

**DENSITY AND SUSCEPTIBILITY CHARACTERISATION OF MAJOR
ROCK UNITS AND ROCK TYPES, MOUNT ISA INLIER**

JUNE 2004

**I1 & I2 PROJECTS
PMD*CRG**

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INTRODUCTION

The following report compiles density and magnetic susceptibility measurements over the Mount Isa Inlier. Data is based entirely on datasets from BMR Report 265 (Hone et.al., 1987) and Xstrata (MIM, 2004). From a combined compilation of just under a 1000 entries, the data were reduced down to 706 by removing duplicate readings.

Attributes documented cover density (saturated and grain), susceptibility (induced and remanent), porosity, sample condition and lithological descriptions. However, rarely are all attributes present for each sample and only in 312 cases are both density and magnetic susceptibility measurements present.

Of the above samples, only Hone et. al. (1987) document remanence for all samples measured. Consequently, tabling and discussion of permanent magnetisation of Mount Isa rocks has not been undertaken and the reader is referred back to BMR Report 265.

Whilst there are substantial gaps in unit and lithology coverage, the combined datasets should provide a starting point for potential field modelling and petrophysical characterisation of the Mount Isa Inlier.

DATASETS

Figure 1 shows spatial distribution of all samples across the Mt Isa Inlier, with the complete BMR and Xstrata databases presented in Appendix I and Appendix II respectively. With few exceptions, BMR database has been reproduced by Xstrata.

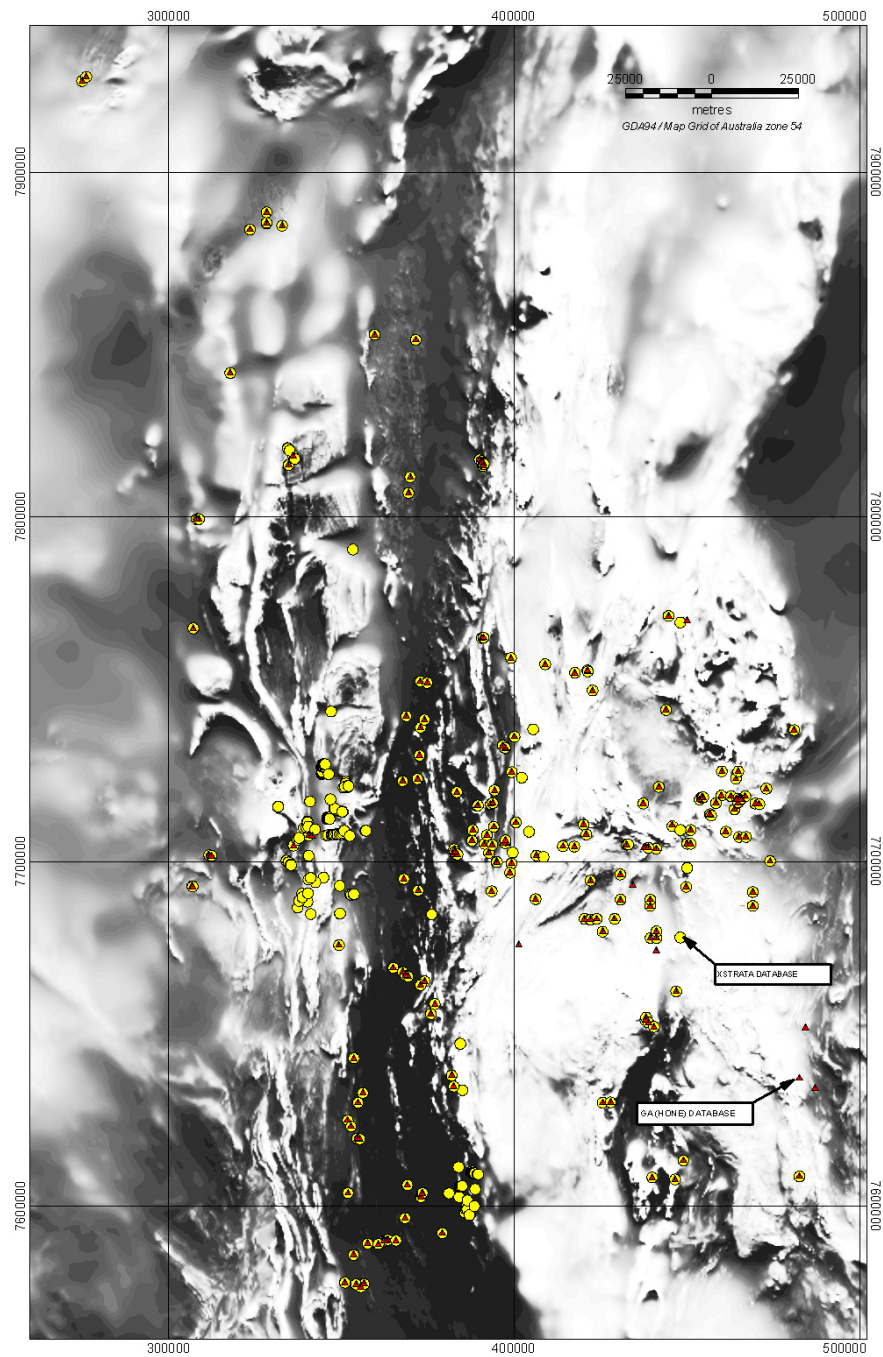


Figure 1 Density and susceptibility databases, Mount Isa Inlier. Yellow circles show coverage by Xstrata and red triangles show BMR Report 265 coverage. Sample sites overlain on total magnetic intensity.

The distribution between west and eastern succession is fairly equal, but not surprisingly, most samples occur within a narrow swath around the Cloncurry/Mount Isa transport corridor. This has implications for the representativeness of unit sampling and particularly, coverage of equivalent units to the north and south of the central Isa belt.

GENERAL ROCK-TYPE CHARACTERISATION

The 706 samples have been classified into one of six rock types based on general unit descriptions:

Quartzites	-	1
Felsic Volcanics	-	2
Granites	-	3
Sedimentary and Non Volcanic Sequences	-	4
Basalt	-	5
Gneissic (of undefined parent rock)	-	6

Figure 2 shows the spatial distribution colour coded to the above classification with basic statistics on density and susceptibility provided in Table 1.

