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Report on Arunta Lag and Drilling Geochemical Data (WMC Titree Project)

For
Anglo American Exploration

By

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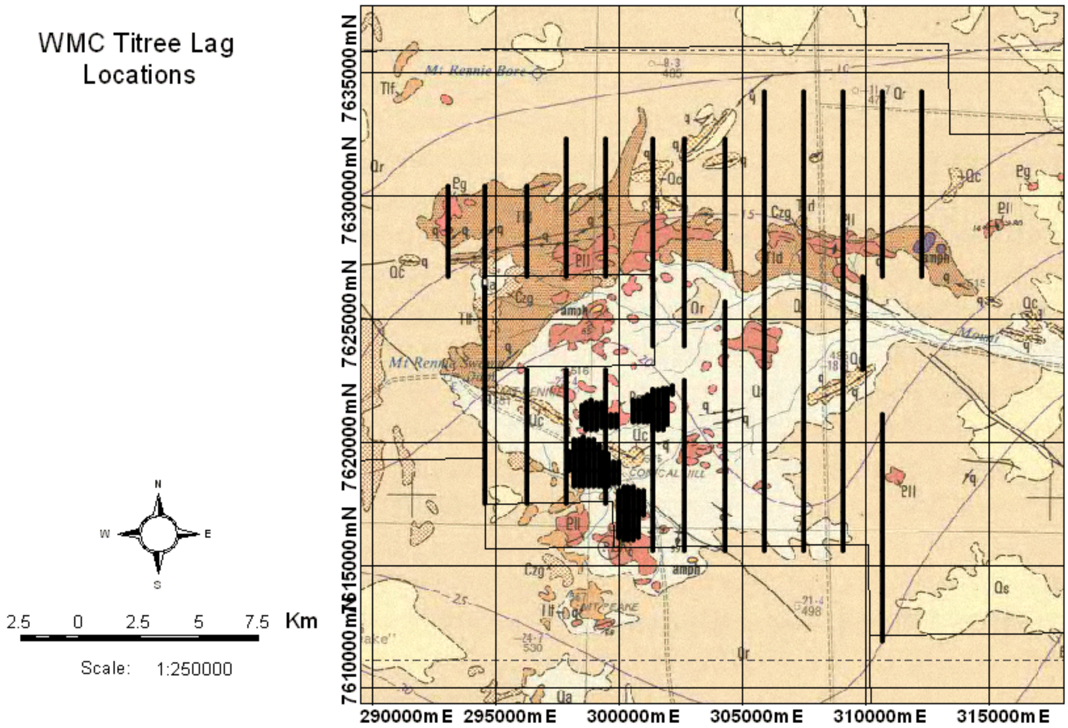
INTRODUCTION

The WMC -6+2mm lag data and RC drilling data from the Titree (Arunta) have been evaluated.

The lag data consists of 3259 samples on a 1500x100m grid with fill in the Tompkins area to 200x50m. The interpretation was directed to Ni-Cu sulphide potential but major highlights for other assay variables were also recorded.

137 RC drill holes were available. Only holes with geochemistry of interest to Ni geochemistry were examined in any detail.

Lag Geochemistry



The plot show the location of the samples on a geological backdrop (250k) The basement units are granites and schists and show as pink on the plan. The yellow – brown units are all tertiary quaternary weathering and alluvial units.

Statistics

The table summarises the percentile statistics for the 3259 lags.

e : titree94_STATS.dbf

Variable	No_Samp	Max_Value	P25	P50	p97_5	Contrast	PCT_BD
AS	3259	85.00	-5.00	5.00	25.00	5.00	45
BI	3259	245.00	0.20	0.60	3.70	6.17	7
CO	3259	640.00	-5.00	5.00	50.00	10.00	37
CR	3228	6,400.00	195.00	290.00	3,800.00	13.10	0
CU	3259	830.00	10.00	20.00	290.00	14.50	8
FE%	3259	71.70	1.80	4.80	44.60	9.29	0
MN	3259	35,500.00	180.00	345.00	2,350.00	6.81	0
MO	3259	7.50	1.00	1.50	3.50	2.33	7
NI	3259	920.00	10.00	15.00	120.00	8.00	7
AU (ppb)	3258	37.00	-1.00	-1.00	2.00	2.00	87

There is significant contrast for all the elements except Au and Mo. This contrast is however driven by Fe variation in the samples (Contrast 9.3) and examination

of the data reveal clusters of samples representing typical high iron lags (25-50% Fe) as well as areas where the samples are dominated by coarse quartz or other iron poor phases.
The data set therefore requires normalisation of the samples using iron. A simple normalisation often works but it was found with these data that it was best to treat the key variables on an individual basis. This was achieved by a regression like process where the data were binned in 5 percent Fe groups and the percentile statistics calculated for each bin.

Group	Variab	No_Samp	Mean	SD	P50
5	CU	1646	11	12	10
10	CU	406	28	17	25
15	CU	150	45	70	30
20	CU	104	62	59	50
25	CU	129	67	53	40
30	CU	165	131	113	85
35	CU	267	144	124	90
40	CU	218	113	94	70
45	CU	98	84	74	50
50	CU	55	51	16	45
55	CU	18	43	13	35
60	CU	1	55	0	
65	CU	2	88	3	

The table above illustrates the process for Cu. From the data it can be seen that the P50ile values rise until about 30% Fe (Group) and then flatten off. The fall at higher values can be attributed to lower numbers of samples in the bin not creating representative numbers. Cu P50 rises 75 ppm over 25 % Fe increase which creates and expected value for Cu of [**10+Fe*3**]. Similar relationships were derived for Ni,As,Bi and Cr and these were used to normalise the data on the following basis.

Actual Value/Expected Value

This creates a range of values reflect the deviation from the "norm" as a ratio. For samples above 30% Fe a value of 30% is used in the normalisation as the samples have "an iron quota" and projecting the normalisation to higher iron contents is counterproductive. This is preferred to using the residual approach as the residual will also increase as the Fe content increases. Note the increase in Standard deviation in the above table as the iron content increases.
The ratio is also easily related back to the contrast concept in the stats table. A good contrast variable will give a value of 4 or above and this can be used as rough bench mark in using this ratio data.
The tabulation shows the changes in the contrasts for the normalised variables. The proportional differences are a relative reflection on the level of influence iron had on the un-normalised values. In these data the Fe control is most pronounced for Cr and Cu.

