Geochemistry Summary: Tanami Desert, Northern Territory

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By

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Executive Summary

This report summarises geochemistry data from within the Newmont lease areas collected in the 2004 field season by Lex Lambeck. This report highlights main trends represented by trace element ratio plots. The highest grade gold occurs in the well bedded carbonaceous horizons of the Blake Beds, as shown in the Th/Sc-Zr/Sc plot of the Callie geochemistry which best distinguishes the ore-bearing sediments. All the Newmont prospects sampled in the Tanami region plot within the Killi Killi/SHIM groups suggesting the prospects haven't been explored deep enough into the regional stratigraphy to encounter the ore-bearing beds (Fig. 1). The study recommends some deeper holes drilled into the regional stratigraphy to elucidate potential lateral equivalent units of the Blake Beds found at Callie. A more comprehensive discussion of the data will be provided in a GA record detailing the geochemistry and sequence stratigraphic understanding of the Tanami Region that will be available before the end of 2005. The appendix contains complimentary rare earth element plots and geochemistry data normalised to post-Archaean average Australian shale (PAAS) and to chrondrite compositions.

Contents

Main findings of Callie pilot study

- Prior to the 2004 field season, a pilot study was completed at Callie (Lambeck A., 2004). This pilot study presented and indicated a preliminary stratigraphic framework for the Tanami region:

    - A composite core for the Callie stratigraphy which suggested a transgressive/regressive suite with four distinctive geochemical units;

    - That the Blake beds (i.e. Dead Bullock Formation) mark a marine transgression. This unit is overlain by the Madigan beds (Killi Killi Formation) which indicates progradation and are suggestive of sediments proximal to a basin fan system;

    - That the basin appears to have two distinct geochemical provenances: the Dead Bullock Formation has a mafic source provenance, where as the Killi Killi beds have a felsic provenance. The ORAC and SHIM units, which are located at the top of the Dead Bullock Formation, have geochemical signatures that are intermediate between the two end member compositions. The ORAC unit is dominantly mafic rich with a minor felsic input where as the SHIM unit is predominately felsic with a minor mafic input (Fig. 1);

    - That in detail the geochemical groups comprise: 1) the Lower Dead Bullock Formation group, which includes the Lower Blake Laminations, Lower Blake Beds, Callie Laminated Beds, Magpie Schist, Callie Boudin Chert and Upper Blake Beds; 2) the ORAC Group, which includes the Lower Orac Chert, Middle Orac Schist, Upper Orac Chert and Upper Orac Schist; 3) the SHIM Group, which includes the Dead Bullock Member, Schist Hills Iron Member, Colgate Schist, Manganiferous Chert and Seldom Seen Schist; and 4) the Killi Killi Group, which is the highest group in the stratigraphy and comprises the Madigan Beds.

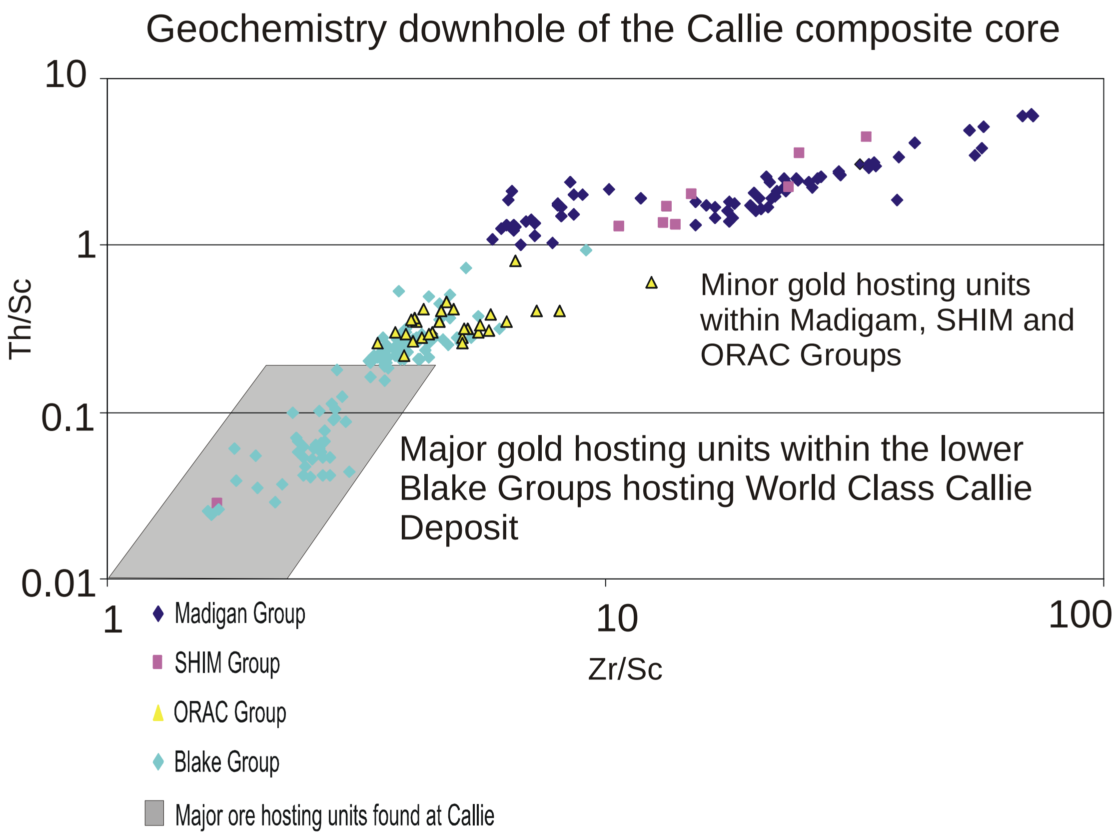

Figure 1. Th/Sc-Zr/Sc diagram illustrating some geochemical results from the 2003 Callie pilot study. The bipartite distribution of the data shows the basal mafic Lower Dead Bullock Group plotting lower than the upper part of the composite core made up of the felsic Killi Killi Group. The ORAC and SHIM groups have geochemical signatures that are intermediate between the two end member compositions. The lower part of the Lower Dead Bullock Group (illustrated by the grey shading) hosts the main Callie host unit (CLB). This shaded region could be used as an exploration tool to recognise favourable parts of the stratigraphy and therefore help find further world class gold deposits in the Tanami region. All the Newmont prospects sampled in the Tanami region plot within the Killi Killi/SHIM groups suggesting the prospects haven't been explored deep enough into the regional stratigraphy to encounter the ore-bearing beds.

2004 field work

- Eleven diamond cores were logged in total in the Newmont lease area. The areas covered were Anomaly 2, Magellan 2, Groundrush, Titania, Old Pirate, and a revision of the Callie composite core.

- Cores with the least mineralisation and with minimum recorded fault zones were selected. Sedimentary facies characteristics such as grainsize, lithology, sedimentary structures, and grain composition were tabulated for each core. Grainsize information was collected as a continuous curve.

- Cores were sampled at 5-metre intervals for geochemistry. Due to time constraints only nine of the cores were sampled for geochemistry.

Geochemistry

- Whole-rock major and trace element analysis was performed on 488 samples. Samples were prepared by grinding core to a fine powder using a purpose built core-filleting machine. The geochemistry of the diamond-impregnated grinding wheel was analysed and the wheel was found to contain significant (> 1 %) levels of manganese, iron, nickel, copper, zinc, silver and tungsten. These elements were excluded from the study.

- Major and trace element analyses were undertaken at Geoscience Australia's geochemical laboratory, using a Perkin Elmer Elan 6000 ICP-MS following the methods of Jenner et al. (1990) and Pyke (2000), and a Phillips PW2404 4kW sequential X-ray fluorescence (XRF) spectrometer using the methods of Norrish and Chappell (1977).

- The geochemistry of the sample suite from the Tanami region was culled to remove all possible effects of mineralised fluids that could affect the original sedimentary geochemistry of the host rocks. All analyses containing > 5 % carbonate and > 5 % loss of ignition were removed from the data set.

- All the plots are superimposed upon the Callie data from the 2003 field work season to illustrate possible correlations.