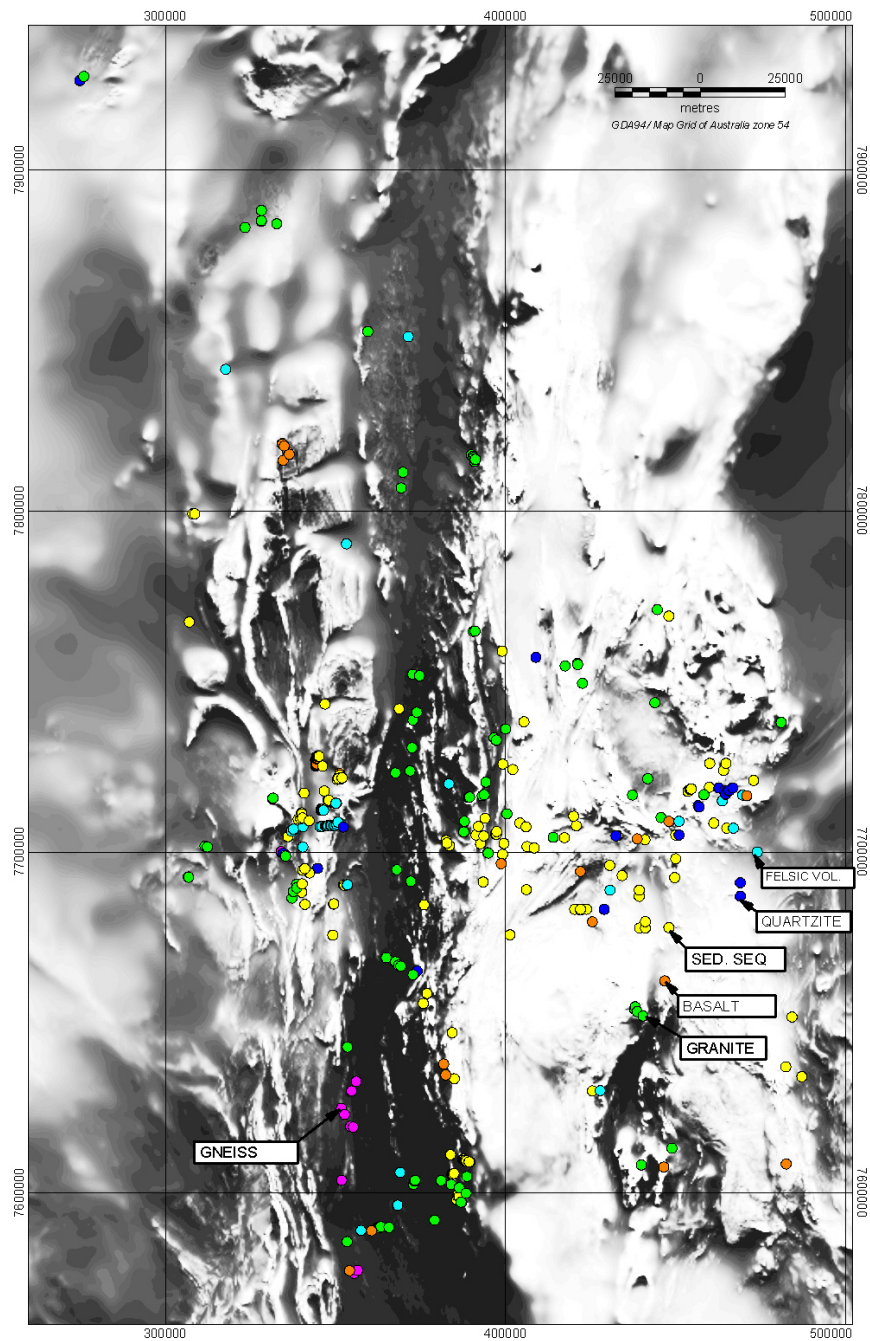


Figure 2 Density and susceptibility measurements across the Mount Isa Inlier classified in lithology. Colour code as follows: blue – quartzite, cyan – felsic volcanics, green – granite, yellow – sedimentary sequences, orange – basalt, red – gneissic. Coding based on unit classification and not necessarily rock description.

Rock	Density (saturated)			Density (grain)			Magnetic Susceptibility		
	N/M/SD	(g/cc)		N/M/SD	(g/cc)		N/M/SD	(SI*10 ⁻⁵)	
Quartzite	28	2.79	0.28	7	2.77	0.01	31	1989	5110
Felsic Volcanic	34	2.81	0.16	10	2.72	0.15	101	2027	2363
Granite	94	2.66	0.06	80	2.68	0.06	101	858	2041
Sedimentary	17 2	2.74	0.18	99	2.81	0.21	275	2279	2212
Basalt	22	2.94	0.12	17	2.99	0.09	101	1511	2487
Gneissic	11	2.69	0.13	9	2.68	0.07	11	917	2086

Table 1 Major rock-type densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III, with sample size (N), geometric mean (M) and standard deviation (SD).

As shown in Table 1, distinction has been made between saturated and grain density. The term 'saturated' refers to a volumetric density with open pores filled with water, and 'grain' density representing an equivalent rock with zero porosity. Since most of these competent rocks have very small effective and true porosities, dry bulk density can be assumed to be near equivalent to the saturated density and grain density. Nevertheless, the measured saturated density will be smaller than the grain density and the apparent reversal with some rocks in Table 1 is due to sampling from different populations. A detailed discussion of density measurements is provided by Emerson, D.W., (1990).

Based on Table 1, gneisses and granites within the Mount Isa Inlier are typically rocks with the lowest mean densities; the highest densities attributable to basalts. In terms of magnetics however, any characterisation would appear to be extremely difficult. If this is not just reflecting the intrinsic nature of Isa rocks, then the likely cause is varying degrees of weathering on sample sets with the most severe impact being on the magnetic mineral content.

Results of Table 1 are presented graphically in Figures 3 and 4 for saturated densities and magnetic susceptibilities respectively. Despite poorly populated distributions, there appears to be a tendency for Poisson distribution for density and banded distribution for magnetics.

The dataset were further reduced to samples where both density and magnetic susceptibility measurements exist. In view of the more common saturated density (equivalent to volumetric density bulk density) this has been used for the density-magnetic scattergram of Figure 5.

Bin	Quartzite	Volcanic	Granite	Sed.	Basalt	Gneiss
2.50	0	0	0	6	0	0
2.55	1	1	4	0	0	0
2.60	2	0	12	7	0	1
2.65	6	8	35	17	1	6
2.70	8	12	24	34	4	1
2.75	3	0	15	31	5	1
2.80	2	1	4	19	6	1
2.85	3	1	0	13	2	0
2.90	0	1	0	10	3	0
2.95	0	1	0	2	2	0
3.00	1	0	0	6	11	0
3.05	1	0	0	3	7	1
3.10	0	0	0	3	3	0
3.15	1	0	0	0	3	0
3.20	0	0	0	0	0	0
3.25	0	0	0	0	0	0
3.30	0	0	0	0	0	0
3.35	0	0	0	0	0	0
3.40	0	0	0	0	0	0
3.45	0	0	0	0	0	0
3.50	0	0	0	2	0	0
3.55	0	0	0	0	0	0
3.60	1	0	0	0	0	0
3.65	0	0	0	1	0	0
3.70	0	0	0	0	0	0
3.75	1	0	0	0	0	0
3.80	0	0	0	0	0	0
3.85	0	0	0	0	0	0
3.90	0	0	0	0	0	0
3.95	0	0	0	0	0	0
4.00	0	0	0	0	0	0
4.05	0	0	0	0	0	0
4.10	0	0	0	0	0	0