Co was not used in the interpretation as it is strongly controlled by Mn as well as Fe (Correlation .89).

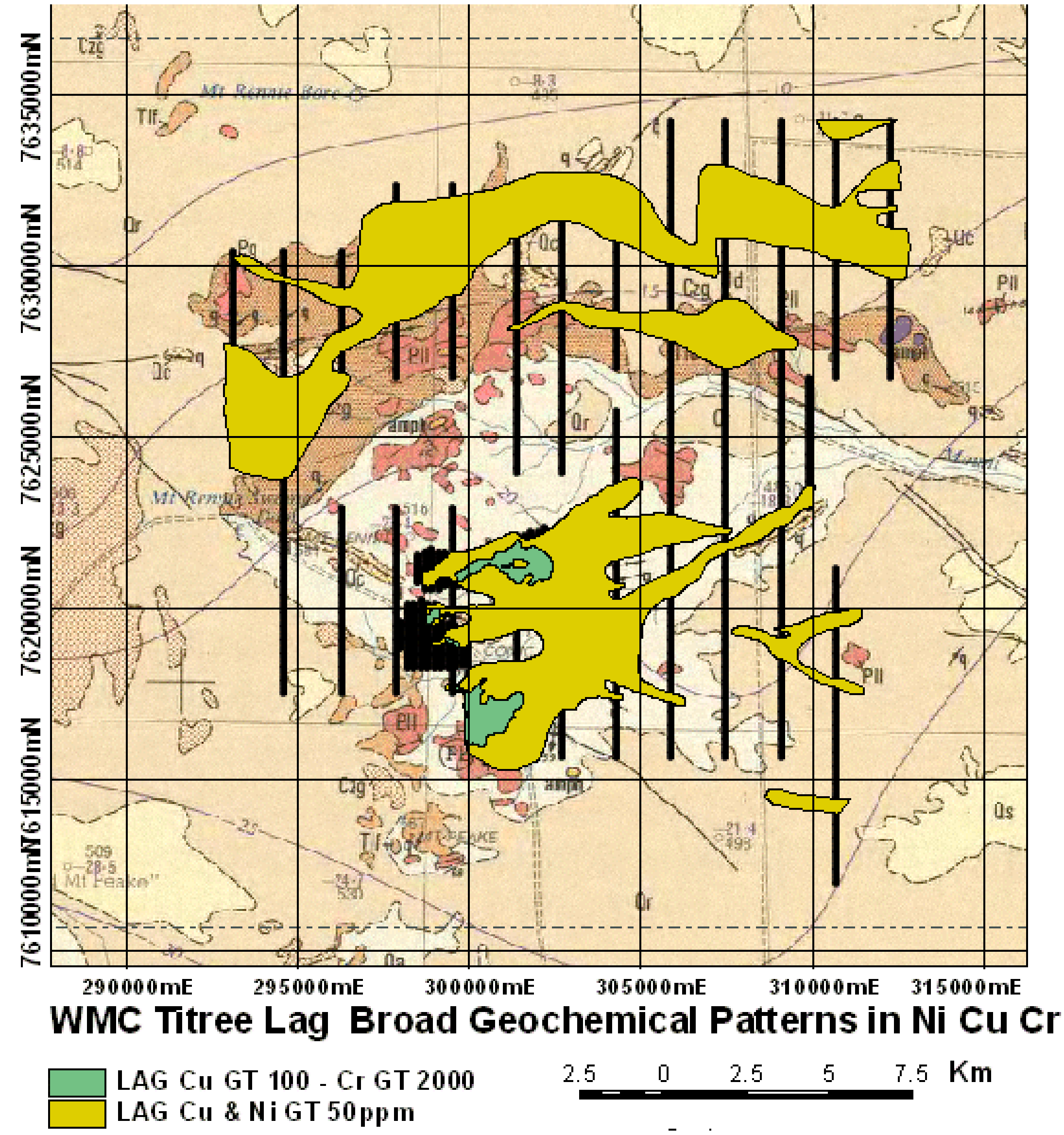
Interpretation

The key available variables were Cu Ni and Cr. The data set lacks the key sediment discriminator Zn.
The interpretation was tackled a number of levels.

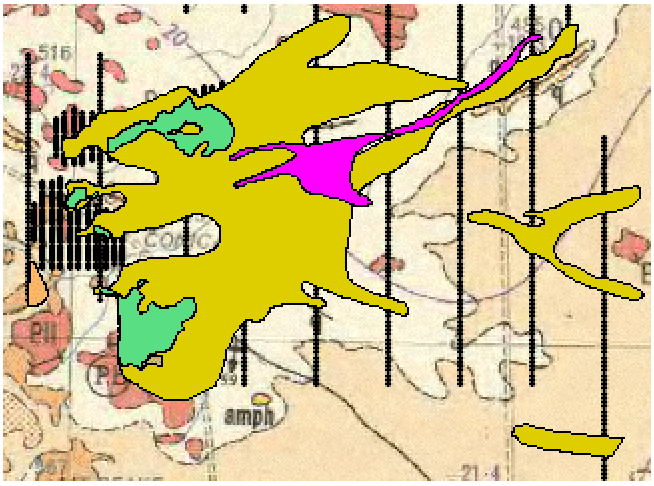
<u>Broad Regional Features</u>

Looking at the Ni and Cu data distribution for the normalised variables it was clear that there was a subdivision between areas with Ni and Cu both >50 ppm