- As outlined in Lambeck (2004), the geochemistry results support the Newmont stratigraphy at Callie, with each major lithological unit having distinct geochemical attributes.

Geochemistry results of logged diamond drill cores

Revised Callie Composite core

- The composite core completed in 2004 (Lambeck A., 2004) has been revised and simplified, three diamond drill cores now form the DBD composite as opposed to five diamond cores. The basal section of the revised composite core was relogged to extend deeper into the basin using diamond hole DBD378

- The central part of the 2004 pilot study composite log was revised and an underground exploration hole, diamond hole X885_2088, that was thought to best represent true thickness of stratigraphy was logged to avoid possible structural repetition identified by Whitaker E., (*pers comm.*, 2004) in the original Lambeck A., (2004) composite section.

Diamond drill hole DBD378

Why was this hole used in the GA Tanami study?

- Newmont mine exploration drilled this diamond-hole deep into the stratigraphy for the Callie Mine, providing access to the deepest stratigraphic levels.

Facies Trends: Transgression

- The fining upward trend in grainsize in drill core DBD378 suggest that the water depth steadily increased, indicating a marine transgression. This interpretation is supported by an increasing content of carbonaceous material towards the top of the hole.

Geochemistry Results

- Geochemistry from Dead Bullock Diamond, (DBD), 378, from the Lower Blake Laminations through to the Callie Boudin Chert beds suggests a mafic geochemical signature (Fig. 2). This result reinforces the characteristic Lower Dead Bullock geochemical signature outlined in Lambeck (2004).

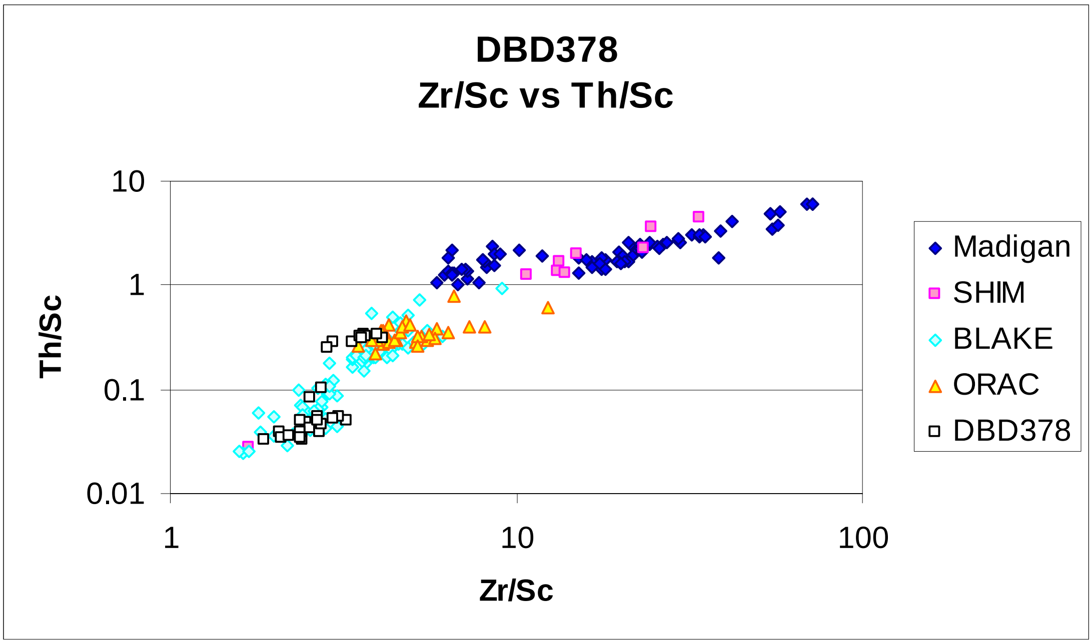

Figure 2. Data from DBD378 (open squares) are superimposed upon Th/Sc-Zr/Sc data from the 2003 Callie pilot study (see Fig. 1).

Diamond drill hole X885_2088

Why was this hole used in the GA Tanami study?

- This hole was drilled as an underground exploration hole with the aim of drilling through an anticline to intersect through the entire mine stratigraphy which had never been done before. However, the hole was terminated in the Seldom Seen Schist which appeared to be at least 160 m thick, far exceeding previously recorded thicknesses of this unit.
- This underground diamond exploration hole was included in the present study as the Newmont mine staff believed that it best represents the true thickness of the Callie stratigraphy. Geochemistry was completed to allow comparison with the original Callie Composite core.

Facies Trends: Progradation /Aggradation

- The diamond drill core represents two tends: the basal section coarsens upwards represented by a cyclic stacking of turbidites indicating progradation. The upper section; the Seldom Seen Schist, could represent a further period of aggradation as represented by black carbonaceous mudstone.

Geochemistry Results

- The Blake Bed samples from X885_2088 plot within the Lower Dead Bullock Group sample range defined in Lambeck (2004) (Fig. 3).
- The ORAC beds plot within the ORAC Group sample range defined in Lambeck (2004).
- The Seldom Seen Schist part of the SHIM Group as defined by Lambeck (2004) plot within the SHIM/Killi Killi Groups.

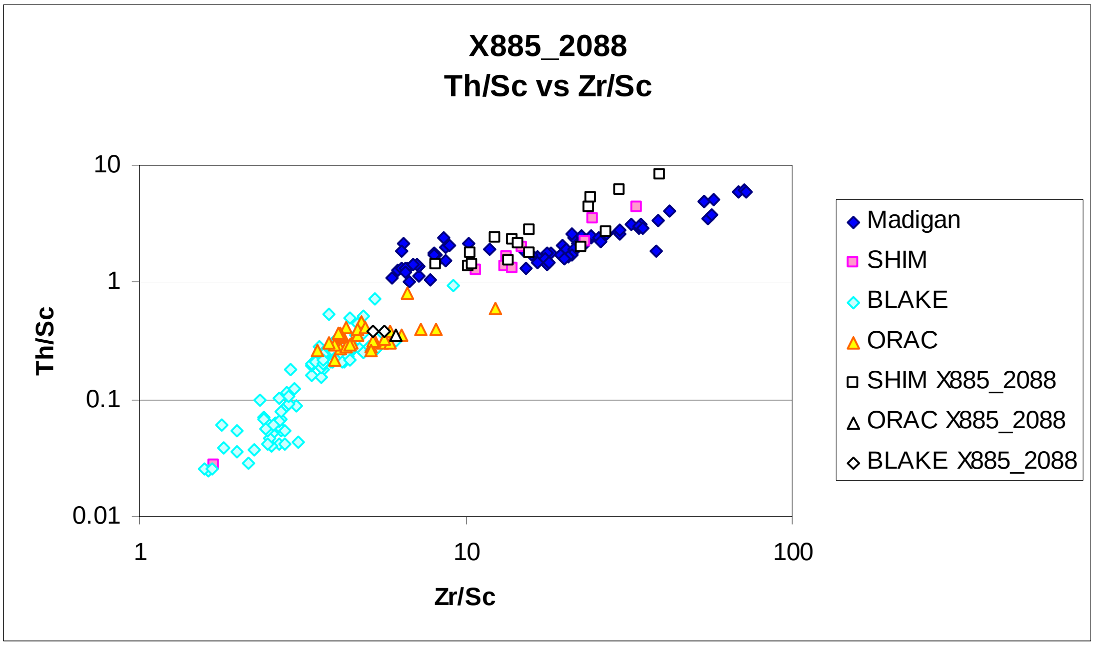

Figure 3. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure. 2. The geochemistry data from core X885-2088 are overlain to provide stratigraphic correlations.

Diamond Drill Hole DBD445

Why was this hole used in the GA Tanami study?

- The position of this core was uncertain within the mine stratigraphy framework; it was postulated that it could be part of the basal unit found stratigraphically below the LBL, or it could be part of a facies previously unrecognised in the Madigan Beds. The core was used to further define facies variations within the regional stratigraphy.