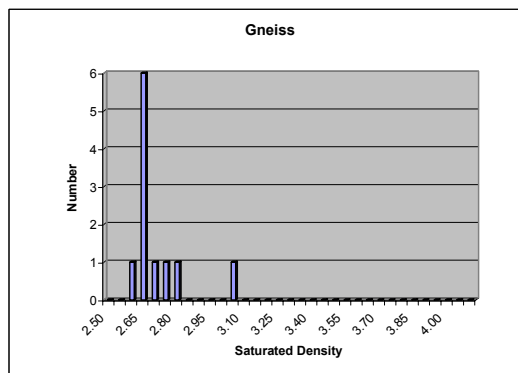
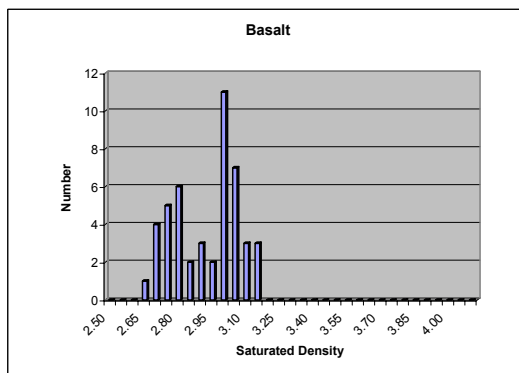
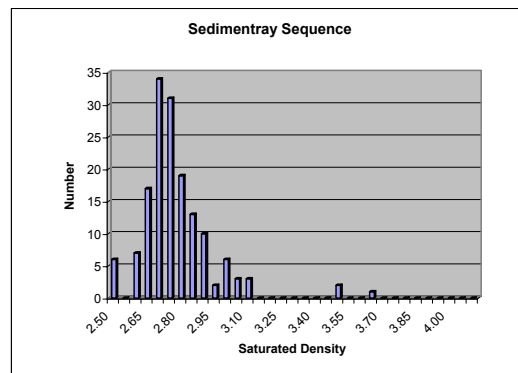
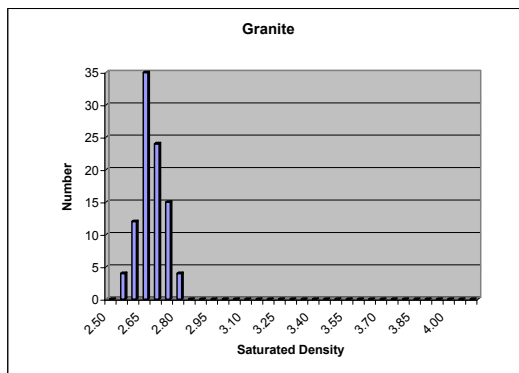
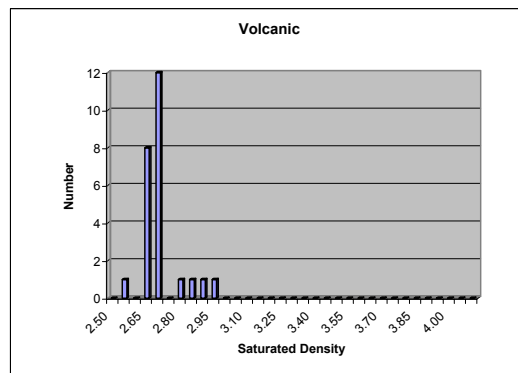
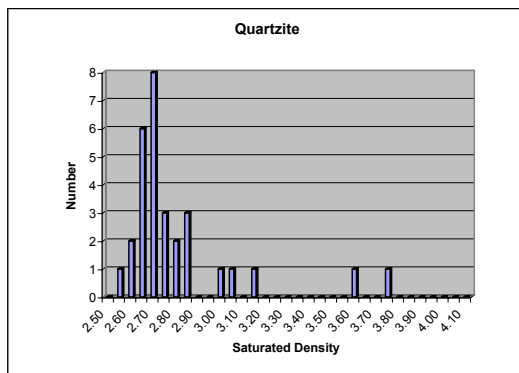


Figure 3 Frequency distributions of densities for major rock-types, Mount Isa

Bin	Quartzite	Volcanic	Granite	Sed.	Basalt	Gneiss
5	7	6	11	87	47	2
10	3	0	7	11	1	1
20	3	1	14	20	0	1
50	4	2	26	39	5	2
100	2	0	6	14	7	0
200	3	2	7	28	19	3
500	4	1	5	16	13	0
1000	1	2	5	10	18	0
2000	1	1	4	7	17	0
5000	2	4	11	17	43	1
10000	0	2	4	4	20	1
20000	2	0	1	5	3	0
50000	1	0	0	2	0	0
100000	0	0	0	0	0	0
200000	0	0	0	0	0	0
5000000	0	1	0	0	0	0

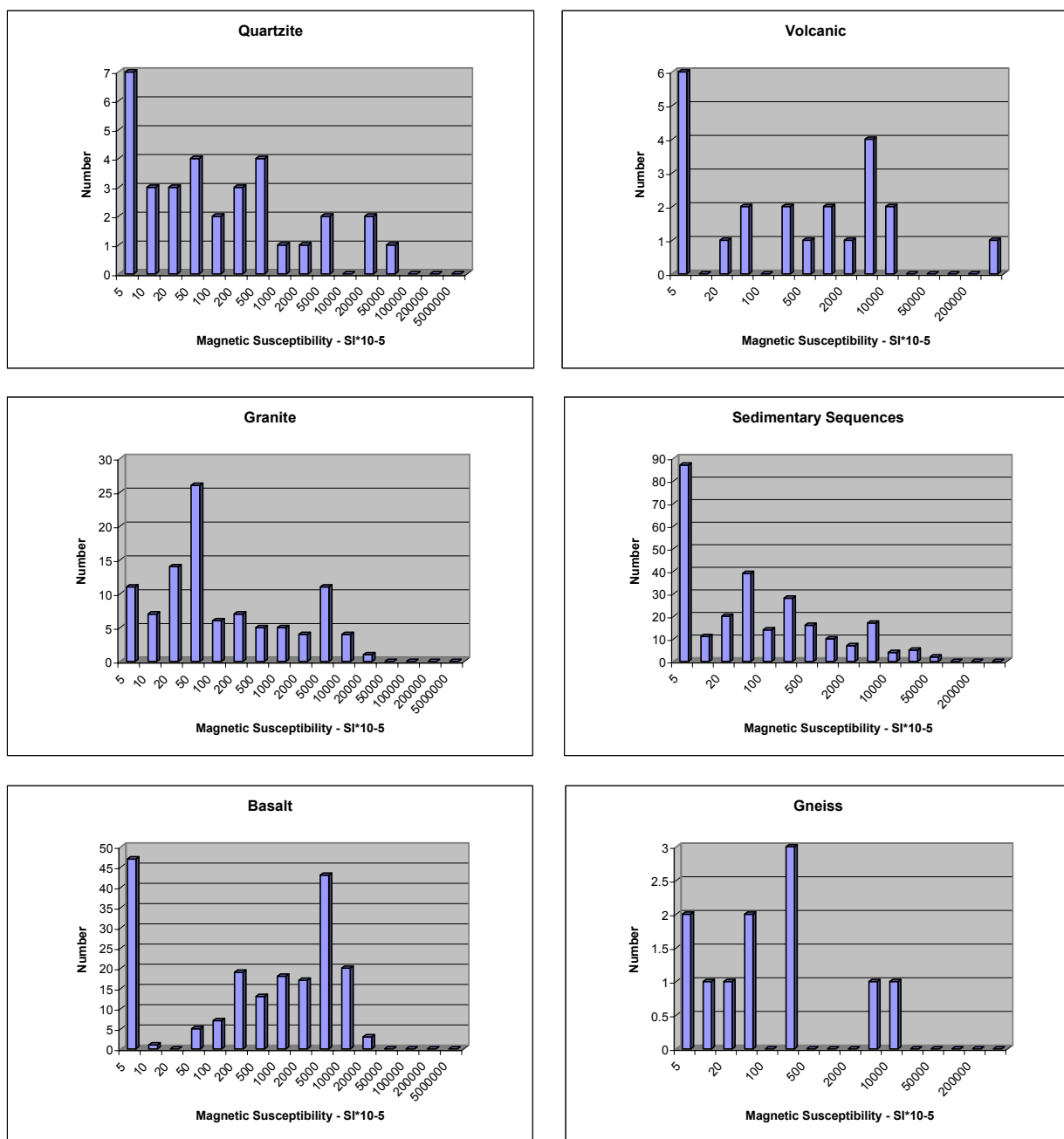


Figure 4 Frequency distributions of magnetic susceptibilities for major rock-types, Mount Isa

