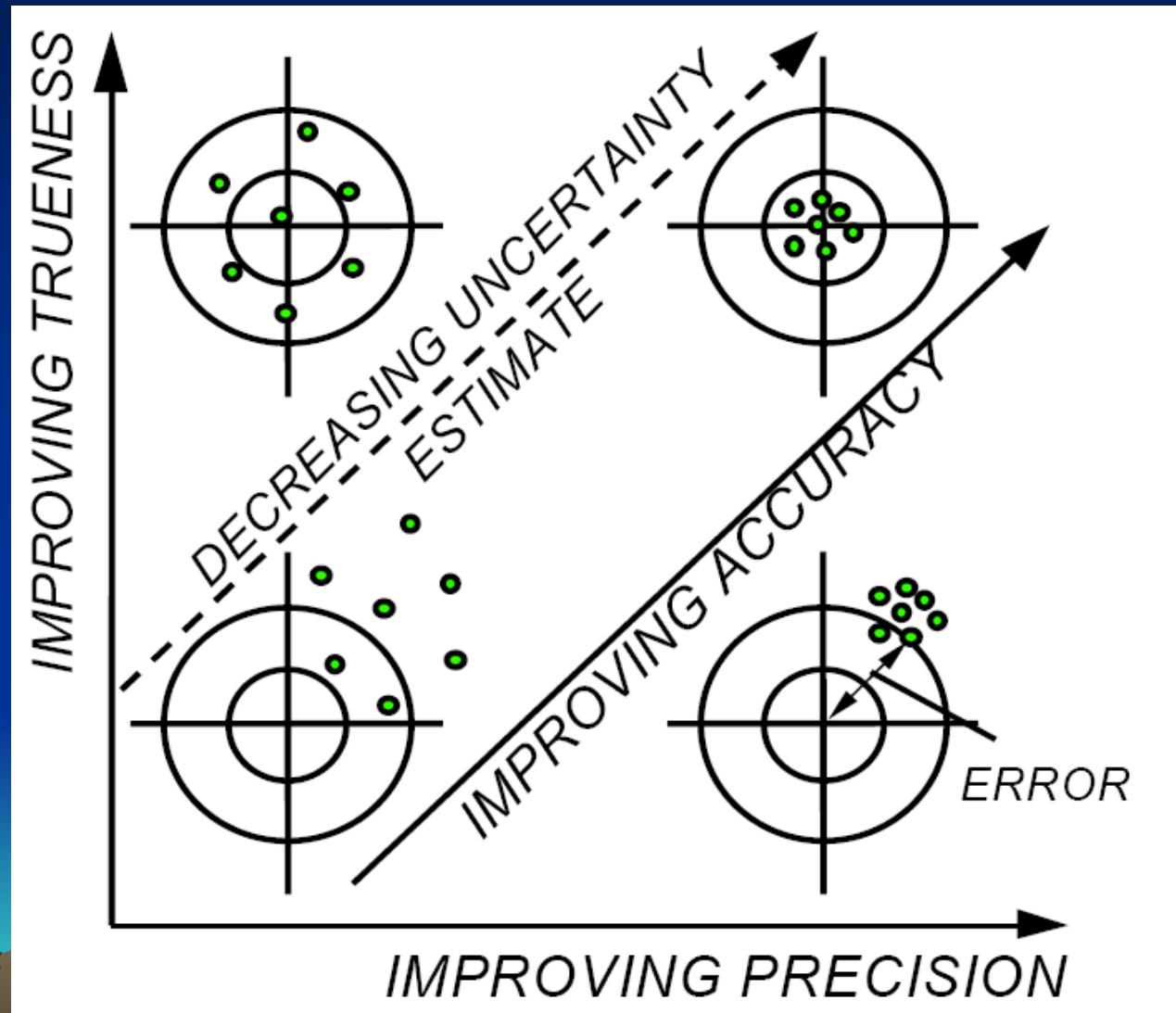
Precision



The closeness of agreement between independent test results obtained under stipulated conditions.