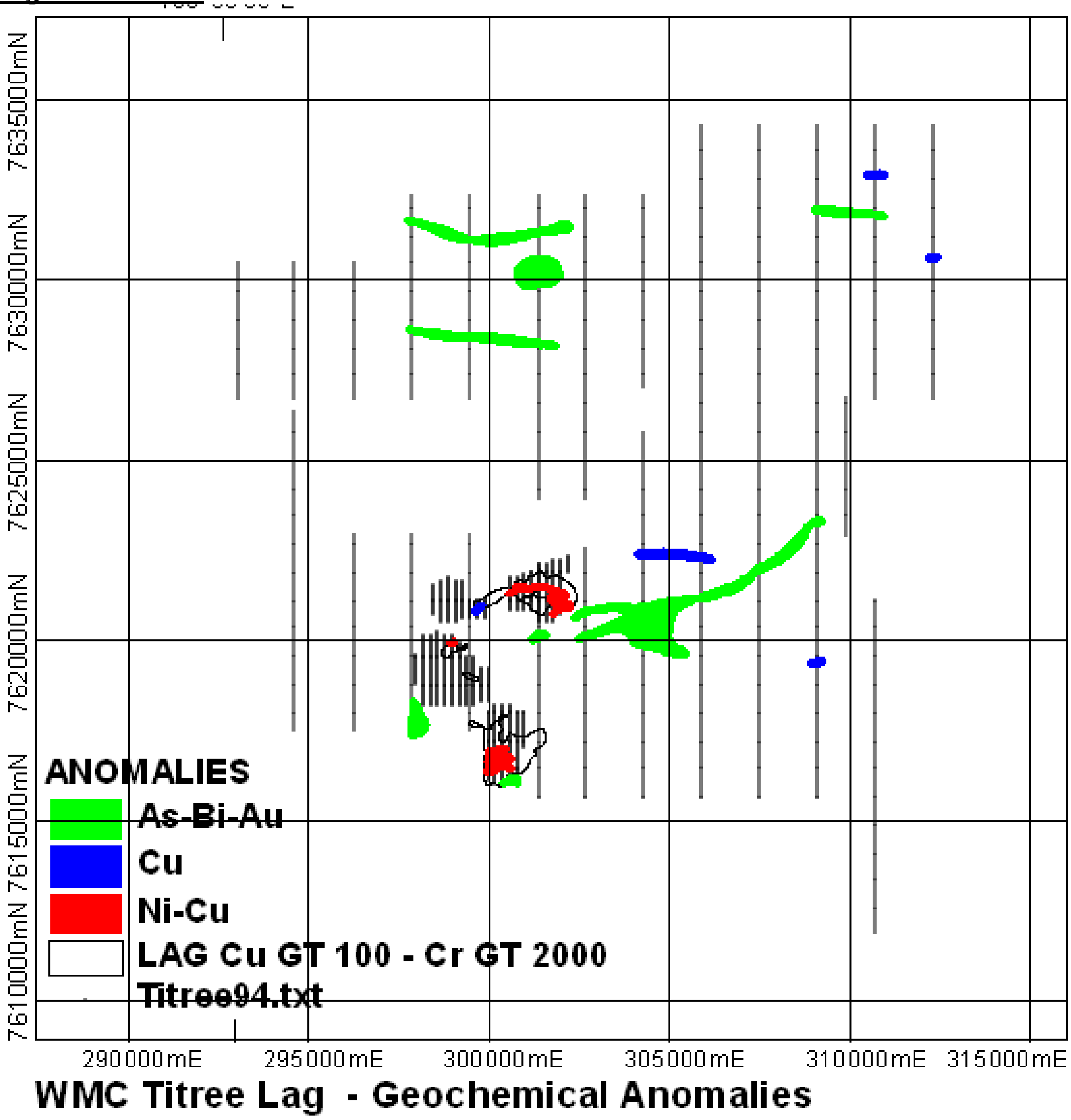
(nominal – reflection of the normalised value in areas of Fe > 25%) and the remainder of the area.
A second lithological discriminator was the close correlation between Cu >100ppm and Cr >2000ppm and these themes were intersected to produce a theme that will reflect the location of mafic/ultramafic rocks. Normally Ni would be included but its values at the surface are more subdued than Cu.



The Ni-Cr features are located in the SW of the sampled area at the Tompkin/Conical Hill. The suggest an almost semi-circle distribution of the mafic/ultramafic rocks which includes thickenings in the N and S. Conical hill is located at the centre of this semi-circle which is occupied by a broad low magnitude Bi geochemical response which is shown in magenta on the following diagram.



Lag Anomalies



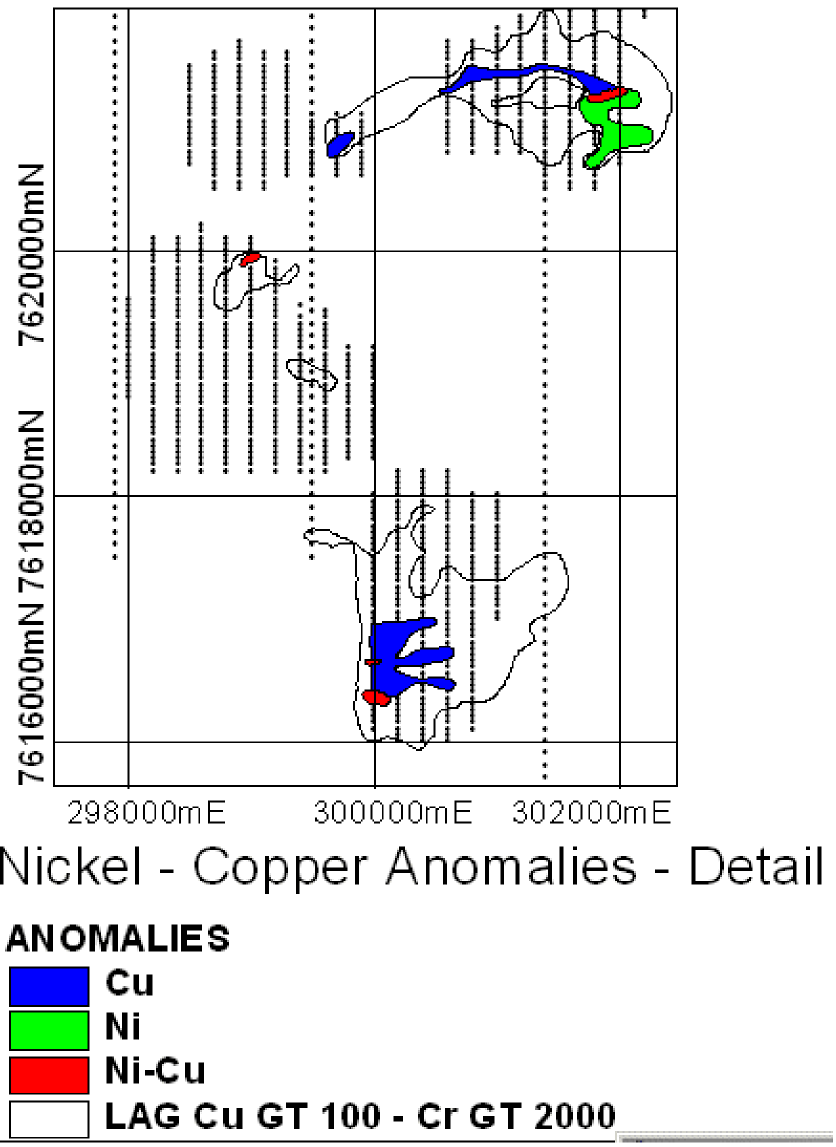
The data were then examined to define anomalies. From a non Ni-Cu aspect Bi dominates the anomalies with or without weak Au or As. The Bi anomalies are good contrast anomalies of two types:

- Broad lower contrast eg centre section of the conical hill anomaly
- Linear anomalies which are generally 1 sample (100m) wide.