Facies Trends: Aggradation/Progradation

- Matrix supported wacke and greywacke display a cyclic stacking of coarse to muddy turbidites with large rip-up clasts and quartz clasts within the wacke which indicate sediments higher in the stratigraphy proximal to a basin fan.

Geochemistry Results

- Geochemistry places DBD445 in the Killi Killi Group (Fig. 4).

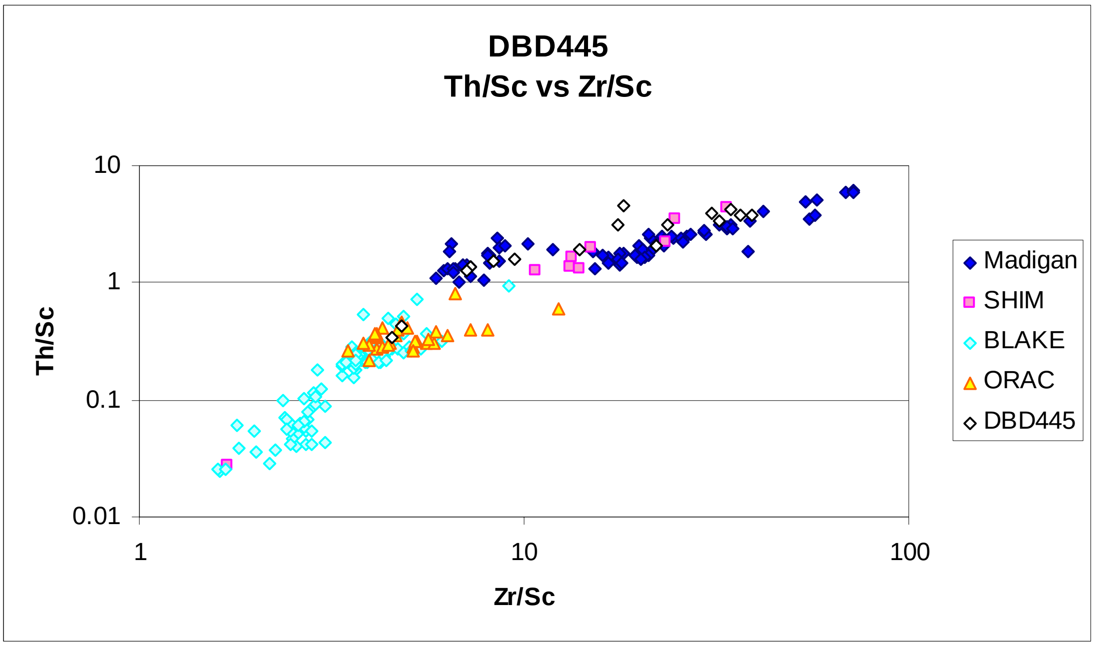

Figure 4. Th/Sc-Zr/Sc Callie template diagram as discussed in Fig. 2. The geochemistry data from core DBD445 are overlain to provide stratigraphic correlations, placing DBD445 within the Killi Killi Group.

Diamond Drill Hole OPD_1

Why was this hole used in the GA Tanami study?

- This hole was used to determine the location of the Old Pirate stratigraphy relative to the Callie stratigraphy.

Facies Trends: Aggradation/Progradation

- A cyclic stacking of fining upwards, coarse to muddy turbidites.

Geochemistry Results

- Geochemistry places Old Pirate 1 in the Killi Killi Group (Fig. 5).

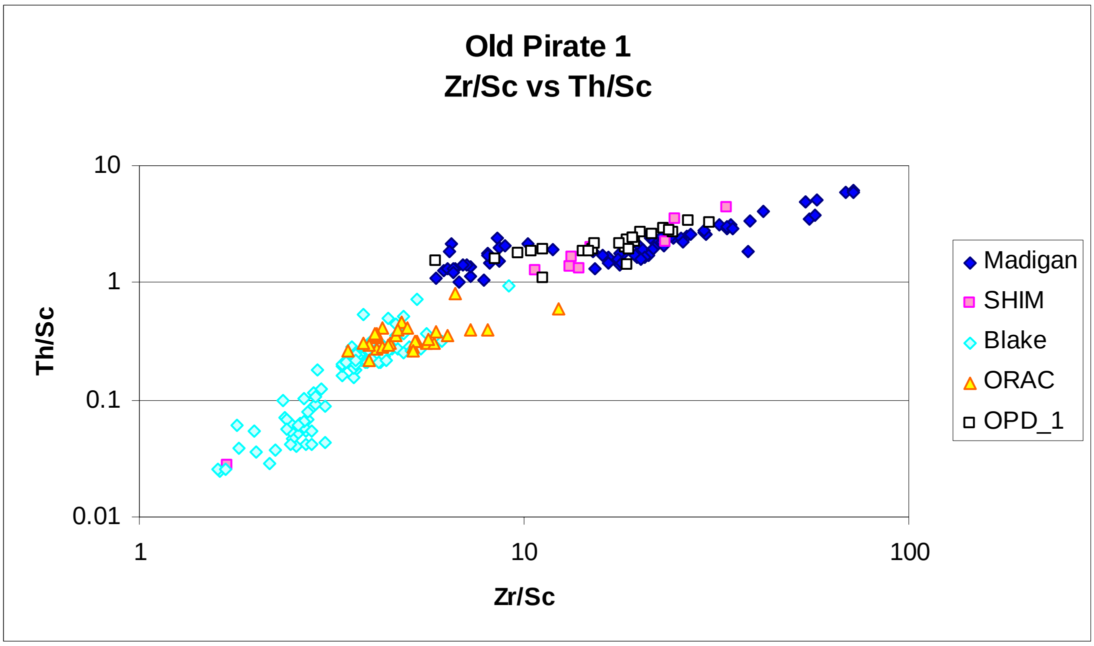

Figure 5. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure 2. The geochemistry data from core Old Pirate 1 are overlain to provide stratigraphic correlations, placing Old Pirate 1 within the Killi Killi Group.

Diamond Drill Hole Anomaly 2

Why was this hole used in the GA Tanami study?

- This hole was studied to test the location of the Anomaly 2 stratigraphy relative to the Callie stratigraphy.

Facies Trends: Aggradation/Progradation

- Rhythmically stacked turbidites with multiple fining upward cycles of coarse sandstone to mudstone.

Geochemistry Results

- Geochemistry places the Anomaly 2 drill hole in the Killi Killi Group (Fig. 6).

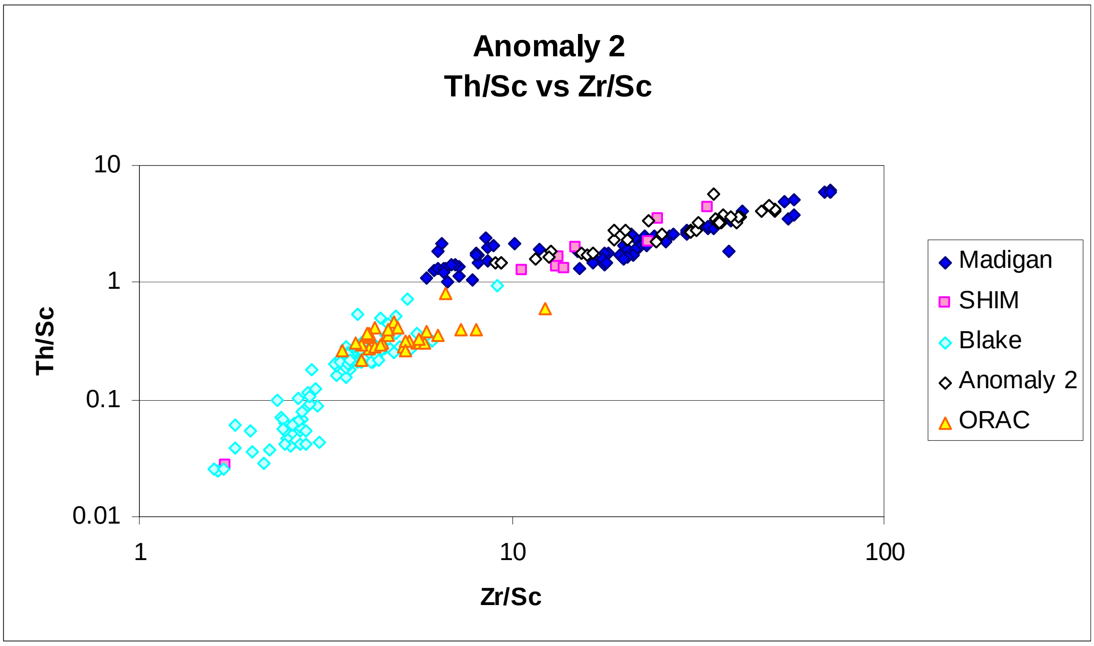

Figure 6. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure 2. The geochemistry data from core Anomaly 2 are overlain to provide stratigraphic correlations, placing Anomaly 2 within the Killi Killi Group.