- Precision depends only on the distribution of random errors and **does not relate to the true value.**
- Less precision is reflected by a larger standard deviation.
- Quantitative measures of precision depend critically on the stipulated conditions
 - Same Sample Digest
 - Digest Temperate etc
 - Time between measurements

Precision - Accuracy



Assaying - Errors



- Sampling Errors – Inhomogeneity in pulp
- Weighing
- Acid strength
- Dilution volumes
- Temperature
- Time of digest
- Calibration solutions
- Instrument calibration

Bias



Bias The difference between the expectation of the test results and an accepted reference value.

QA/QC Quality Assurance /Quality Control



- Two Sides – Laboratory & Company
 - The laboratory must have systems to manage the internal quality of the laboratory
 - The company under protocols of JORC { Australia} and 43-101 {Canada} must externally monitor the quality of the assay data related to mineral exploration and ore reserve estimation.

QA/QC Quality Assurance /Quality Control



Both laboratory and company use the same measures.

- Standards – monitor quality
- Duplicates
 - Estimate the errors involve in sampling and splitting
 - Laboratories use these more to directly monitor quality
- Blanks
 - Monitor contamination in the preparation process
 - Laboratory – reagent quality

Standards (CRM)



Prepared powder materials of known chemical composition

- Primary Certified Reference Materials
\$1000/kg
- Commercial Standards for Mineral Exploration \$30-200/Kg
- Project Matrix Matched Standards

Commercial Reference Materials



- Materials targeted at the exploration and mining industries
- Produced on a larger scale
- Limited number of manufacturers
 - Rocklabs (NZ)
 - Geostats
 - Ore Research
 - African Mineral Standards



Standards What Do They Tell Us?



- On batch by batch basis verify that the assay data are acceptable.
- Indicate the optimal precision of the laboratory-method as these are very homogeneous samples.
- Indicate accuracy/bias of the laboratory-method.



Information Obtained from the Certification Documents

OREAS 52P
Cu – Au Porphyry Copper
Example

The Certificate



RE
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CERTIFICATE OF ANALYSIS FOR COPPER-GOLD STANDARD OREAS 52P SUMMARY STATISTICS

Recommended Values, 95% Confidence and Tolerance Intervals

Constituent	Recommended value	95% Confidence interval		Tolerance interval $1-\alpha=0.99, \rho=0.95$	
		Low	High	Low	High
Gold, Au (ppb)	183	176	190	179	187
Copper, Cu (%)	0.387	0.382	0.392	0.377	0.397