The significance of these anomalies is unknown but they do indicate the lags are seeing bedrock features in the locations where they occur.
There are 3 defined Cu (Cu-Bi) anomalies in which the Cu is not obviously associated with Cr or Ni.
The final group have Ni-Cu affinities. Except for the anomaly in the NE section of the survey area which is weak but was highlighted by the normalisation process all the other anomalies are in the Tompkins area. These anomalies were defined on the following basis:

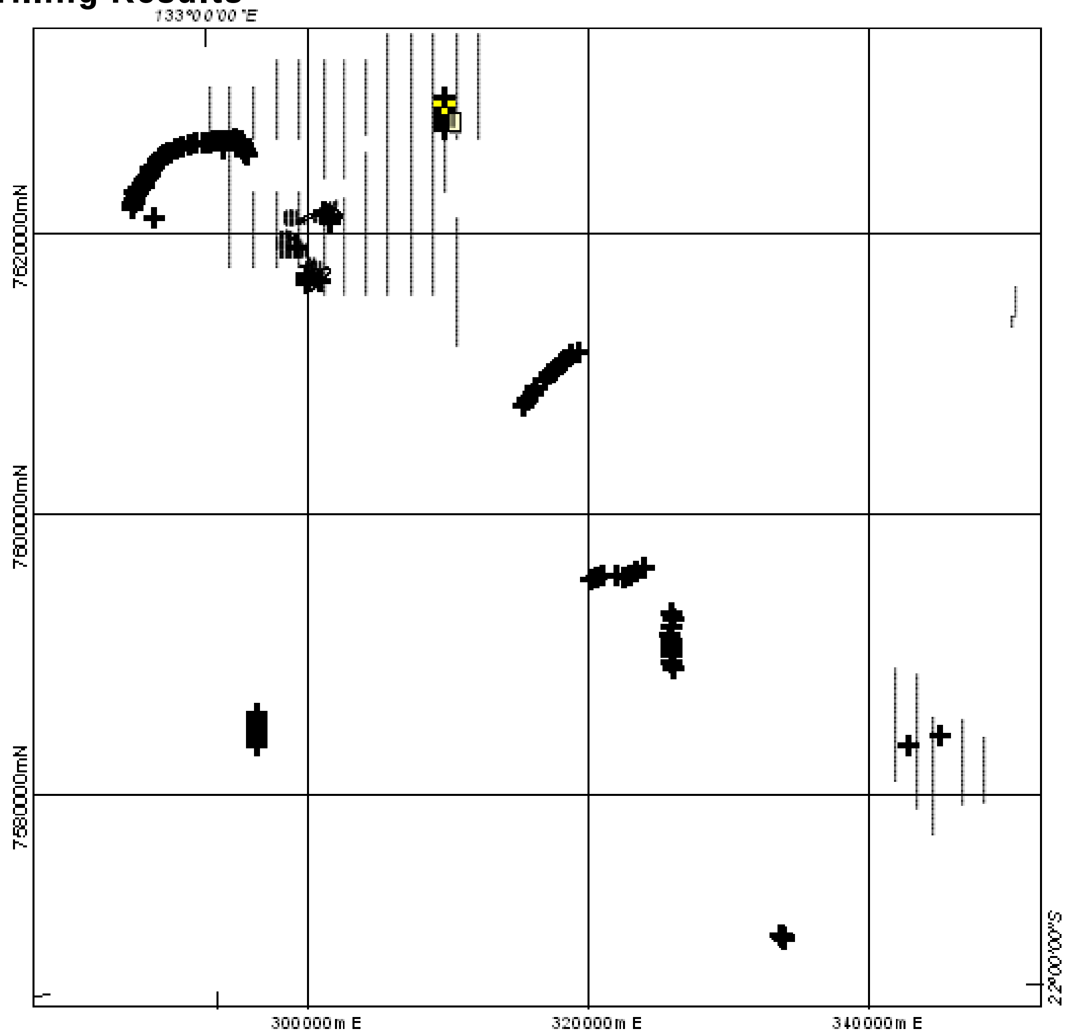
- Cu > 400 ppm
- Ni > 200ppm
- Ni and Cu

The main anomalies are composites of all 3 which have been separated into separate anomalies to show the variation. The major issue is the contrast at “anomalous” levels. Once you are in the areas of higher Cu (>200) and Ni (>100) there is little variation in the data which makes defining discrete anomalies difficult. The problem is most pronounced for Ni, which is quite subdued given the Ni levels in drilling regolith materials. The detailed breakdown of the Ni-Cu components of the anomalies is depicted in the following plot.