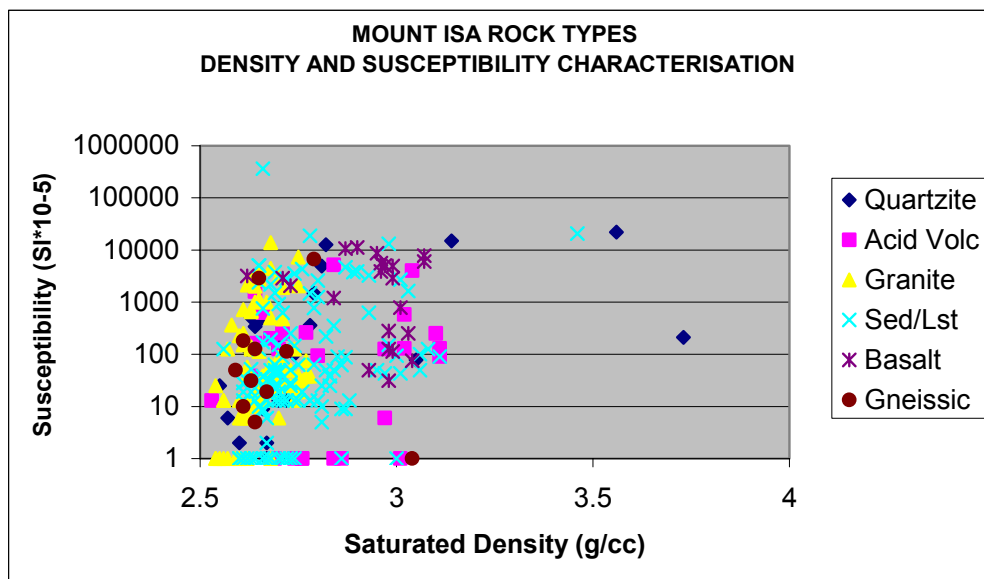


Figure 5 Susceptibility versus saturated density for Mount Isa rock types.

From Table 1 and Figures 3-5, additional comments are as follows:

1. With the exception of a few unusual quartzite samples, the entire dataset occupies a fairly amorphous band between 2.6 and 3.0g/cc with susceptibilities of 0 to 10000×10^{-5} SI.
2. Isa granites show the tightest distribution in density. They have a geometric mean of 2.66 and 2.68g/cc for the saturated and grain density respectively (SD of 0.06)
3. Basalts show a bimodal distribution with centres on 2.8 & 2.94g/cc (saturated). The lower density population is predominantly Eastern Creek Volcanics.
4. Note the much higher average density for sedimentary units over granites. This has been observed in regional forward modelling across both the eastern and western succession, where invariably, granites and not sediments are associated with Bouguer minima.

An additional data reduction has been performed to divide all rock-type data into units (Appendix III). Whilst it was envisaged that these subsets could be rigorously analysed, individual 'residual' population subsets are fairly small and lend themselves to 'tokenism' at best. Nevertheless, if strict statistical validity tests can be put aside, some informative observations can be made.

On a type by type basis, these are summarised in the following sections.

BASALTS

Table 3 sets out mean densities and susceptibilities for the main basalts sampled with results presented graphically in Figure 6.

Basalt	Density (saturated) N/M/SD (g/cc)			Density (grain) N/M/SD (g/cc)			Magnetic Susceptibility N/M/SD (SI*10 ⁻⁵)		
Cone Creek	1	2.84	-	-	-	-	1	1200	-
Cromwell	3	2.96	0.10	3	3.01	0.10	5	5750	4643
Pickwick	4	2.98	0.02	3	3.02	0.05	4	2900	2843
Pickwick Unidiff							80	1020	1851
ECV - Undiff	14	2.81	0.12	2	2.75	0.07	81	2412	2429
Toole Creek	9	2.99	0.16	1	3.10	-	8	157	172
Marraba	2	2.77	.09	1	2.79	-	2	2725	3500
Generic Dyke	12	2.91	0.14	9	2.97	0.10	12	3145	3208

Table 2 Major basalt densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

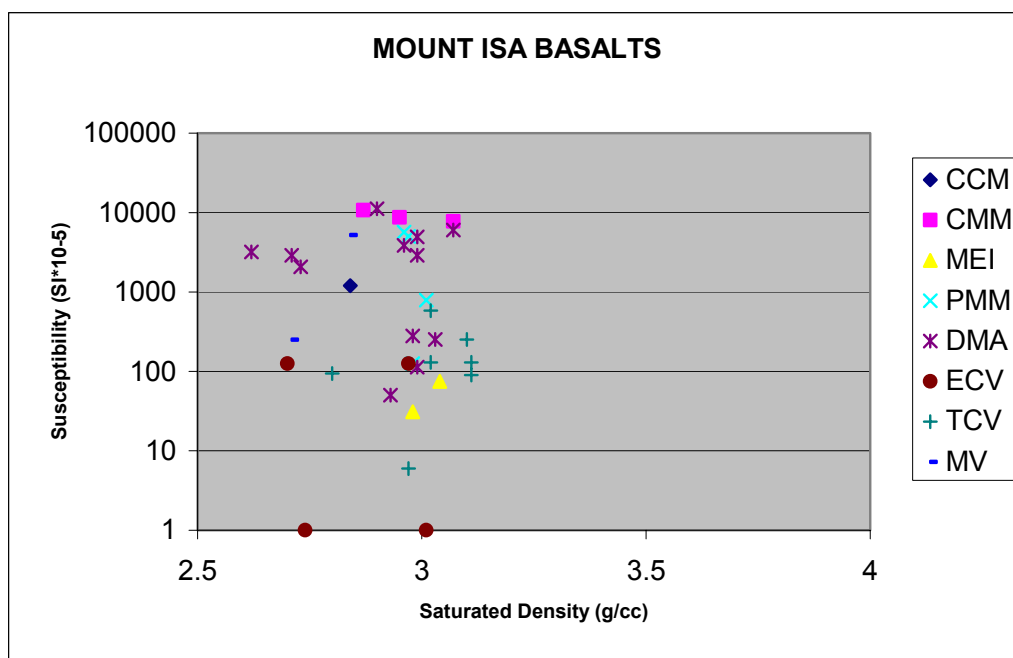


Figure 6 Susceptibility versus saturated density for Mount Isa basalts. Codes are as follows: CMM – Cromwell, CCM – Cone Creek, MEI – Mount Erle Igneous Complex, PMM – Pickwick, DMA – Dolerites/Amphibolites, ECV – Eastern Creek Volcanics, TCV – Toole Creek Volcanics and MV – Marraba Volcanics.

The Cromwell Metabasalt (CMM) is the most magnetic of basalts encountered within the region. Based on this small sample set it can be distinguished from the Pickwick metabasalt (PMM) of the Eastern Creek Volcanics, which has an equally variable but smaller mean magnetisation. Undifferentiated ECVs (ECV) also form a discrete group of lower magnetised material although it is unclear whether they encompass the above metabasalt units and the Lena quartzite or, a completely different expression of Eastern Creek Volcanics. For similar reasons, a class of Pickwick samples (labelled undifferentiated) have also been treated separately; covering a broad range of rock descriptions but yet still singularly described as Pickwick Member.

Dolerite/Metadolerite/Amphibolite (DMA) covers samples from dykes over the Marraba, Selywn and Mary Kathleen 100,000 geological sheets. Whilst it presents a reasonably well-scattered (spatial) distribution, the abundance of different-timed intrusives throughout the Inlier, makes it uncertain as to how meaningful these mean values are.

GRANITES

A total of 87 samples cover 16 granites within the database. Table 3 details granite densities and susceptibilities based on the dataset of Appendix III.