Diamond Drill Hole Magellan 2

Why was this hole used in the GA Tanami study?

- This hole was examined to test the location of the Magellan 2 stratigraphy relative to the Callie stratigraphy.
- Mine stratigraphy suggests it is part of the ORAC group due to its high carbonaceous content.

Facies Trends: Aggradation

- Black carbonaceous mudstone, with small-scale fining upwards cycles, and nodules.

Geochemistry Results

- Geochemistry places Magellan 2 within the Killi Killi Group (Fig. 7) except for two outliers that plot in the Lower Dead Bullock Group. These outliers are the second and third highest in the stratigraphy.
- If true, these results suggest that thick black carbonaceous mudstones may also be present locally in the Killi Killi Group as well as in the Orac and Blake Beds.

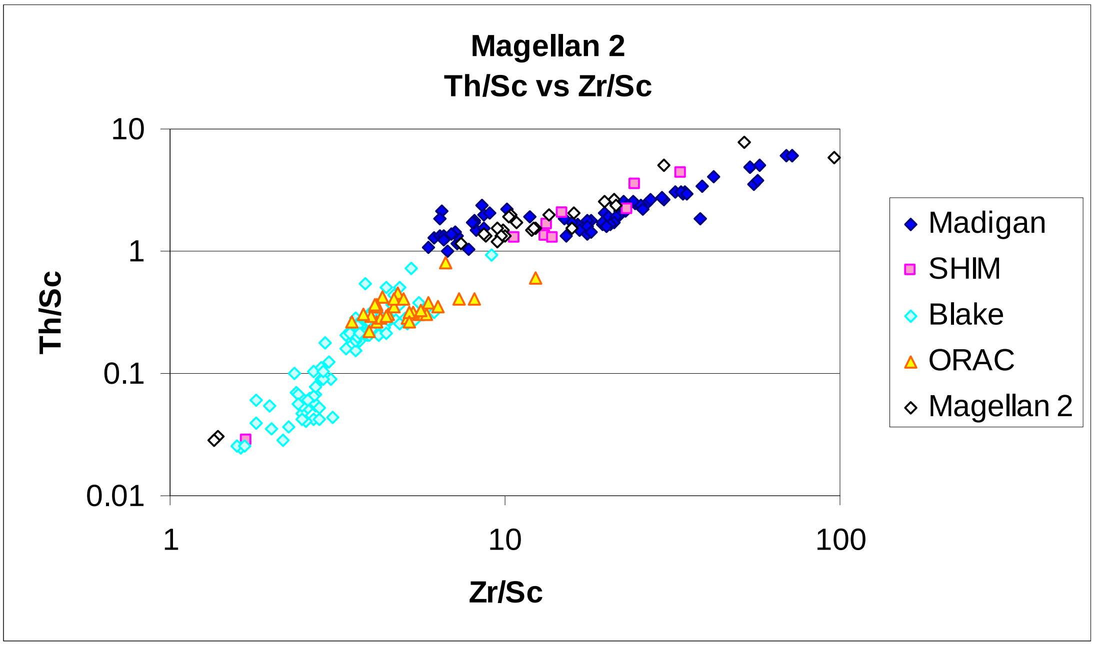

Figure 7. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure 2. The geochemistry data from core Magellan 2 are overlain to provide stratigraphic correlations, placing Magellan 2 within the Killi Killi Group except for one outlier that plots in the Lower Dead Bullock Group. This outlier is the second highest in the stratigraphy.

Diamond Drill Holes: **Titania**

- Three diamond drill cores were logged at Titania, TID01, TID015 and TID058. Only two cores TID01 and TID058 were sampled for geochemistry, Titania 058 was done in three separate sections: 1) a basal section, 2) the centre of the core and 3) the top of the core, due to time constraints.

Diamond Drill Holes Titania 1 and Titania 058

Why were these holes used in the GA Tanami study?

- These holes were used in this study to test the location of the Titania stratigraphy relative to the Callie stratigraphy.

Facies Trends: Progradation

- Turbiditic mudstones coarsening upwards into coarse greywackes.

Geochemistry Results

- Geochemistry places Titania 1 in the Killi Killi Group, the drill hole is not deep enough to see the ORAC, Blake sediment (Fig. 8).
- Geochemistry places Titania 058 in possibly the SHIM/ORAC Group (Fig. 9). The geochemistry requires a complex interpretation because the basal unit groups with the Madigan Beds which are the highest in the Callie Stratigraphy. Two explanations for the basal unit plotting in the Madigan group are given: the first, which is favoured, is structural repletion of the Madigan Beds and the second, is that the chemistry in this case is not unique. Further work is undergoing to understand this result.

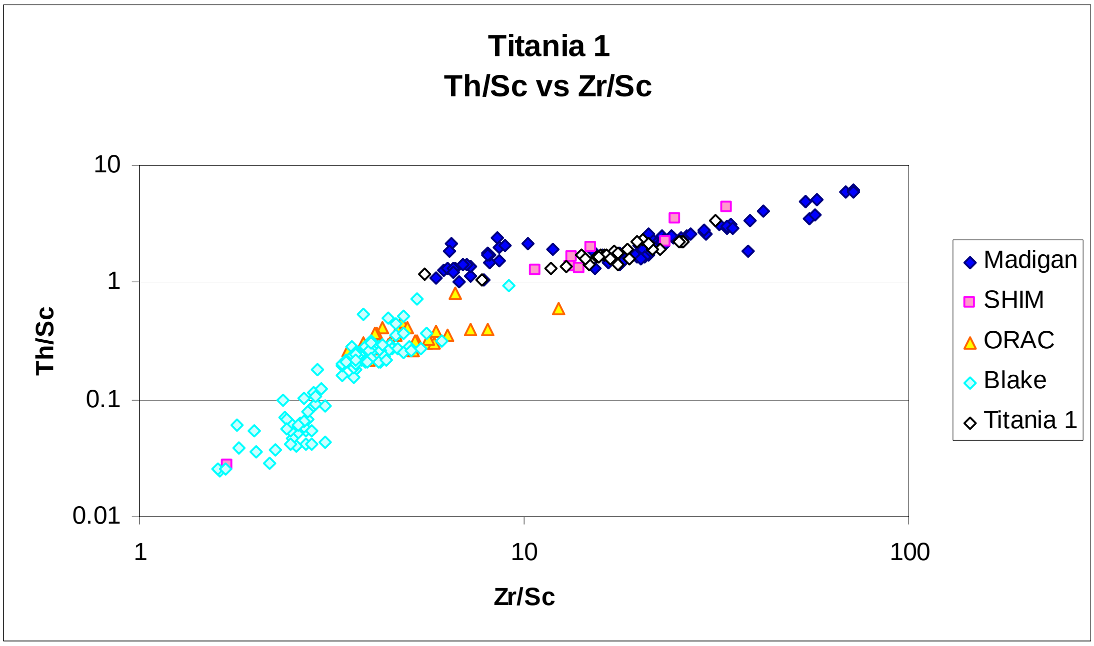

Figure 8. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure 2. The geochemistry data from core Titania 1 are overlain to provide stratigraphic correlations, placing Titania 1 within the Killi Killi Group.