Nickel - Copper Anomalies - Detail

Drilling Results



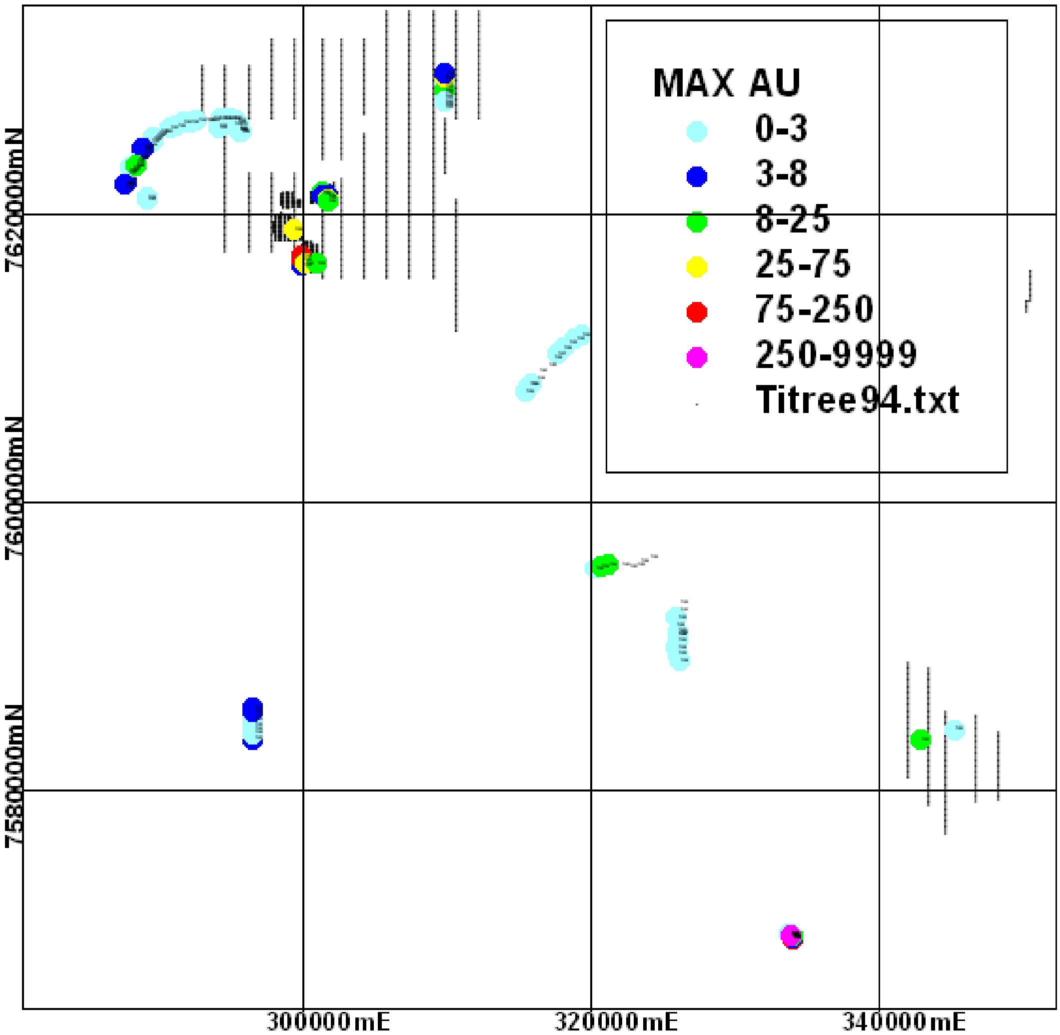
HOLE LOCATIONS - WMC TITREE

The drilling (137 holes) can be placed in two groups.

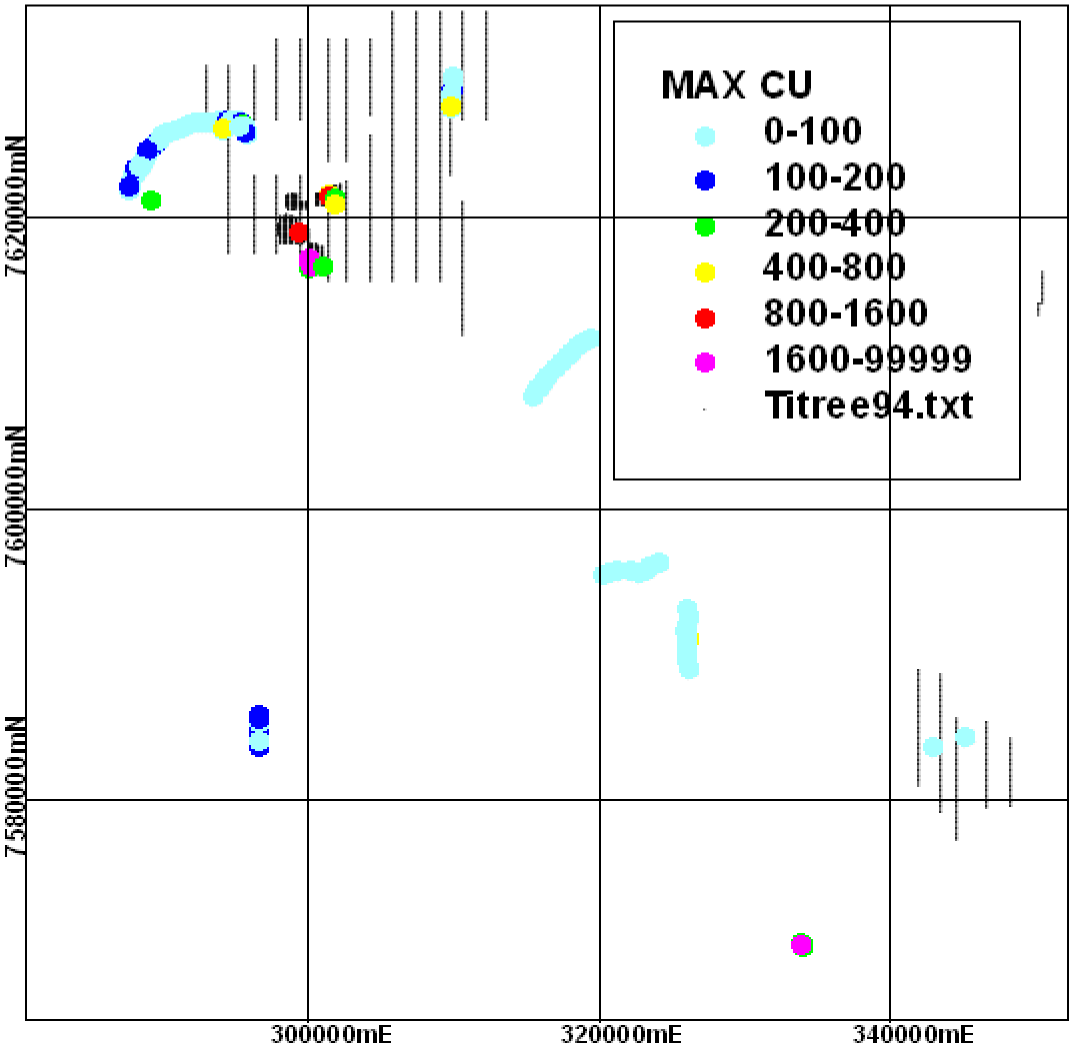
- Regional Traverses
- Isolated holes into mafic/ultramafic in the area of the Ni-Cu lag anomalies.

Gold-Copper

Cu/Au was the target in many of the drill holes. The following plot summarises the gold results.