Granite	Density (saturated) N/M/SD (g/cc)			Density (grain) N/M/SD (g/cc)			Magnetic Susceptibility N/M/SD (SI*10 ⁻⁵)		
Big Toby	5	2.67	0.05	5	2.68	0.05	5	150	282
Gin Creek	1	2.56	-	1	2.65	-	1	0	-
Hardway	8	2.66	0.04	8	2.68	0.05	8	206	383
Mount Dore	1	2.64	-	1	2.66	-	1	138	-
One Tree	8	2.71	0.05	8	2.74	0.05	8	28	7
Wills Creek	1	2.65	-	1	2.67	-	1	13	-
Woonigan	1	2.54	-	1	2.61	-	1	0	-
Yeldham	2	2.66	.01	2	2.66	.01	2	500	500
Kalkadoon	22	2.68	.05	22	2.70	.05	22	193	666
Wonga	11	2.65	.06	11	2.68	.06	12	226	570
Naraku	11	2.66	.04	9	2.68	.04	11	3647	3892
Sybella	7	2.63	.05	-	-	-	8	110	170
Weberra	5	2.56	.02	5	2.59	.02	5	7	11
Wimberu	5	2.62	.02	5	2.66	.03	5	977	1772
Mt Margaret	4	2.67	.05				5	4936	2093

Table 3 Major granite densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

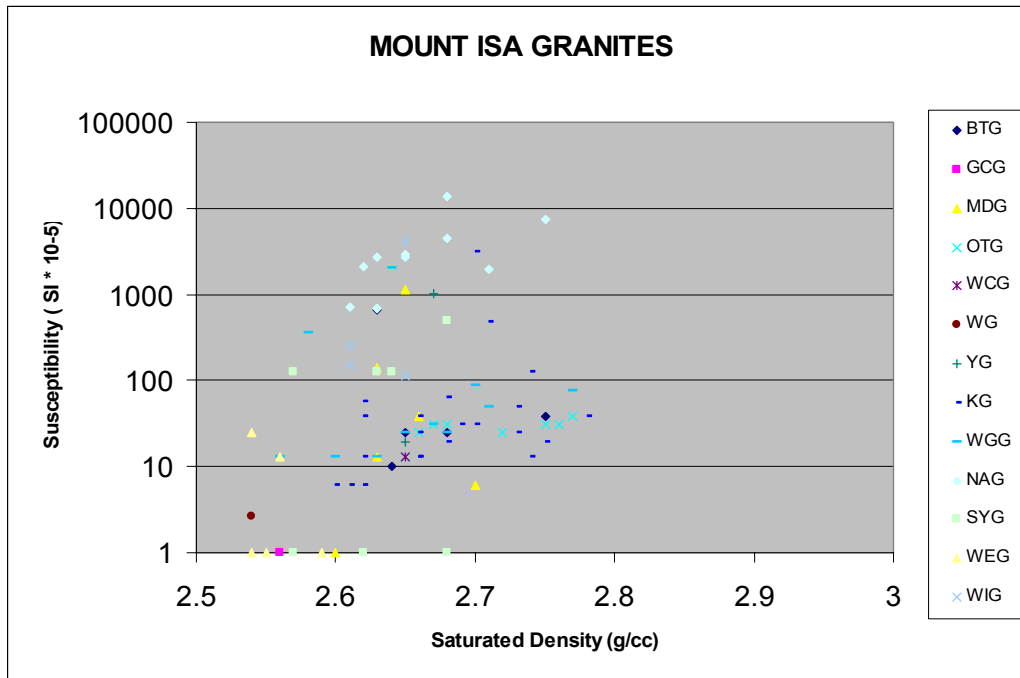


Figure 7 Susceptibility versus saturated density for Mount Isa granites. Granite coding is as follows: BTG – Big Tree, GCG – Gin Creek, MDG – Mount Dore, OTG – One Tree, WCG – Wills Creek, WG – Woonigan, YG – Yeldham, KG – Kalkadoon, WGG – Wonga, NAG – Naraku, SYG – Sybella, WEG – Weberra & WIG – Wimberu.

Table 3 shows typical densities for granites, with One Tree (2.71) and Woonigan (2.54) being extremes. Magnetisations are similarly varied, with a tendency for higher magnetisations and variability amongst the denser bodies. Figure 7 summarises the results graphically, with results as follows:

1. There is an overall tendency for density to increase with increasing (iron) magnetic component.
2. More significant, is the partition of the dataset into three families:
 - a. Those showing a pattern of lower susceptibility range of 10 to 100 SI, but nevertheless increasing with density. This set is populated by predominantly Early Proterozoic granites.
 - b. Those showing a pattern of higher susceptibilities ranging from 100 to 10000SI, increasing with density. This set is populated by Late Proterozoic granites
 - c. Finally, the Weberra, Sybella and Wonga granites of Middle Proterozoic age showing a broad range of susceptibilities with little correlation to density.

Most of this dataset has been sourced from Hone where the weathering condition has been recorded on just under 75% of samples. Figure 8 shows scattergrams for the Kalkadoon Granite of density and susceptibility against samples classified as either fresh (1) or slightly weathered (2). On initial inspection the degree of weathering appears to control density scatter, but a

review of spatial distribution demonstrates that this differentiation is more likely just to be sample-location dependent.

With the entire granite dataset classified as either fresh or slightly weathered, more detailed analysis based on what may be a minor differentiation (and possibly observer-dependent classification) would appear to be over-analysing.

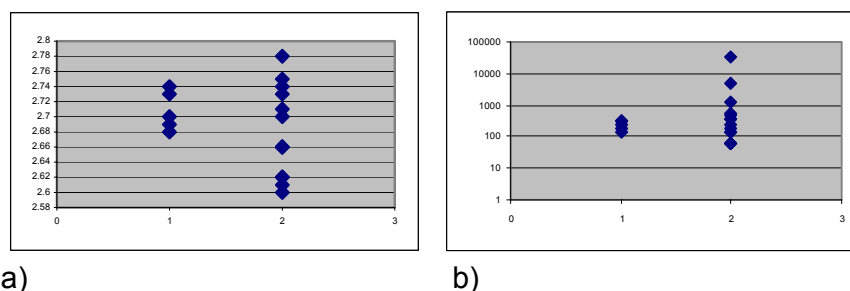


Figure 8 Kalkadoon Granite density (a) and susceptibility (b) versus weathering condition. Samples are either fresh (1) or slightly weathered (2).

QUARTZITES

Five quartzites have been logged, with details presented in Table 4 and Figure 9.

Quartzite	Density (saturated) N/M/SD (g/cc)			Density (grain) N/M/SD (g/cc)			Magnetic Susceptibility N/M/SD (SI*10 ⁻⁵)		
Torpedo	3	2.72	.03	3	2.70	.06	3	14	15
Warrina							3	12	14
Knapdale	1	2.55		1	2.68		1	22	
Ballara	1	2.82		1	2.93		1	12690	
Mitakoodi	4	2.77	.09	2	2.82	.04	3	3138	1716
Mt Guide	2	2.65	.04				3	42	72
Mt Norna	18	2.84	.33				18	2182	6060
Lena	1	2.7					1	126	

Table 4. Major quartzite densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

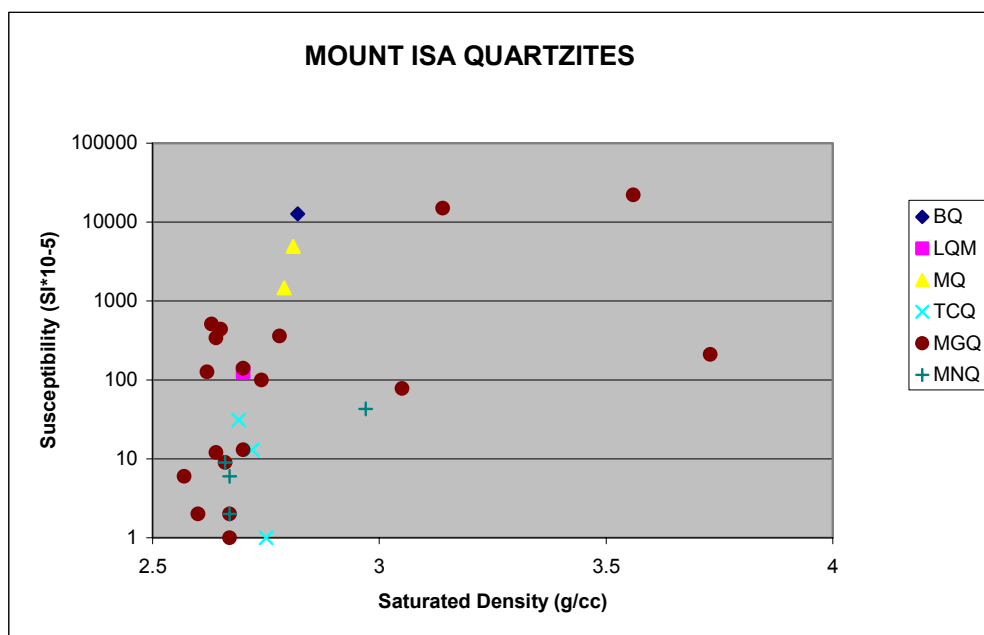


Figure 9 Susceptibility versus saturated density for Mount Isa quartzites. Codes are as follows: BQ – Ballara, LQ – Lena, MQ – Mitakoodi, TCQ – Torpedo Creek, MGQ – Mount Guide & MNQ – Mount Norna Quartzite.