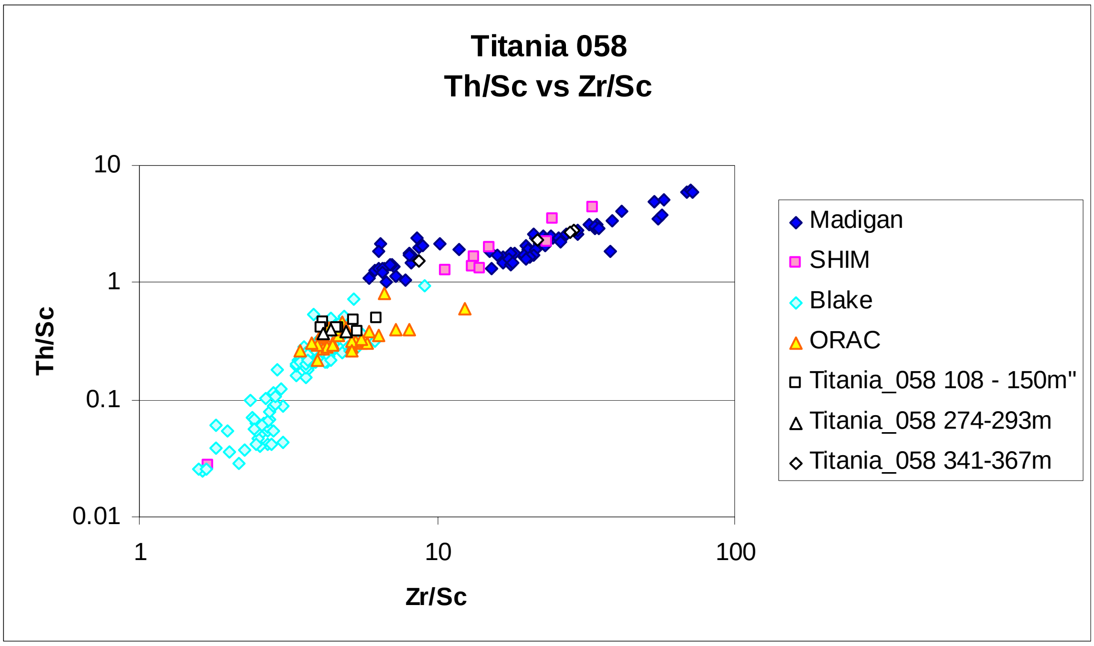

Figure 9. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure 2. The geochemistry data from core Titania 058 are overlain to provide stratigraphic correlations. Geochemistry places Titania 058 in possibly the SHIM/ORAC Group. The geochemistry requires a complex interpretation because the basal unit groups with the Madigan Beds which are the highest in the Callie Stratigraphy. Two explanations for the basal unit plotting in the Madigan group are given: the first, which is favoured, is structural repletion of the Madigan Beds and the second is that the chemistry in this case is not unique. Further work is undergoing to understand this result.

Groundrush GHD045D_1

Why was this hole used in the GA Tanami study?

- Most continuous diamond hole through the Hanging wall and Footwall Units in the Groundrush mine area so provides the best test of the stratigraphy relative to the Callie Stratigraphy.

Facies Trends: Aggradation

- Matrix supported wacke with large quartz and felsic grains proximal to a basin fan.

Geochemistry Results

- Geochemistry places Groundrush within the Madigan/SHIM Group except for one outlier which is from a mudstone in the Hanging Wall Schist.

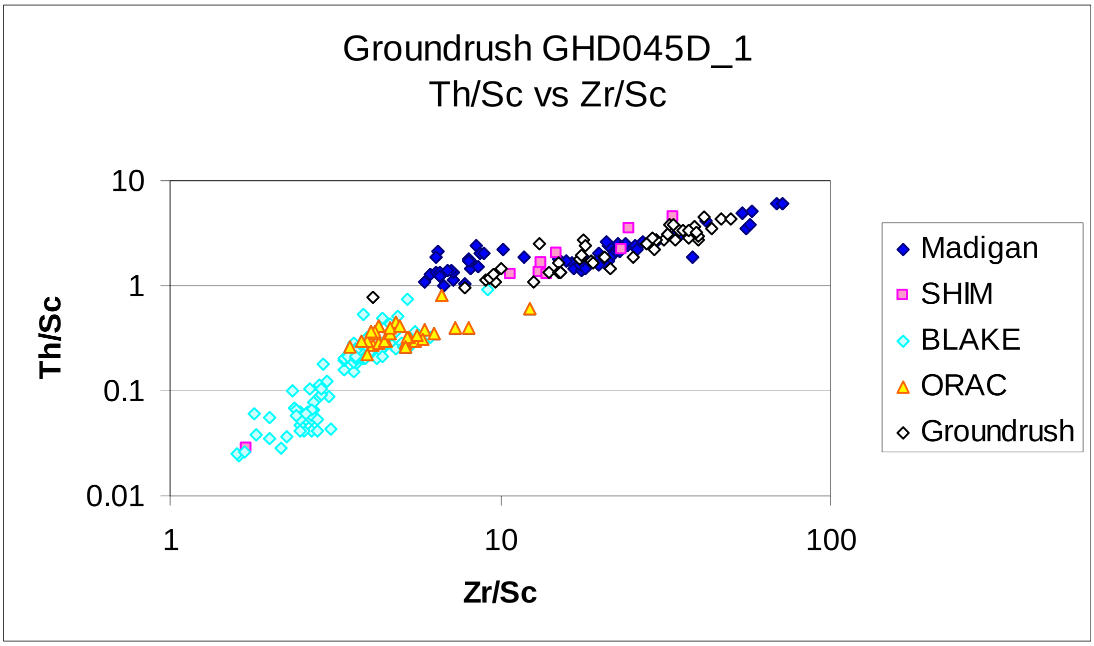

Figure 10. Th/Sc-Zr/Sc Callie template diagram as discussed in Figure 2. The geochemistry data from the Groundrush core are overlain to provide stratigraphic correlations, placing Groundrush within the Killi Killi Group.

Implications for ore genesis

- The integrated geochemical facies and sequence stratigraphy approach has important implications for ore genesis. The highest grade gold occurs in the well bedded carbonaceous horizons of the Blake Beds Group. As shown in the Th/Sc versus Zr/Sc scatter plot and other geochemical plots found in Appendix A, B and C, the Blake Beds have a distinctive geochemistry.

- Black shales can be found in the Lower Dead Bullock group as well as in the Killi Killi group and can be distinguished by geochemistry.

- At this stage the distinctive Lower Dead Bullock geochemistry can only be found within the Blake Beds at Callie aside from a couple of outliers. All the Newmont prospects analysed in this study don't appear to go deep enough into the stratigraphy or into laterally equivalent lower Blake Bed stratigraphy in the Newmont lease area.

Recommendation

- The study recommends some deeper holes drilled into the regional stratigraphy to elucidate potential lateral equivalent units of the Blake Beds found at Callie.

Acknowledgements

This study could not have taken place without the support and enthusiasm of Newmont Australia. Many thanks to Geoff Lowe who provided Geoscience Australia with the initial opportunity to work with Newmont. Ian Bamborough, James Emslie, Darren Cook, David Larsen and Antonio Macolino from Newmont are thanked for their many useful discussions. All the core shed folk are thanked for there help and support in core layout and sampling. Andrew Crispe from the Northern Territory Geological Survey also provided many useful discussions.

At Geoscience Australia; Peter Southgate, David Huston, David Champion and the North Australia Project provided extremely helpful discussions and advice. Thanks to John Pyke, Bill Pappas and Liz Webber, for analyses. Thanks to Inge Zeilinger for her help with entering all the geochemical data into Geoscience Australia's data bases.