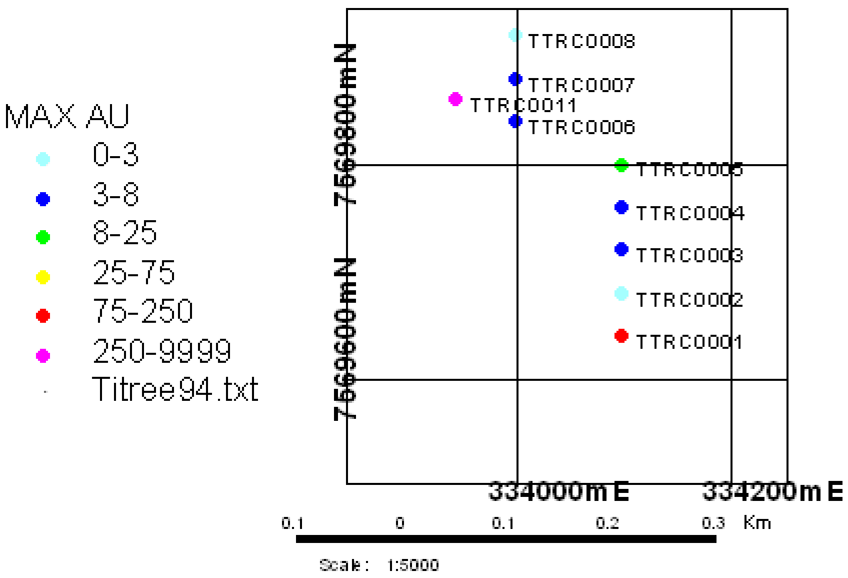


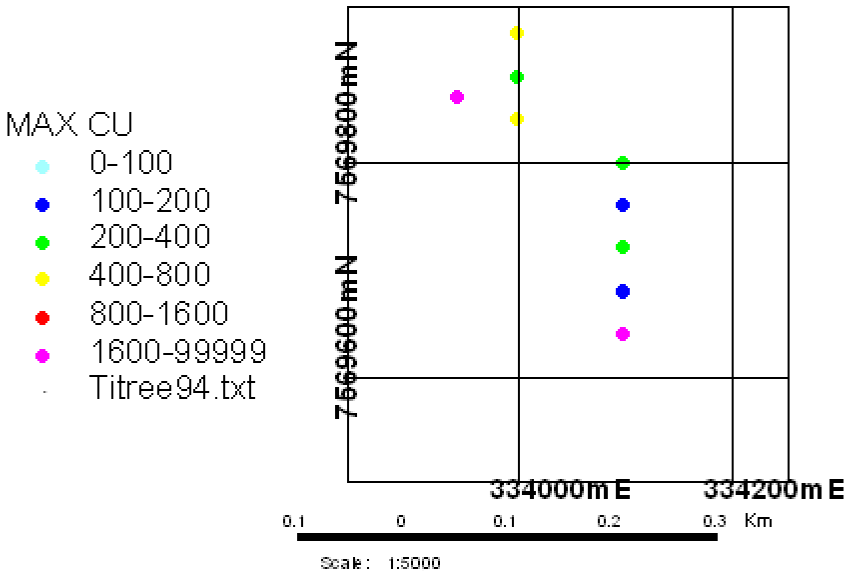
WMC TITREE - GOLD IN DRILLING



WMC TITREE - COPPER IN DRILLING

Away from the Ni-Cu area the most anomalous area for both Cu and Au is in the south of the area.





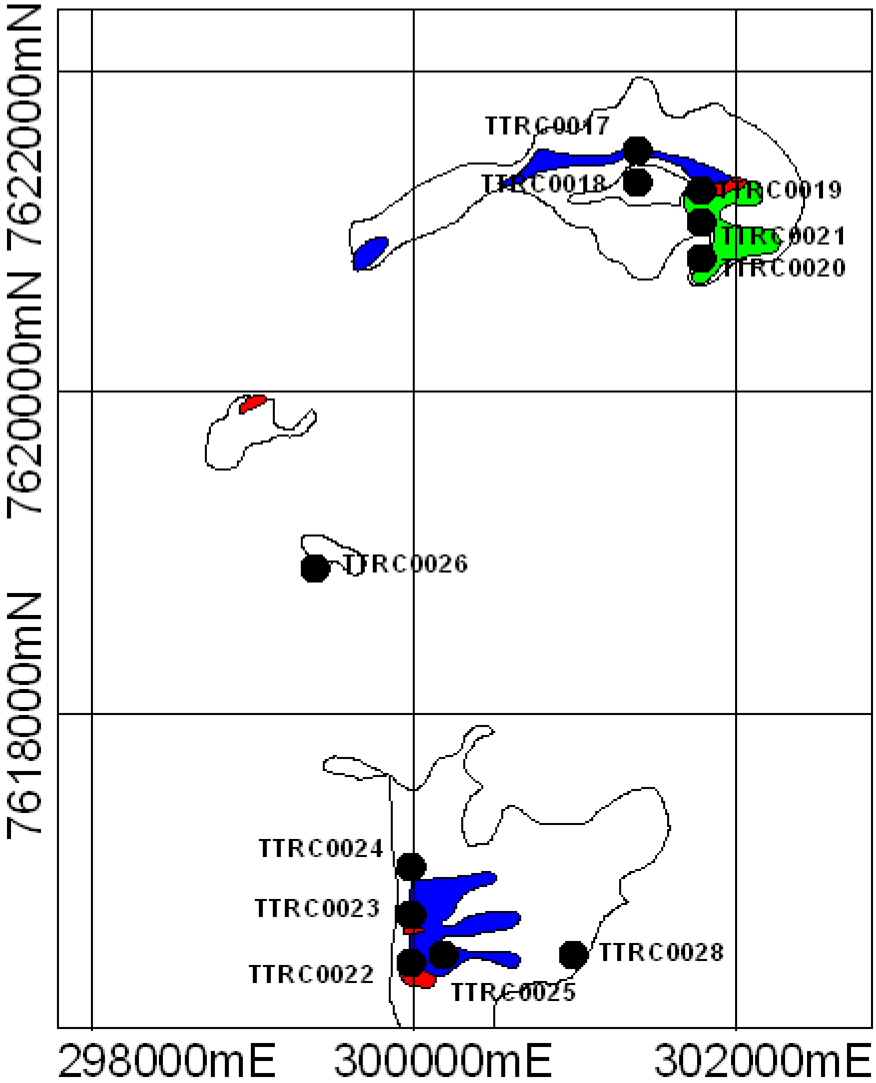
This prospect is off the lag grid. The same two holes TTRC0001 and 11 are most anomalous in both Au and Cu.
Both holes have highly anomalous Cu with spotty gold. Bi is highly anomalous in hole 11.
The geology from the logs is meta sediments. The results for the most mineralised sections of the 2 holes follow.