With the exception of the Mt Norna Quartzite, unit samplings are relatively poor. Nevertheless, a few points to note are:

1. A broad range of densities with significant intergranular porosity as noted by the change from saturated to grain density for three of the quartzites.
2. A good correlation between heavier quartzites and more iron (magnetic) content. The distribution is essentially bipolar and the quartzites are either moderately magnetic or non magnetic.

Note also that the rock descriptions attached to the quartzite members are extremely varied and cover anything from shales, to acid volcanics through to metadolerites. Only in 14 of the 35 samples are they actually described as quartzites.

The Mt Norna Quartzite sampling offers an opportunity to test the relationship of density and susceptibility to weathering (Figure 10). Just under 20 samples are attributed from fresh (F) to highly weathered (H). In this case, while there is not a strong spatial dependency of sample to weathering, the sample population is too small to apply rigorous dependency tests.

On a more qualitative basis, it appears that as the weathering becomes more severe, the mean and scatter of density and susceptibility increase. This is rather perplexing, but can be explained by the lithology descriptions that show that the more weathered samples tend to populate the more iron-rich rock types. As with the weathering test on granites, results are being skewed by unrepresentative population sets.

Observ	Easting	Northing	Weather	Index	Density	Susc	Lithology
10	464700	7717000	F	1	3.05		78 metadolerite
7	456900	7713200	S	2	2.64		340 impure quartzite 1
11	465500	7718000	S	2	2.57		6 feldspathic quartzite
12	465600	7718000	S	2	2.74		100 porphyritic rhyolite
13	465700	7718000	S	2	2.60		2 siltstone
14	465700	7718100	S	2	2.64		12 rhyolite
17	469000	7691000	S	2	2.66		9 feldspathic quartzite
18	447400	7770000	SW	2	2.67		6 fine/med-grained quartzite
2	456600	7713600	M	3	2.63		510 impure quartzite 1
3	462700	7718800	M	3	3.14		15000 quartzite/greywacke
6	451000	7705000	M	3	2.67		2 calc. quartzite
8	464700	7716900	M	3	2.65		440 banded ironstone
9	464700	7716900	M	3	2.70		140 labile quartzite
15	466800	7718800	M	3	2.78		360 white quartzite
16	469000	7687000	M	3	2.70		13 laminated shale
19	447400	7770000	MW	3	2.97		43 siltstone
1	352300	7707300	H	4	2.67		0.1 feldspathic quartzite
4	464400	7718000	H	4	3.56		22000 banded quartz-magnetite
5	465400	7718000	H	4	3.73		210 banded hematite rock

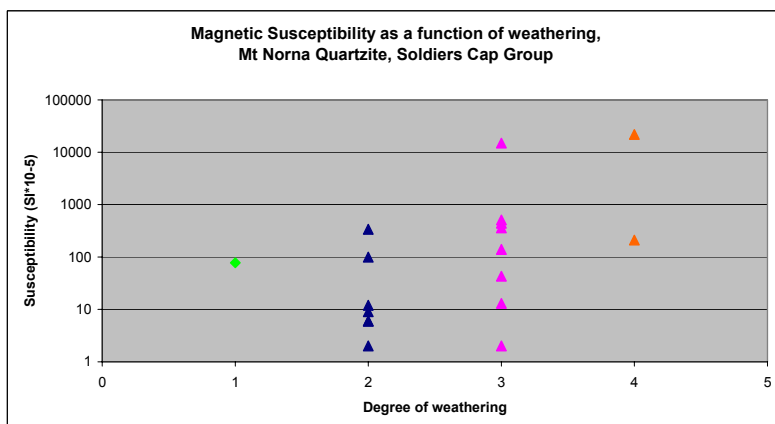
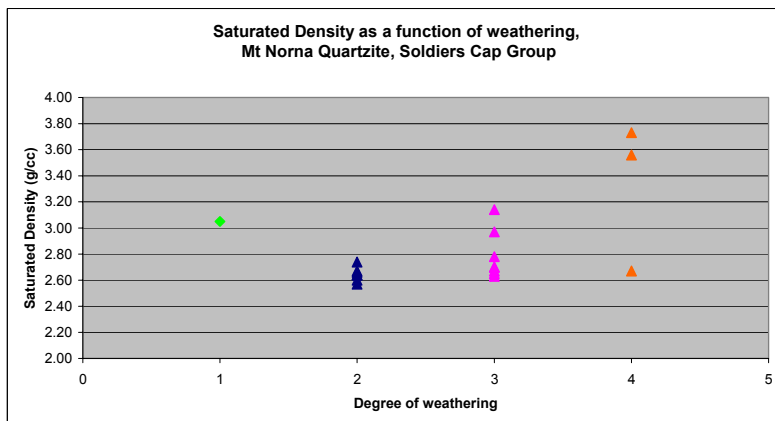
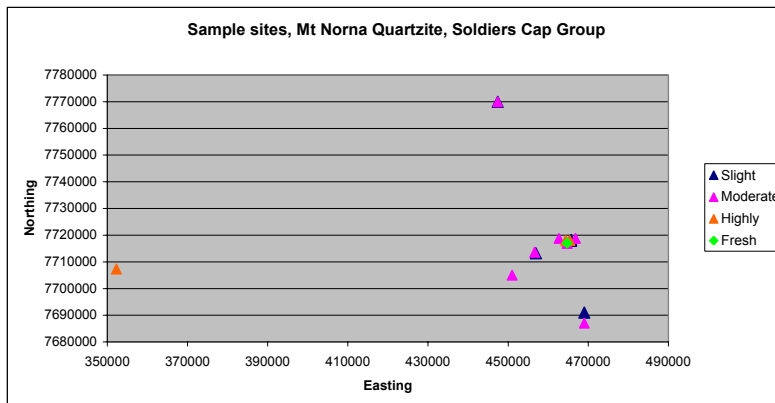


Figure 10 Impact of weathering on Mt Norna Quartzite density and susceptibility measurements.

FELSIC VOLCANICS

Table 5 summarises measurements made on Felsic Volcanics and shown as a scattergram of densities versus susceptibility in Figure 11.