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Appendix

A) Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

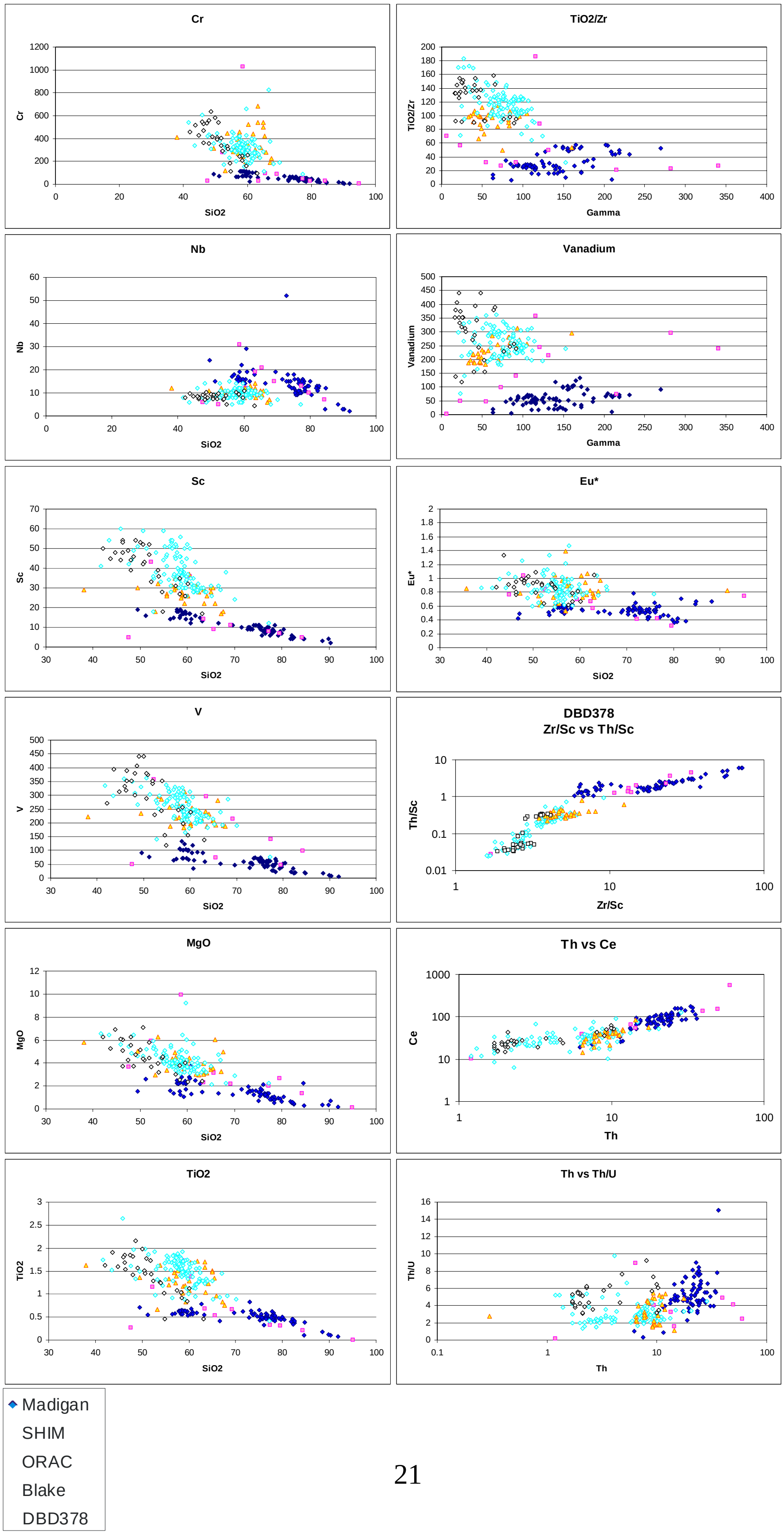
B) Geochemical data normalised to PAAS, Post-Archaean average Australian Shale.

C) Geochemical data normalised to Chrondrite.