OREAS 52 - CRM - COPPER CERTIFICATION DATA

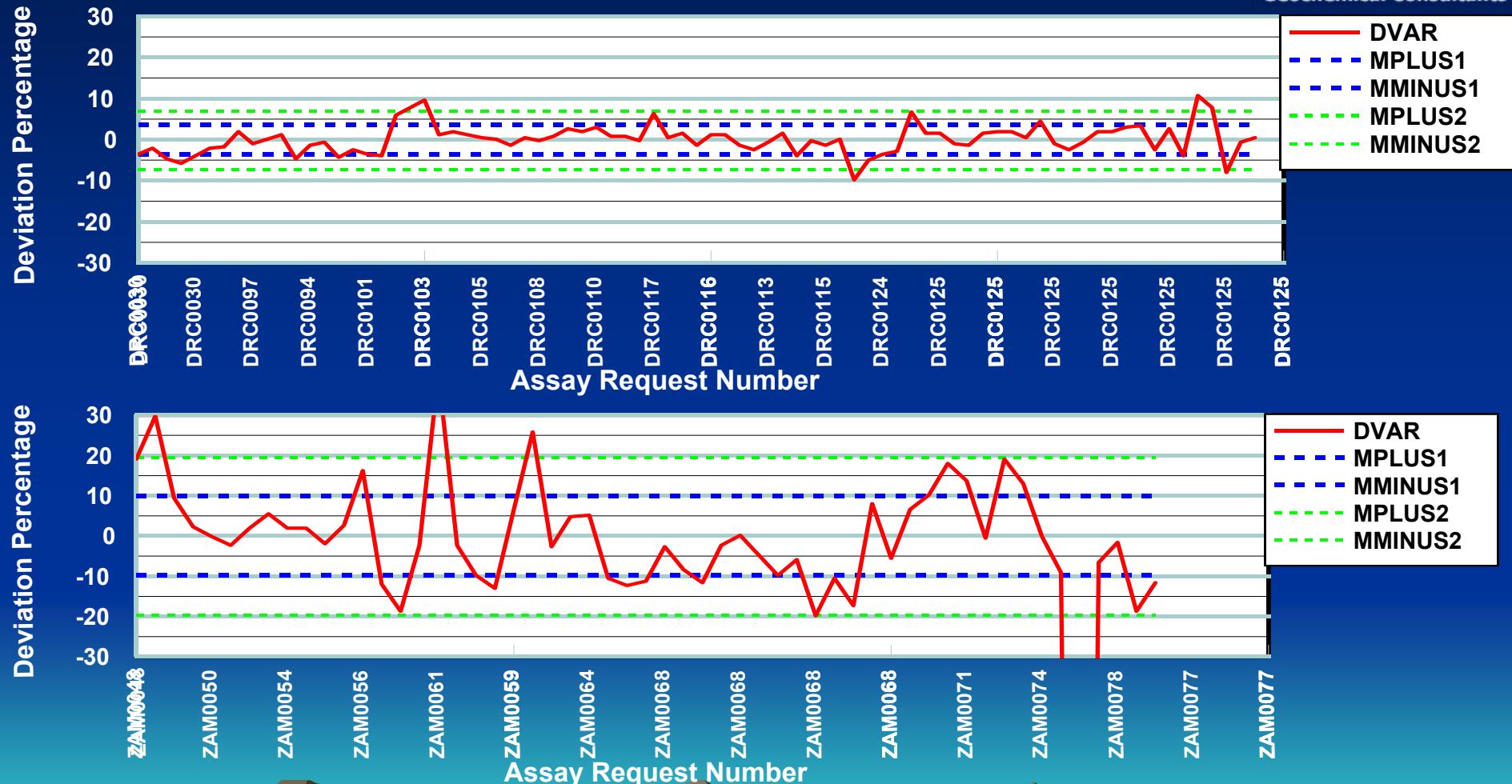
LAB	1	2	3	4	5	6	7	8	9	10	11	12	13	15
SAMP	*OES	*OES	*OES	*AAS	*OES	*OES	*OES	*AAS	*AAS	*OES	*AAS	*AAS	*OES	*OES
1	3690	3650	3990	3920	3870	3800	3870	4000	3700	3918	3960	3780	3730	3840
2	3780	3500	4160	3960	3860	3825	3870	4200	3900	3913	3880	3800	3670	3850
3	3740	3270	4050	4000	3870	3850	3810	4100	3900	3889	3920	3830	3740	3910
4	3780	3330	3790	3960	3940	3900	3910	4000	3800	3827	3900	3800	3770	3850
5	3800	3530	3980	4070	3800	3850	3820	4100	3700	3831	3890	3780	3780	3900
6	3840	3490	3940	3970	3910	3800	3920	3800	3700	3847	3900	3790	3780	3990
Mean	3772	3462	3985	3980	3875	3838	3867	4033	3783	3871	3908	3797	3745	3890
SD	52	139	122	51	48	38	45	137	98	41	29	19	42	57
RSD	1.4	4.0	3.1	1.3	1.2	1.0	1.2	3.4	2.6	1.1	0.7	0.5	1.1	1.5
Bias	-2.5	-10.6	3.0	2.8	0.1	-0.8	-0.1	4.2	-2.2	0.0	1.0	-1.9	-3.2	0.5
Rejected				Certified Value 3870 Tolerance 95% 50 as % 1.3				MEAN 3875 MEAN 3771 MEAN 3993						
Read	10	10	10	10	10	25	10	100	100	1	10	10	10	10
Read Error	0.26	0.26	0.26	0.26	0.26	0.65	0.26	2.58	2.58	0.03	0.26	0.26	0.26	0.26