hole_id	from	to	wthg	colo	lithroot	magsu	Cu_pp	Cr_p	Au_p	Bi_ppm	Ni_p	Co_ppi	Mn_ppn	Fe_pct
TTRC0001	31	32	ww	bn	a-h	0.58	290	90	9	0.10	25	20	620	5.30
TTRC0001	32	33	ww	bn	a-h	0.92	480	105	4		35	75	2250	6.00
TTRC0001	33	34	ww	bn	a-h	0.69	720	95	5	0.20	55	125	4850	8.50
TTRC0001	34	35	ww	bn	a-h	0.53	700	90	2		60	80	2900	9.10
TTRC0001	35	36	mw	bn	a-h	0.37	475	75	6	0.20	40	40	2000	6.50
TTRC0001	36	37	mw	bn	a-h	0.41	960	100	4	0.40	50	145	10600	7.20
TTRC0001	37	38	ww	bn	cv-h-a	0.40	1800	80	14	0.20	80	145	5100	10.50
TTRC0001	38	39	ww	bn	cv-h-a	0.28	1600	85	46	1.40	60	50	1550	10.20
TTRC0001	39	40	ww	bn	cv-h-a	0.35	530	65	6	2.30	30	25	920	6.10
TTRC0001	40	41	ww	bn	cv-h-a	0.33	450	60	3	1.80	35	50	1750	6.20
TTRC0001	41	42	ww	bn	cv-h-a-s	0.32	445	85		1.70	35	55	1900	7.00
TTRC0001	42	43	ww	bn	cv-h-a-s	0.31	440	75		1.60	40	30	1300	7.20
TTRC0001	43	44	ww	bn	cv-h-a-s	5.85	1400	65	7	8.80	85	235	10600	16.00
TTRC0001	44	45	ww	bn	cv-h-a-s	0.41	440	75	1	2.00	40	35	560	7.20
TTRC0001	45	46	ww	bn	cv-a-s-h	0.44	1450	60	15	1.50	80	180	9800	12.70
TTRC0001	46	47	ww	bn	cv-h	0.43	2450	40	13	1.60	155	240	10600	30.90
TTRC0001	47	48	ww	bn	cv-h-s	0.50	2200	50	8	6.50	125	95	2450	23.20
TTRC0001	48	49	ww	bn	cv-a-h-s	0.35	1650	50	26	0.80	90	115	2750	17.90
TTRC0001	49	50	ww	bav	cv-a-h-s	0.25	650	55	11	0.20	45	50	1350	9.20
TTRC0001	50	51	ww	bav	a-s	0.64	485	70	10	0.50	30	30	880	6.90
TTRC0001	51	52	ww	bav	a-s	0.58	320	70	4	0.20	20	20	560	5.40
TTRC0001	52	53	ww	bav	a	1.10	270	55	2	0.30	20	15	550	4.80
TTRC0001	53	54	ww	bav	a	1.11	255	80	2	0.30	20	20	510	5.80
TTRC0001	54	55	ww	bav	a	0.84	190	75		0.20	20	15	390	4.80
TTRC0001	55	56	ww	bav	a	0.74	160	80		0.20	20	15	410	4.80
TTRC0001	56	57	ww	bn	a	1.01	325	90		0.30	25	35	1700	6.50
TTRC0001	57	58	ww	bn	cv-a	0.68	1100	45	22	1.40	85	50	10000	19.90
TTRC0001	58	59	ww	bn	cv-a	0.33	355	75	7	3.50	95	50	1950	6.80
TTRC0001	59	60	ww	bn	cv-a	0.47	260	80	3	1.80	105	60	1650	7.40

hole_id	from	to	wthg	colo	lithroot	magsu	Cu_pp	Cr_p	Au_p	Bi_ppm	Ni_p	Co_pp	Mn_pp	Fe_pct
TTRC0011	0	1	mw	bn	MSph	0.71	550	80	4	19.90	40	20	260	13.30
TTRC0011	1	2	mw	bn	MSph	0.34	570	65	6	11.40	40	20	265	13.10
TTRC0011	2	3	mw	bn	MSph	0.34	440	65	4	8.80	40	25	610	10.30
TTRC0011	3	4	mw	bn	MSph	0.15	820	80	2	8.00	75	175	3550	8.60
TTRC0011	4	5	mw	vbn	MSph	0.21	1350	65	2	21.00	95	220	4150	8.70
TTRC0011	5	6	mw	vbn	MSph	0.31	2250	60	4	22.00	125	245	4300	12.00
TTRC0011	6	7	mw	vbn	MSph	0.48	2850	65	18	12.50	135	165	2600	12.70
TTRC0011	7	8	mw	bn	MSph	0.32	2400	65	17	11.50	90	45	750	12.30
TTRC0011	8	9	mw	vbn	cv	28.50	2850	45	10	5.30	200	180	1550	27.60
TTRC0011	9	10	mw	vbn	MSph	1.51	2250	55	9	40.00	75	85	1950	17.70
TTRC0011	10	11	mw	vbn	MSph	0.41	2800	65	2	16.50	70	65	2000	14.20
TTRC0011	11	12	mw	bn	MSph	1.07	1300	50	10	4.60	40	25	530	17.50
TTRC0011	12	13	mw	bn	MSph	0.76	2250	50	29	460.00	75	55	2650	18.20
TTRC0011	13	14	mw	bn	MSa	0.39	1150	60	47	205.00	50	20	485	11.50
TTRC0011	14	15	vw	bn	MSa	0.30	930	45	29	160.00	30	15	345	11.30
TTRC0011	15	16	mw	bav	MSa	1.14	1300	55	93	350.00	30	15	260	11.10
TTRC0011	16	17	vw	bav	MSa	3.37	1600	110	560	7.50	40	20	370	24.70
TTRC0011	17	18	vw	bn	MSph-a	1.36	1600	80	19	8.50	40	20	460	19.80
TTRC0011	18	19	vw	bn	GR??	1.07	910	75	19	2.70	35	25	285	11.70
TTRC0011	19	20	vw	bn	MSa? a	0.69	890	95	3	3.50	35	20	275	10.30
TTRC0011	20	21	vw	bav	MSa/ a	0.88	930	65	4	4.00	30	20	270	12.00
TTRC0011	21	22	vw	bav	MSa	1.65	610	75	13	4.90	30	25	780	13.30
TTRC0011	22	23	vw	bav	MSa	4.84	750	80	3	24.00	40	25	1050	16.70
TTRC0011	23	24	vw	bav	MSa	2.57	730	70	18	15.70	30	35	1950	15.40
TTRC0011	24	25		bav	a	0.88	230	90	53	22.00	45	30	1650	10.00
TTRC0011	25	26		bav	a h/mt	15.10	330	65	220	3.00	115	85	1900	17.60
TTRC0011	26	27		bav	a h	1.39	125	75	10	1.10	105	90	2700	11.00
TTRC0011	27	28		bav	a	1.52	220	100	1	1.30	25	15	490	7.80

<u>Nickel – Copper</u>

10 holes shown of the following plot were drilled in the area of the Ni-Cu lag anomalies.