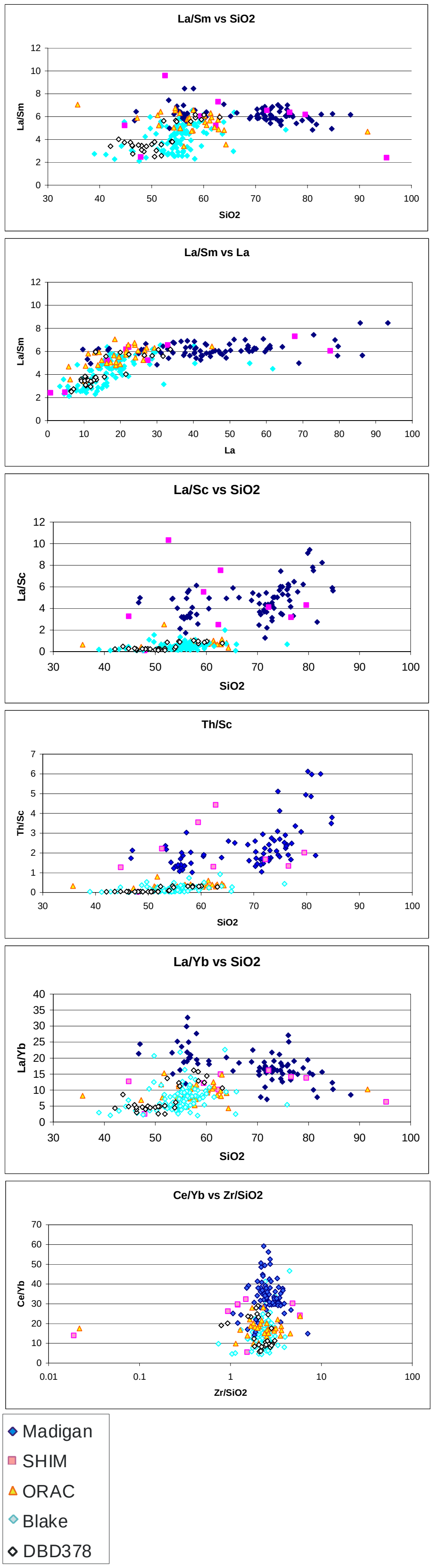
Appendix A

Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

DBD378



DBD378

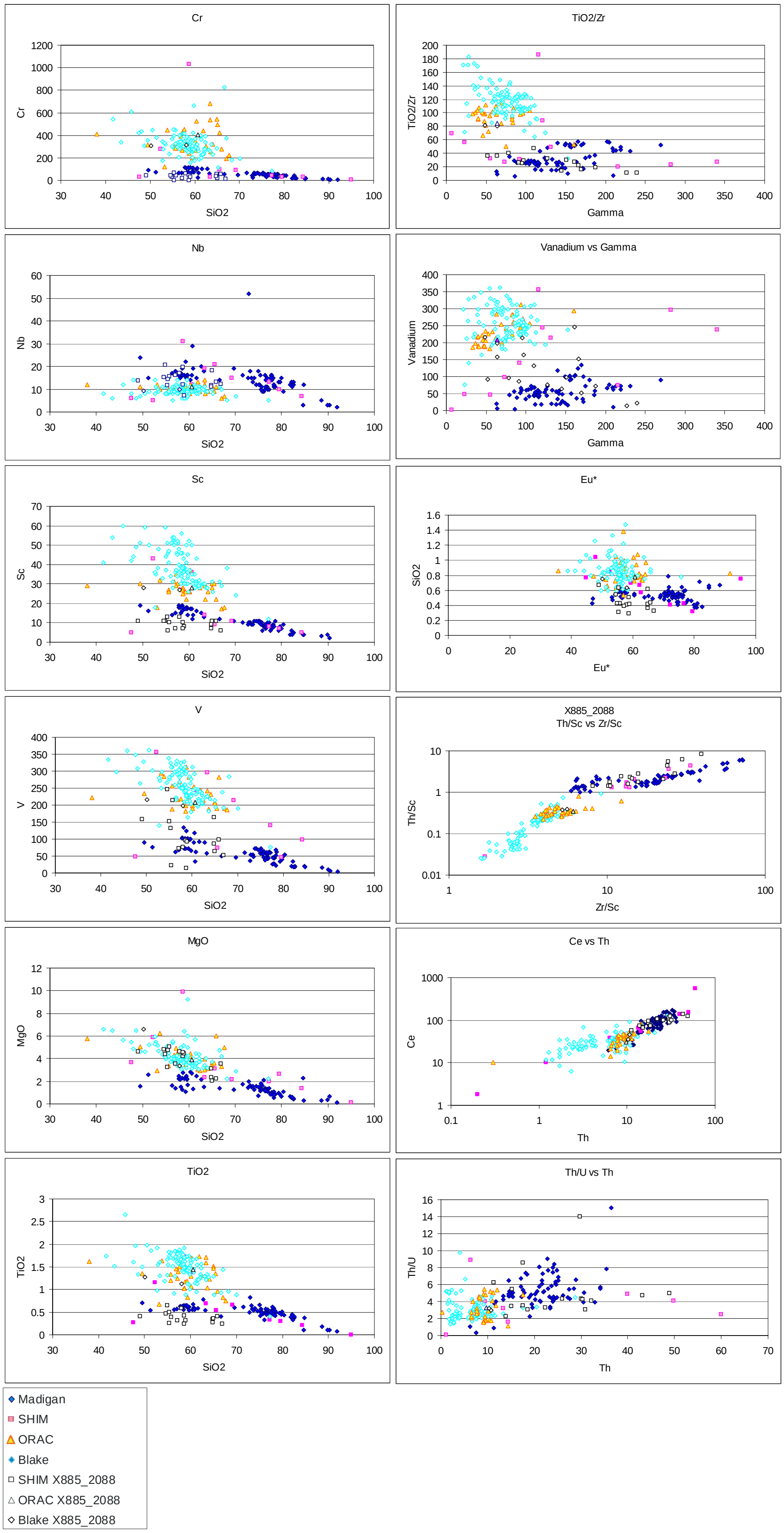


La/Sm vs SiO2
La/Sm
SiO2
La/Sm vs La
La/Sm
La
La/Sc vs SiO2
La/Sc
SiO2
Th/Sc
Th/Sc
SiO2
La/Yb vs SiO2
La/Yb
SiO2
Ce/Yb vs Zr/SiO2
Ce/Yb
Zr/SiO2
Madigan
SHIM
ORAC
Blake
DBD378

Appendix A

Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

X885_2088



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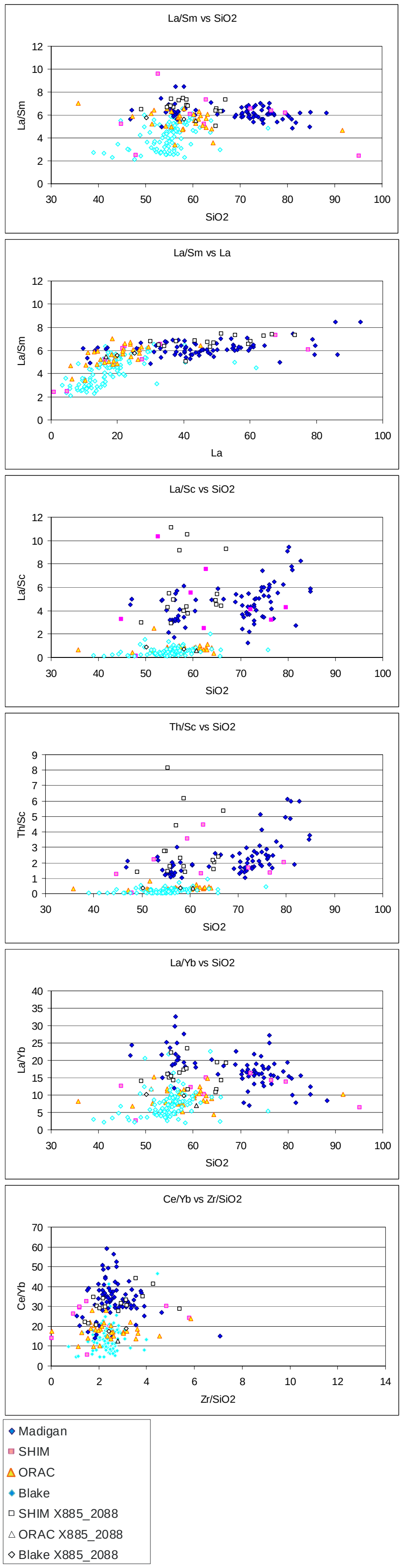

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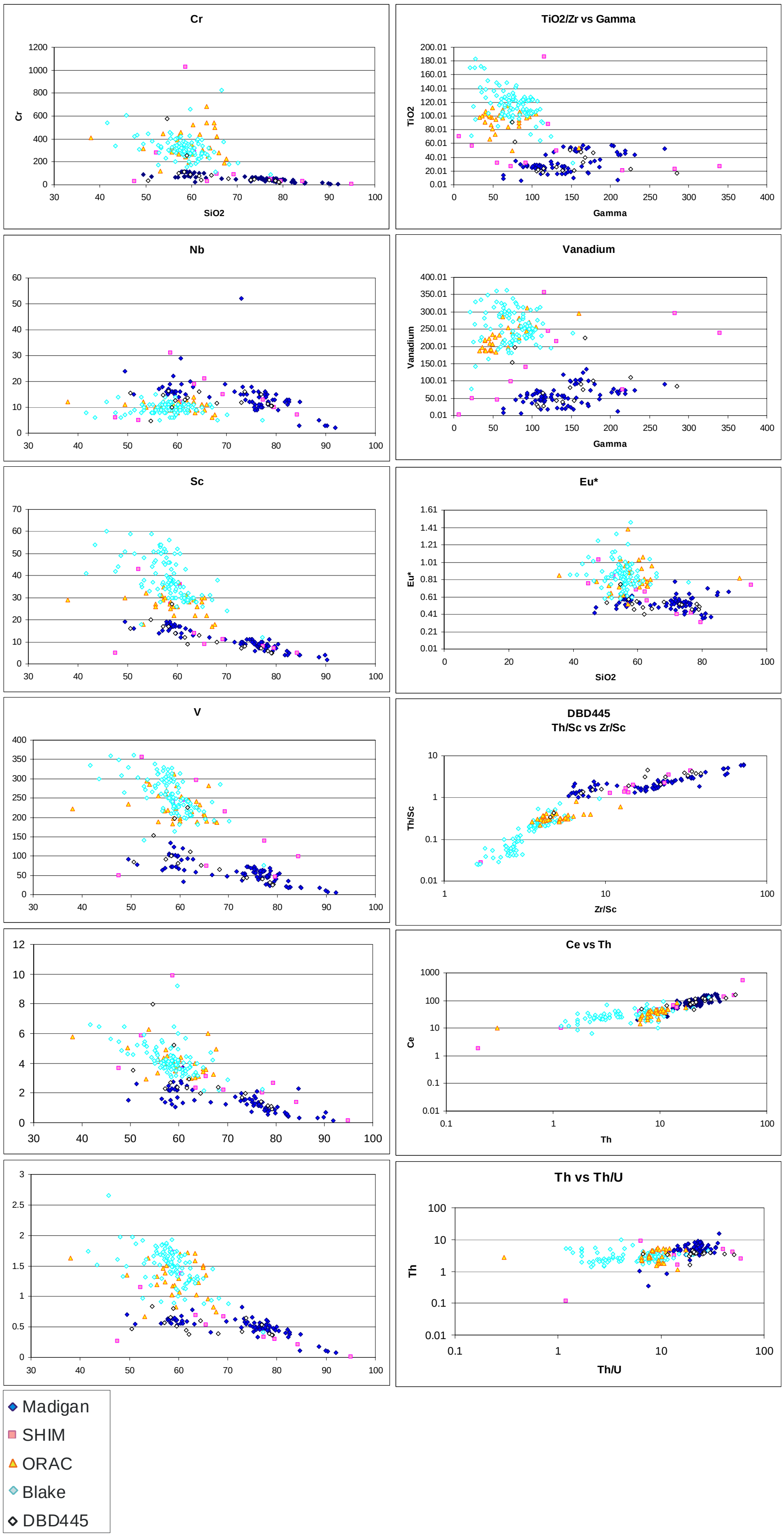