SAMP	ARS_NO	STD	EL	VAL	STD	RSD	CL	DEV%	RESULT
DE0191	ZAM0048	45P	Cu	986	720	12	B	37	FAIL15
DE0191	ZAM0048	45P	Ni	400	293	14	B	36	FAIL15
DE0211	ZAM0048	13P	Cu	3340	2896	12	A	15	FAIL10
DE0251	ZAM0048	45P	Cu	853	720	12	B	19	WARN15
DE0251	ZAM0048	45P	Ni	349	293	14	B	19	WARN15
DE0271	ZAM0048	13P	Cu	3640	2896	12	A	26	FAIL10
DE0271	ZAM0048	13P	Ni	2520	2161	8	A	17	FAIL10

SAMP	STD	EL	VAL	STD	RSD	C	DEV	RESULT
DE0191	45P	Al	5	4	8.4	D	26.7	WARN25
DE0191	45P	Ba	220	177	7.4	C	24.3	WARN20
DE0191	45P	Be	0.8	0.6	8.3	D	29.4	WARN25
DE0191	45P	Ca	0.3	0.3	6.3	B	19.0	WARN15
DE0191	45P	Co	130	101	10.1	B	28.7	FAIL15
DE0191	45P	Cr	1155	931	7.4	B	24.0	FAIL15
DE0191	45P	Cu	986	720	12	B	37	FAIL15
DE0191	45P	Fe	23	18	8	B	31.0	FAIL15
DE0191	45P	Mn	1320	1094	6.3	B	20.6	FAIL15
DE0191	45P	Ni	400	293	14	B	36	FAIL15
DE0191	45P	P	460	379	6	B	21.2	FAIL15
DE0191	45P	Pb	29	19	31.6	D	53.4	FAIL25
DE0191	45P	Sc	67	56	6.2	B	19.6	WARN15
DE0191	45P	Ti	0.25	0.20	8.2	C	24.4	WARN20
DE0191	45P	V	301	240	7.2	C	25.4	FAIL20
DE0191	45P	Zn	166	125	11.5	B	32.7	FAIL15

Standards
Example of
Assay Batch
with
Significant
Problems

Standard Control Chart 13P – Cu Production Data From 2 Laboratories



Standards Summary



- A single laboratory may offer multiple methods for the one element even with the same digest. (different weights or reading instruments)
- These will often produce subtly different values and precisions
- We are unable to change the values generated by an individual laboratory
- Once we have decided the laboratory is suitable for the assaying
 - We document the accepted value for each method in use.
 - We use these accepted values for testing the outcome of production standards

Blanks – Steel Contamination



Chromium

ARS_NO	SAMP_NO	ELEMENT	VALUE	BLKMEAN	MVAR
DRC_RC001	DA3320	Cr	910	60	1517
DRC_RC001	DA3340	Cr	910	60	1517
DRC_RC001	DA3360	Cr	875	60	1458
DRC_RC001	DA3380	Cr	825	60	1375
DRC_RC001	DA3420	Cr	875	60	1458
DRC_RC001	DA3431CL	Cr	920	60	1533
DRC_RC001	DA3440	Cr	925	60	1542
DRC_RC001	DA3460	Cr	910	60	1517
DRC_RC001	DA3480	Cr	840	60	1400
DRC_RC001	DA3485CL	Cr	830	60	1383