Ni Cu Area Hole Locations

All holes contained mafic rocks associated highly anomalous Ni-Cu geochemistry which was investigated in some detail in an attempt to resolve whether the geochemistry indicates potential sulphide sources or is all attributable to weathering.

The holes were stratified into the following units based on the logs and the geochemical patterns

- F fresh rock
- CM Cobalt Manganese rich zone (also Ni)
- CF Ferruginous clays above the CM zone
- DC Duricrust

For each of these units the statistics were calculated. The tabulated data show the mean values for each unit over the 10 hole data set used. Enrichment factors indicate that elements are on a global basis highly enriched in the weathering profile. This is particularly the case in the manganese rich unit, which occurs above the fresh rock. Co is 1000% enriched in this unit and the enrichments for

Cu, Ni, Au, Mn and Cr are in the 400-700% range. Fe is less enriched in this zone but enrichment continues for Fe up the profile in the over lying units.

Variable	Fmean	CMmean	CFmean	DCmean	CM_EN	CF_EN	DC_EN
Au_ppb	3	14	1	0	466	33	0
Co_ppm	65	661	39	24	1016	60	36
Cr_ppm	368	1707	1805	1483	463	490	402
Cu_ppm	192	886	583	373	461	303	194
Fe_pct	4	11	16	20	275	400	500
magsus	5	7	7	2	140	140	40
Mn_ppm	955	5652	1760	815	591	184	85
Ni_ppm	260	1729	685	196	665	263	75

Above the CM unit the Cr remains relatively constant as it is no doubt associated with the Fe in the ferruginous clays and duricrust. Cu declines slowly with a faster decline in Ni and a dramatic decline in Co and Au.
The data explain why Cu is present at higher levels in surface lag material than Ni as these data indicate that Ni is depleted in the duricrust while Cu is enriched by a factor of 2.

Spatial variation of the enrichments in the manganese rich horizon on a hole-by-hole basis were examined.

HOLE	MnEn	CoEN	CuEn	NiEn	CrEn	FeEn
TTRC0017	376	406	108	224	244	122
TTRC0018	462	751	450	351	273	182
TTRC0019	240	552	209	275	264	161
TTRC0020	199	414	148	252	293	132
TTRC0022	186	163	145	144	197	149
TTRC0023	962	1279	654	565	746	615
TTRC0024	816	1993	579	822	711	244
TTRC0025	1281	2232	900	858	348	182
TTRC0026	501	740	266	986	449	172

There are spatial variations present with holes 23-25 particularly showing higher enrichments for Mn, Ni, Cu, Co. These holes are clustered on the Southern of the two major anomaly groups.

The bedrock at all locations is logged as ultramafic and usually as high magnesium variants. The chemistry of the bedrock however has the following composition.

- Ni 260ppm Cu 190 ppm Cr 368 ppm Co 65 ppm Mn 950 and Fe 5%

The assay data would suggest a basalt to magnesium basalt composition. The question remains, are the high metal levels in the regolith derived from the bedrock that has been intersected?

- There are 10 holes so there should be a reasonable probability that more Ni rich rock could have been intersected rather than always being in close enough proximity to disperse the Ni.
- If we assume that Cr is less mobile than Ni or Cu and look at its enrichment we see that it is generally less enriched in the Mn rich unit but the differences are not huge.

- The fresh bedrock at 190 ppm Cu is quite Cu rich and weathering large volumes of rock of this composition would explain the Cu more easily than relating it all to as yet unseen sulphides.

The conclusion is that most of the enrichment is due to weathering effects. With holes 23-25 either this process is stronger or the values are being supplemented by a proximal ultramafic +- sulphide source.

SUMMARY

In the lag geochemistry the dominant features are :

- The Ni and Cu anomalies which at this stage are attributed to mafic rocks although it is possible that ultramafic rocks are present as the exposure is poor and the drilling density is low.
- Broad and narrow Bi anomalies. There nothing to suggest that these are of any economic interest. Some are associated with Cu and that association was intersected in drilling in the S of the WMC area in holes 1 and 11 with Cu values around 2000 ppm and patchy low level gold.

In the drilling the two strong features are :

- Cu Bi (Au) described above
- Strong Ni-Cu-Co-Mn associated with mafic rocks. Examination of the weathering profile chemistry indicates :
    - The depth of weathering over the mafics is 25-30m and includes from the base up:
        - 5-8m Mn enriched zone above the saprock
        - 5m of Fe rich clays
        - 5m of Duricrust
        - In some holes the duricrust is covered by sand or up to 5m of exotic lateritic debris (geochemistry not compatible with Cu-Cr rich duricrust over the mafics)
    - Anomalism is most likely due to weathering processes.
    - Enrichments of the order of 400% are associated with a Mn rich unit near the base of the weathering profile.
    - In the upper part of the profile (Duricrust) Cu is still enriched but Ni depleted relative to bedrock concentrations. This is why Cu levels in surface lags are higher than Ni and why the Cr – Cu combination defines the position of the mafic rocks in the lags better than Ni.

The lags have outlined an area of mafics that have been tested by sparse drilling. The strong enrichment processes in the regolith make it unlikely that discrete high contrast anomalies will be generated in the lags and which fits with the patterns in the data collected.
Some of the lag anomalies are not closed off with high values for Cu/Ni in end of line samples.
Neither the lag or drilling data set contain Zn as a variable. This may have assisted in the interpretation although it is probable that it would have had the same broad enrichments as the Cu Ni and Co.
PGE's may provide vectors to sulphides in both the lag and regolith drilling.

Richard Carver
15 May 2003