Volcanics	Density (saturated) N/M/SD (g/cc)			Density (grain) N/M/SD (g/cc)			Magnetic Susceptibility N/M/SD (SI*10 ⁻⁵)		
Fiery Creek	1	2.53		1	2.54		1	13	
Argylla	11	2.69	0.09	7	2.73	.11	8	47310	128145
Tewinga (Leichardt?)	1	2.68							
Bottletree	4	2.65	.01	2	2.68	.01	4	2513	2902
Leichardt	9	2.71	.09	5	2.66	.03	9	290	525

Table 5. Major felsic volcanic densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

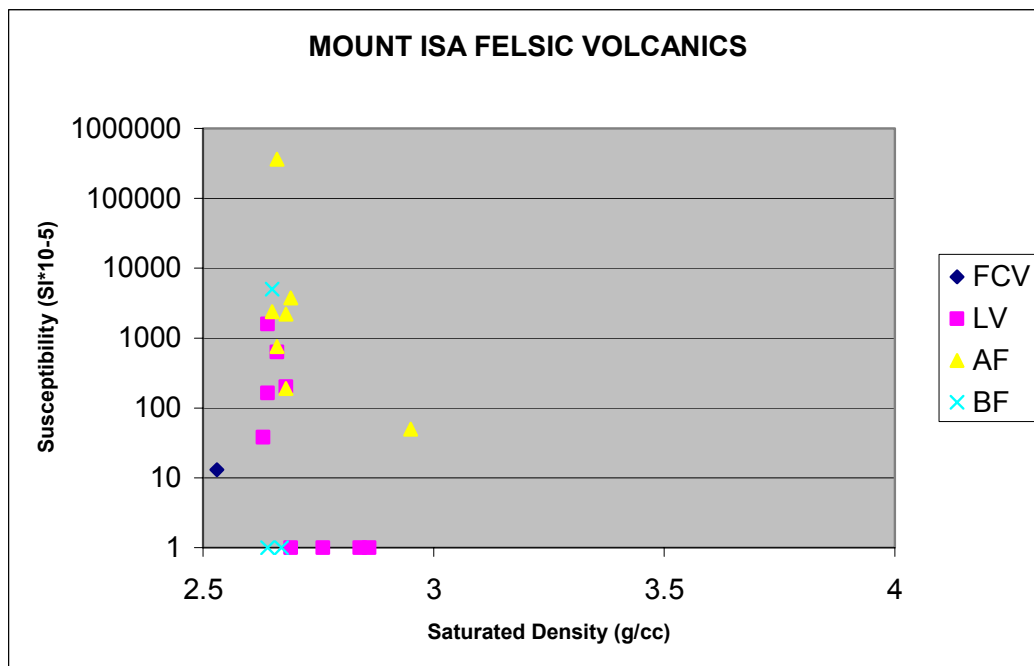


Figure 11 Susceptibility versus saturated density for Mount Isa Felsic Volcanics. Codes are FCV – Fiery Creek, LV – Leichardt, AF – Argylla Formation & BF – Bottletree Formation.

Table 5 shows a relatively minor cross-section of acid volcanics of the Mount Isa Inlier. Not surprisingly, densities are low compared to mafic equivalents, and both densities and susceptibilities are extremely variable – intra-sequence and between the various flows.

SEDIMENTARY AND OTHER NON-VOLCANIC SEQUENCES

Including some of the main formations within the region, Table 1 summarises results for the non-volcanic sequences and presented graphically in Figure 12.

Non-Volcanic Sequences	Density (saturated) N/M/SD (g/cc)			Density (grain) N/M/SD (g/cc)			Magnetic Susceptibility N/M/SD (SI*10 ⁻⁵)		
McNamara									
Paradise Ck	10	2.78	.07	10	2.79	.06	8	6	6
Gunpowder	19	2.73	.1	19	2.74	.11	19	105	370
Surprise Ck	5	2.57	.13				9	20	40
Mount Isa									
Moondarra	6	2.72	0.05	1	2.75		46	77	89
Mary K									
Corella Fm	66	2.78	.18	38	2.85	.26	113	1581	3757
Marimo	11	2.45	.27	11	2.77	.24	1	2	
Overhang	10	2.84	.29	10	2.92	.22	11	2676	6038
Soldiers Cap	5d	2.76	.14	2	2.97	.19	5	3793	8416
Myally Sub	2	2.60					43	15	63
Judenan	7	2.73	.13				5	25	56
Native Bee	7	2.78	.1						
Urquhart	3	2.78	.03						
Mt Novit	3	2.87	.14				1	4700	
Breakaway									

Table 6 Sedimentary and other non-volcanic sequence densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

The main sequence formations of Mount Isa all have atypically high densities and variable magnetic signatures. The Overhang Jaspilite is the densest and most magnetic, reflecting the high iron content. Typical siltstone densities are only observed for the Myally and Marimo; the former result of limited statistical credence given the limited sampling and the latter showing considerable intergranular porosity based on the change from saturated to grain density.

Consequently, the overall picture is that of sediments that have been tightly compacted and/or metamorphosed, with limited characteristics of classical measurements. Such a sample set highlights the danger of applying text-book petrophysical values indiscriminately and based purely on lithological descriptions.

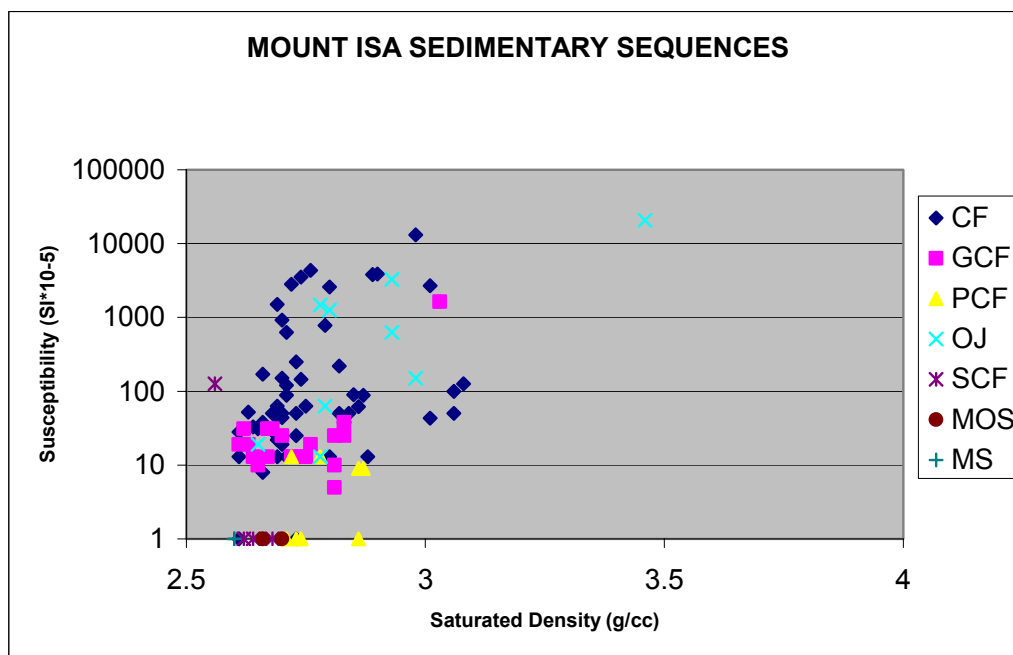


Figure 12 Susceptibility versus saturated density for Mount Isa sedimentary and other non-volcanic sequences. Codes are: CF – Corella Formation, GCF – Gunpowder Creek, PCF – Paradise Creek, OJ – Overhang Jaspilite, SCF – Surprise Creek, MOS – Moondarra Sandstone & MS – Myally Subgroup.

GNEISS

Gneisses are the final ‘litho-type’ subset of the main dataset. This is limited to just two members of the Tewinga Group – undivided and the May Down Gneiss Member. Results are summarised in Table 7. Whilst the May Downs Member is poorly sampled with unreliable values, measurements by Hone on undivided Tewinga Group show a consistent picture with a density and susceptibility in tune with classical values for gneissic rocks.