ELEMENT	Average Blank	BLK	MVAR
Co	7.8	2.5	312
Cr	882	60	1470
Mo	1.0	0.5	206

Notes

- The Cr bowls have 14% Cr in the steel.
- Blank is Siliceous & very hard
- Production samples have low Cr contents <100ppm
- Production samples are soft regolith materials

• Small amounts of Co (5ppm) and Mo (.5ppm) may be contributed to hard samples

• Production samples have much higher concentrations of Co and Mo than the blanks

Blanks Carry Over Contamination



Carry Over Contamination - Estimated From Blanks

DATE	LAB_JOB	SAMP_NO	Total Copper			Acid Soluble (H ₂ SO ₄)		
			Carry Over pct	CU pct	Assay Prior to Blank	Carry Over pct	CU_AS ppm	Assay Prior to Blank
17/07/2008	1251.0/0805975	OO3842	1.6	0.04	2.55	0.3	86	25041
17/07/2008	1251.0/0805975	OO3902	2.9	0.03	1.04	1.9	18	928
16/07/2008	1251.0/0806363	OO1644	1.8	0.03	1.68	0.8	124	15278
16/07/2008	1251.0/0806363	OO1724	0.5	0.03	5.47	0.2	117	52892
16/07/2008	1251.0/0806363	OO1764	1.5	0.05	3.40	0.2	70	31607
25/07/2008	1251.0/0806365	LL3155	1.0	0.04	4.21	0.6	240	40289
25/07/2008	1251.0/0806365	LL3175	0.8	0.05	6.49	0.2	134	57863
28/07/2008	1251.0/0806364	OO1895	2.3	0.04	1.74	2.1	346	16469
28/07/2008	1251.0/0806364	OO1975	4.0	0.05	1.24	0.7	89	12173
30/07/2008	1251.0/0806920	LL3673	1.4	0.03	2.16	0.7	134	19023
10/07/2008	1251.0/0806061	LL3930	2.8	0.03	1.07	1.1	115	10595
10/07/2008	1251.0/0806061	LL3950	2.9	0.04	1.39	0.9	117	13265
31/07/2008	1251.0/0806711	PP3142	2.0	0.06	3.05	0.8	231	29400
31/07/2008	1251.0/0806711	PP3162	1.8	0.08	4.37	1.8	768	42843
31/07/2008	1251.0/0806711	PP3182	2.6	0.05	1.92	2.9	520	17860
31/07/2008	1251.0/0806711	PP3202	1.3	0.05	3.79	1.2	433	36653
31/07/2008	1251.0/0806711	PP3242	2.6	0.04	1.52	2.5	358	14185
29/07/2008	1251.0/0806712	TT3559	3.2	0.06	1.90	2.5	443	17983
Average			2.0	0.04	2.72	1.2	241	25242
				1.6			1.0	

Carry over is about 1% based on the lower detection limit acid soluble Cu data.

Blanks Carry Over Contamination



Table : H:\DRC_PREP_PROCESSING.DB

	BATCH_NO	SAMP_NO	DATE_P_IN	IN_WEIGHT	DRY	SPLT_WGHT	PULV_BOWL	P_NOTES
2203	DRC RC001	DA3329	23/06/2006	2.00	Y	655.00	A	CLEANER
2204	DRC RC001	DA3330	23/06/2006	2.30	Y	808.00	B	
2205	DRC RC001	DA3331	23/06/2006	1.90	Y	654.00	A	
2206	DRC RC001	DA3332	23/06/2006	2.10	Y	723.00	B	
2207	DRC RC001	DA3333	23/06/2006					
2208	DRC RC001	DA3334	23/06/2006	1.70	Y	658.00	A	
2209	DRC RC001	DA3335	23/06/2006	2.00	Y	636.00	B	
2210	DRC RC001	DA3336	23/06/2006	2.30	Y	817.00	A	
2211	DRC RC001	DA3337	23/06/2006	2.10	Y	833.00	B	
2212	DRC RC001	DA3338	23/06/2006	2.10	Y	785.00	A	DIRTY
2213	DRC RC001	DA3339	23/06/2006	2.20	Y	855.00	B	CLEANER
2214	DRC RC001	DA3340	23/06/2006		Y	505.00	A	
2215	DRC RC001	DA3341	23/06/2006	2.50	Y	1.058.00	B	
2216	DRC RC001	DA3342	23/06/2006	2.00	Y	637.00	A	
2217	DRC RC001	DA3343	23/06/2006	1.70	Y	697.00	B	CLEANER

In the system to the right

- 2 Pulveriser bowls (A and B)
- Sample preparation operator records the bowl number against each sample
- Enables previous sample to be located if high values occur in the blank.



Duplicates



Variety of Types – Indicate the errors associated with processes

- Sampling Duplicates
- Sample Preparation Duplicates
- Pulp duplicates

Sampling Duplicates



Geochemistry

- Collect additional sample at 5% of sites



Air Drilling – take a second split during the sampling process in 5% of samples at the drilling site



Diamond Drilling – More difficult

- Quarter core – 5% duplicate quarter core
- Half core – can only take a quarter as there would be no remaining core. Duplicates are not the same sized sample.

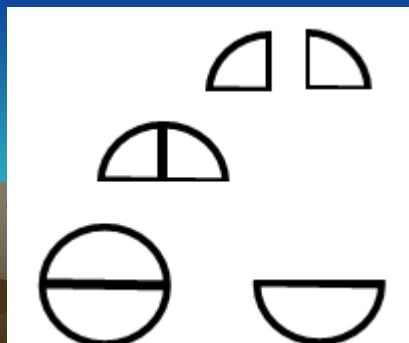


Figure 12.3 Sample being split



Preparation Duplicates

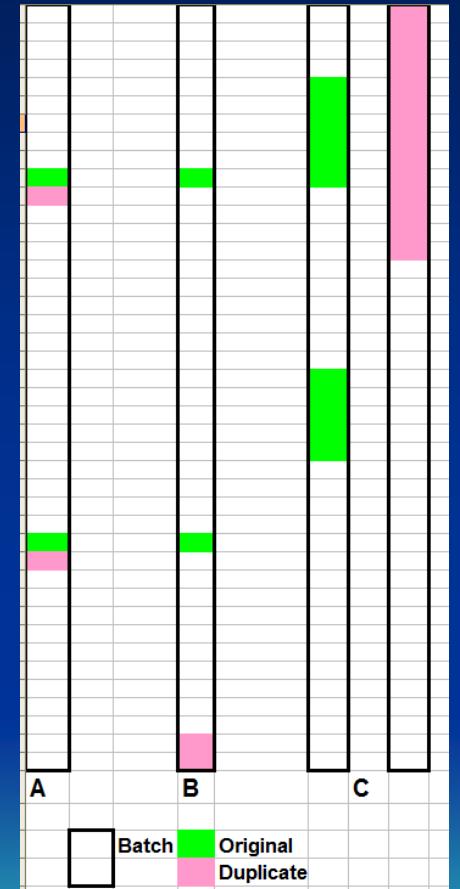


- These can be made anywhere there is an grainsize reduction followed by splitting.
- The key duplicate is generally following the Jaw Crushing where splitting may take only 10-20% of the total through to the pulp stage



Pulp Duplicates

- Duplicate pair interpretation is based on accumulation of data. A single duplicate pair tells us very little.
- At levels well clear of the detection limit the duplicates indicate the assay precision. (10x DL)
- Where there are a large range of grades it is advisable to determine the precision over a number of grade ranges.
- 3 Examples
 - A pulp duplicates in adjacent test tubes in the batch
 - B pulp duplicates placed at the end of the batch
 - C pulp duplicates placed in different batches.
 - When duplicates are selected on basis of results (Au)
 - Or check assays at the same laboratory