Gneiss	Density (saturated)			Density (grain)			Magnetic Susceptibility		
	N	M	SD	N	M	SD	N	M	SD
Tewinga Un	9	2.66	.06	9	2.68	.07	9	1106	2284
Tewinga – May Downs	2	2.84	.28				2	63	90

Table 7 Gneissic densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

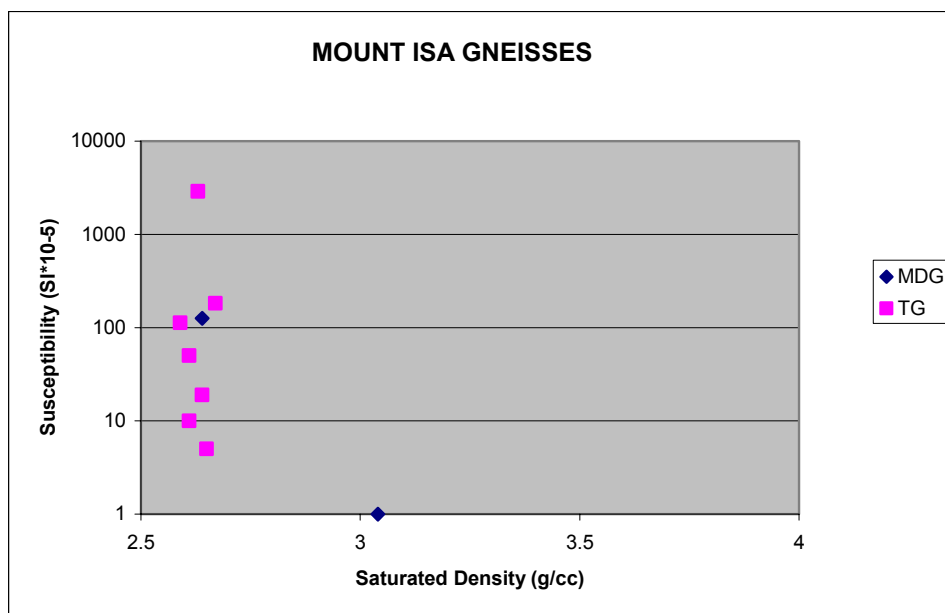


Figure 12 Susceptibility versus saturated density for Mount Isa gneissic rocks. Codes are: MDG – May Downs & TG – Tewinga Group (undifferentiated)

Both sets of data make up some of the lowest density components of the Tewinga Group but are typical of gneisses. Lack of weathering attribution makes it difficult to ascertain whether the broad magnetic character is intrinsic or due to oxidation however.

ORE

Whilst it is not within the scope of this report to model ore scenarios under known host conditions, the ore measurements are clearly an important aspect to the value of a regional petrophysical database. Reproduced directly from Hone et.al. (1987), Table 8 summarises Mount Isa Ore rocks.

Gneiss	Density (saturated)			Density (grain)			Magnetic Susceptibility		
	N	M	SD	N	M	SD	N	M	SD
Mt Isa Pb-Zn	4	3.77	.26	4	3.77	.26	4	1570	1920
Mt Isa Copper	2	2.90	.26	2	2.90	.27	2	7	3
Hilton Pb-Zn	2	3.86	.49	2	3.86	.49	2	35565	47453

Table 8 Principal ore densities and susceptibilities for the Mount Isa Inlier. Statistics based on located samples from Figure 2 & Appendix III with sample size (N), geometric mean (M) and standard deviation (SD).

The lead-zinc ores are typically 30-40% mineralised so it is not surprising that the densities are so high. Even against some of the most iron-rich basalts, ore within an appropriately large volume would represent a good gravity target based on these figures. Interestingly, the copper ore is more marginal but it is not clear from Hone's report how mineralised samples were.

SUMMARY & CONCLUSIONS

Xstrata's proprietary petrophysical dataset effectively doubles on Hone's coverage of density and magnetic measurements across the Mount Isa Inlier. There are still noticeable weaknesses particularly:

1. ECV Members – especially the Lena Quartzite. However, it is quite possible that thickness variations between the various members will dwarf any benefit of better sampling individual units
2. Tewinga Group – poorly differentiated and poorly sampled towards the basal units.
3. Llewellyn Creek Formation at the base of the Soldiers Cap Group
4. Mount Isa Inlier Basement rocks – although limited intersections may impede the sampling of fresh rock.

In the process of combining datasets, differences of classifying weathering are apparent. Whilst it is difficult to see how subjectivity and relativity can be avoided altogether, some consistency would be valuable in the sense that:

1. To determine whether differences between bulk and grain density can be dismissed as a function of surface exposure, rather than as an in-situ attribute (intrinsic porosity).
2. There is the potential to map in-situ properties from surface samples providing that at some stage there is a definitive calibration of the impact of weathering.
3. To readily remove the impact of weathering on density measurements by calibrating the level of weathering to oxidation of iron (and subsequent loss of magnetisation) for some rock types. An underlying assumption would be that 'inherent' variation in magnetisation would be small compared to the impact of exposure.

Hence it is recommended that some effort be put in to standardising 'weathering' scales prior to any additional sampling programs and database construction.

With respect to rock types and lithologies observed, key findings are as follows:

1. On the basis of their pervasiveness and low mean densities, granites are going to be the main source of gravity lows within the Mount Isa Inlier. Where thick sections of low-density sediments may also be a causative source, the distinction should be relatively

easy on the presence or absence of a magnetic and variably magnetic signature (either concomitant or along strike from the gravity anomaly).

2. A variety of basalts occupy the high end of the density spectrum but often share similar magnetic characterisation to granites. The propensity for granites of the Mount Isa district to be highly magnetic and iron-rich has important ramifications for the timing and association between these two types of intrusives.
3. The differentiation of lithologies and units in the middle ground is swamped by ambiguity caused by:
 - a. The variable and often high iron content throughout many of the other rock types
 - b. The lithological diversity of units within groups and subsequently, poor differentiation of members in outcrop and the likelihood of complete mislabelling.
 - c. Common occurrence of inter-volcanic units and detritus throughout most of the major sedimentary sequences
 - d. Broad scale metamorphism and metasomatism that has smeared what may have otherwise been clear density and magnetic variations between rock types.

As a petrophysical database offering insight into the density, magnetic and remanence properties of rock types across an entire province, this is one of the more comprehensive. In terms of addressing ambiguity within potential field data, the compilation demonstrates that petrophysics has its place but cannot overcome the problem of attribute distributions with 'intrinsic' scatter larger than mean lithology contrast.

REFERENCES

- Emerson, D.W., 1990. Notes on mass properties of rocks – density, porosity & permeability. *Exploration Geophysics* 21, 209-216
- Hone I.G., Carberry V.P., and Reith H.G., 1987. Physical property measurements on rocks samples from the Mount Isa Inlier, northwest Queensland. *Bureau of Mineral Resources Report* 265.
- Xstrata (various authors and sources), 2004??. Physical property measurements on rock samples from the Mount Isa Inlier (Extracted from corporate petrophysical database)

APPENDIX I
DENSITY AND SUSCEPTIBILITY MEASUREMENTS
MOUNT ISA PETROPHYSICAL DATABASE
SOURCED FROM GEOSCIENCE AUSTRALIA
(BASED ON BMR REPORT 265)

[ISA_PETROPHYSICS_ANALYSIS_MAY2004_APPENDIX_I.xls](#)

APPENDIX II
DENSITY AND SUSCEPTIBILITY MEASUREMENTS
MOUNT ISA PETROPHYSICAL DATABASE
SOURCED FROM XSTRATA
(BASED ON NUMEROUS SOURCES)

[\\ISA_PETROPHYSICS_ANALYSIS_MAY2004_APPENDIX_II.xls](#)

APPENDIX III
DENSITY AND SUSCEPTIBILITY MEASUREMENTS
MOUNT ISA PETROPHYSICAL DATABASE
COMBINED SET WITH LITHOLOGY CODING
(BASED ON NUMEROUS SOURCES)

[\\ISA_PETROPHYSICS_ANALYSIS_MAY2004_APPENDIX_III.xls](#)