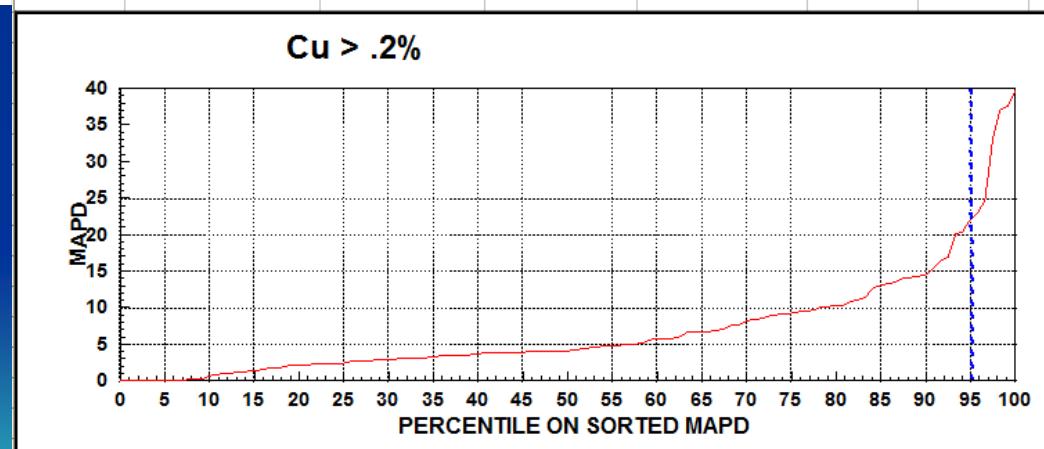


Duplicates – MAPD Variable

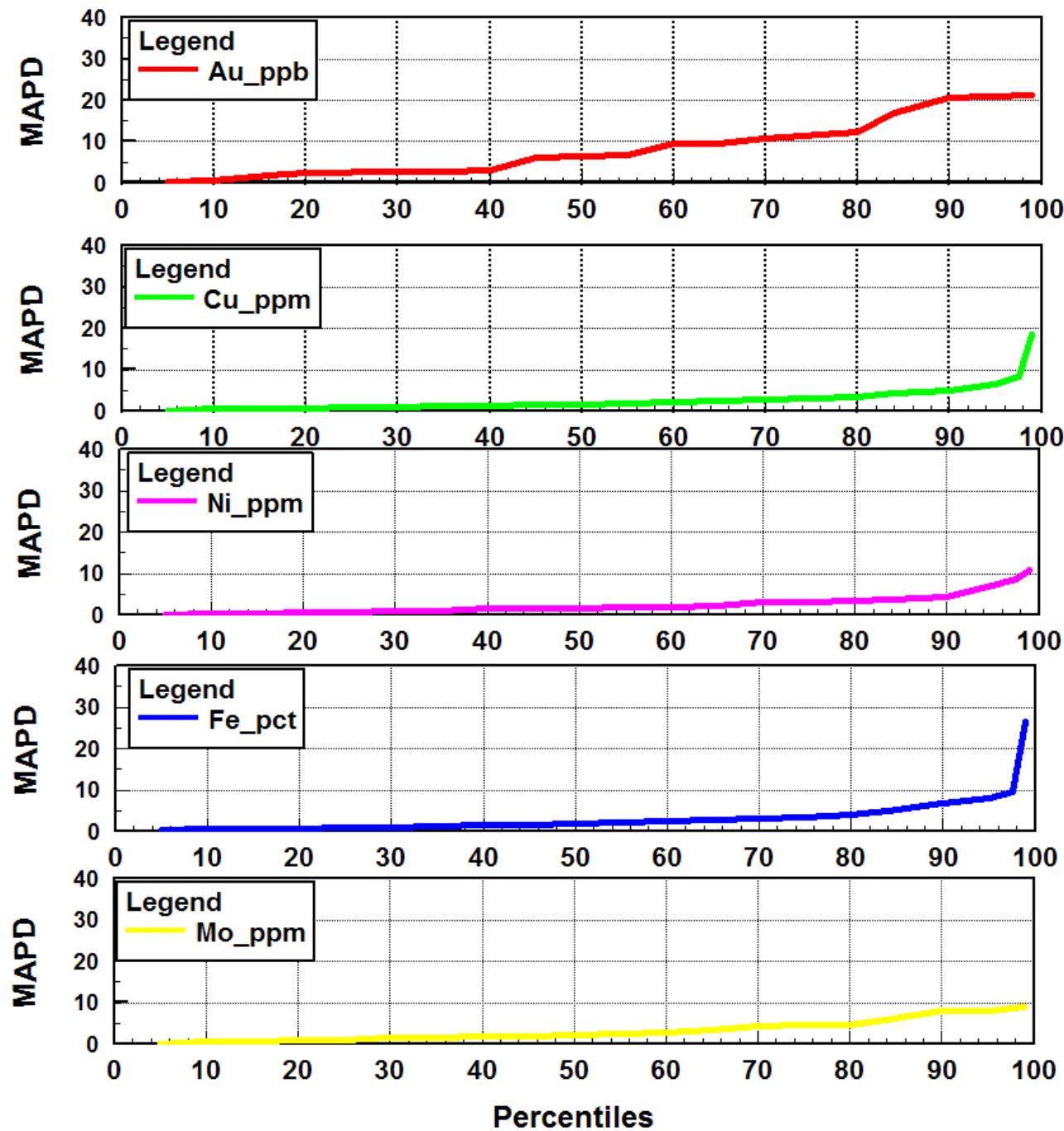


SORTED ON GRADE						
SAMP_NO	SAMP_TYPE	QC_NUMBER	Cu1	Cu2	MAPD	Mean
NN3762	DUPLICATE	NN3763	0.21	0.20	4.9	0.21
LL3860	DUPLICATE	LL3859	0.21	0.20	4.9	0.21
OO3607	DUPLICATE	OO3606	0.22	0.21	4.7	0.22
NN3722	DUPLICATE	NN3723	0.24	0.24	0.0	0.24
OO3627	DUPLICATE	OO3626	0.27	0.22	20.4	0.25
OO3567	DUPLICATE	OO3566	0.25	0.25	0.0	0.25
OO3952	DUPLICATE	OO3951	0.25	0.25	0.0	0.25
NN3862	DUPLICATE	NN3863	0.25	0.26	3.9	0.26
OO3427	DUPLICATE	OO3426	0.26	0.25	3.9	0.26
LL3303	DUPLICATE	LL3302	0.25	0.26	3.9	0.26
LL3383	DUPLICATE	LL3382	0.26	0.25	3.9	0.26
OO1324	DUPLICATE	OO1323	0.26	0.27	3.8	0.27
OO1364	DUPLICATE	OO1363	0.27	0.26	3.8	0.27

Cu Range	COARSE PREPARATION DUPS		PULP DUPLICATES			Range
	STD - MAPD	2x STD MAPD	STD - MAPD	2x STD MAPD	Percent of Error	
.25-.5		4.3	8.6	4.8	6.8	-2-.5
.5 -1		10.3	20.6	3.8	5.8	.5-1
>1		7.4	14.8	2.8	4.8	1-2
ALL > 0.2		7.7	15.4	3.9	5.9	ALL > 0.2



- Precision estimate from 2xSD of MAPD
- Shown as grade ranges
- Error apportioned on basis of squares of SD (variance)



Precision
Plots
Geochemical
Data >100x
Detection
limit

Check Assays



Original Assay Laboratory

- 5 or 10% of samples from ore blocks
- 5-10% Standards for Additional Control

2nd Laboratory – Not always

- As above

Check Assays



- With check assays it is first best to examine whether there is any systematic bias first in this case the formula is very similar :
 - $(V2-V1)/V1*100$ indicating the deviation or bias relative to the original assay.