DBD445

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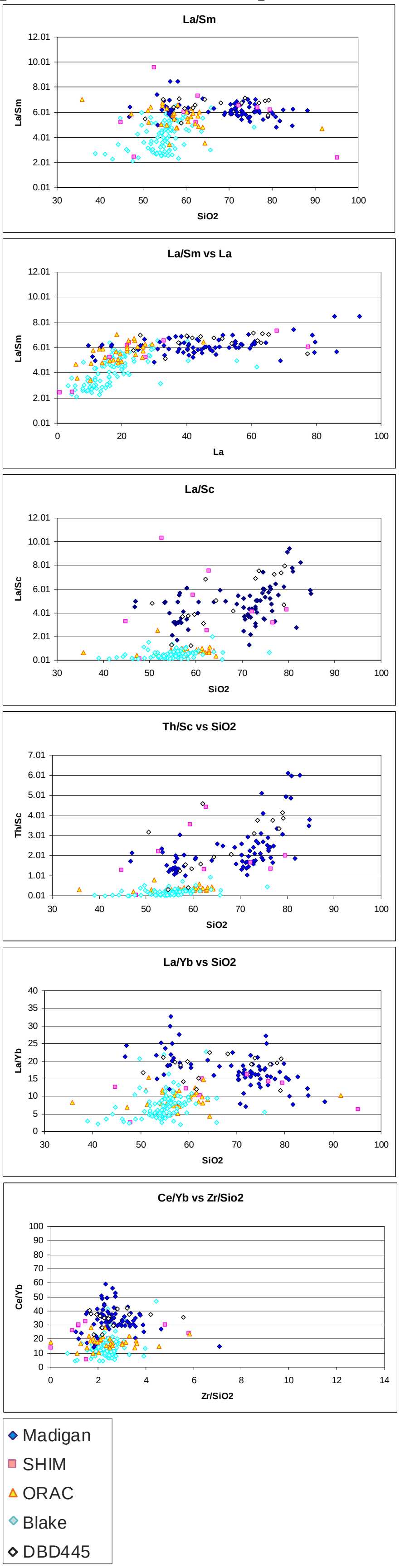

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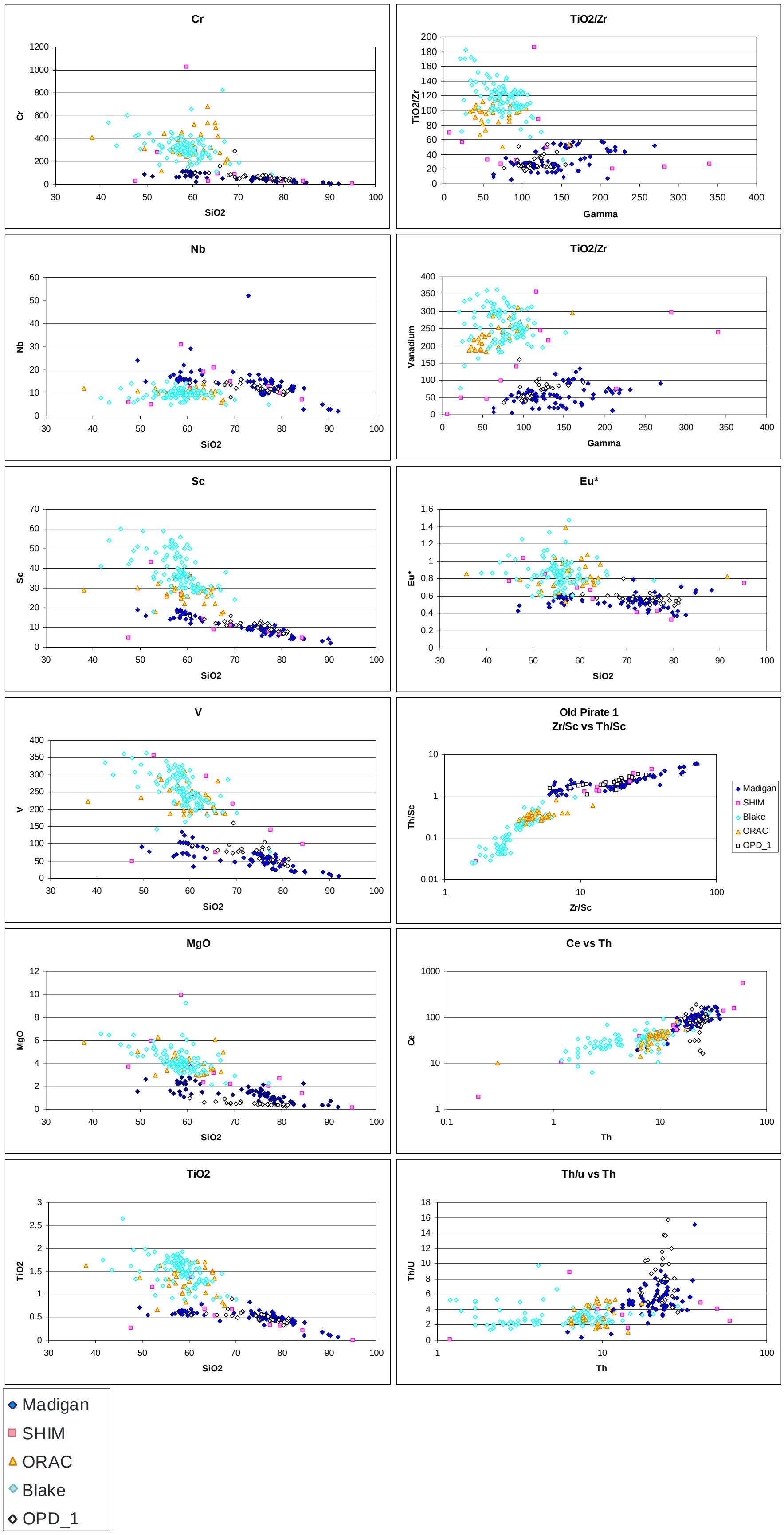
OPD_1



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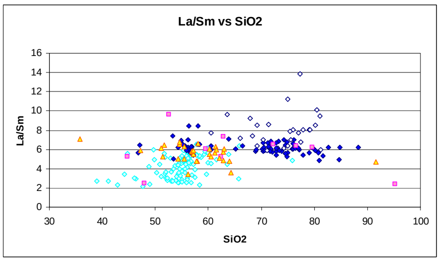
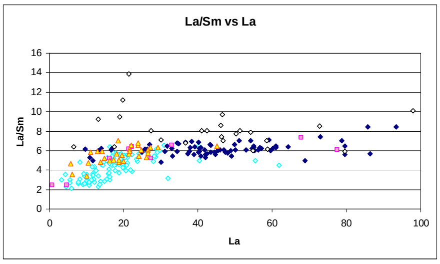
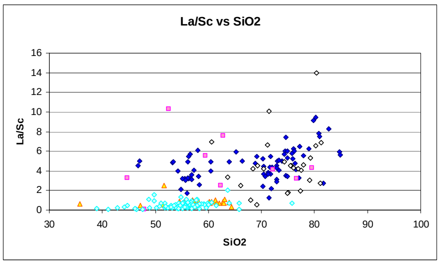
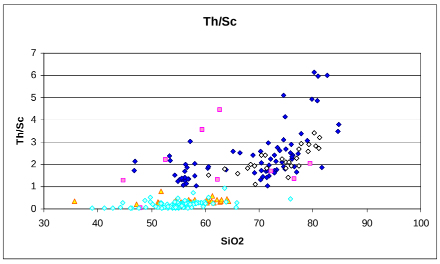
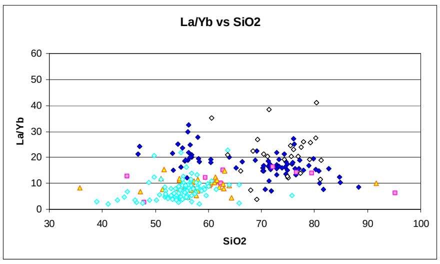
OPD_1

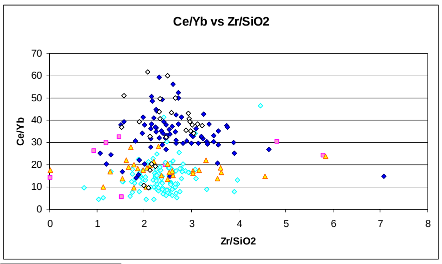












Appendix A

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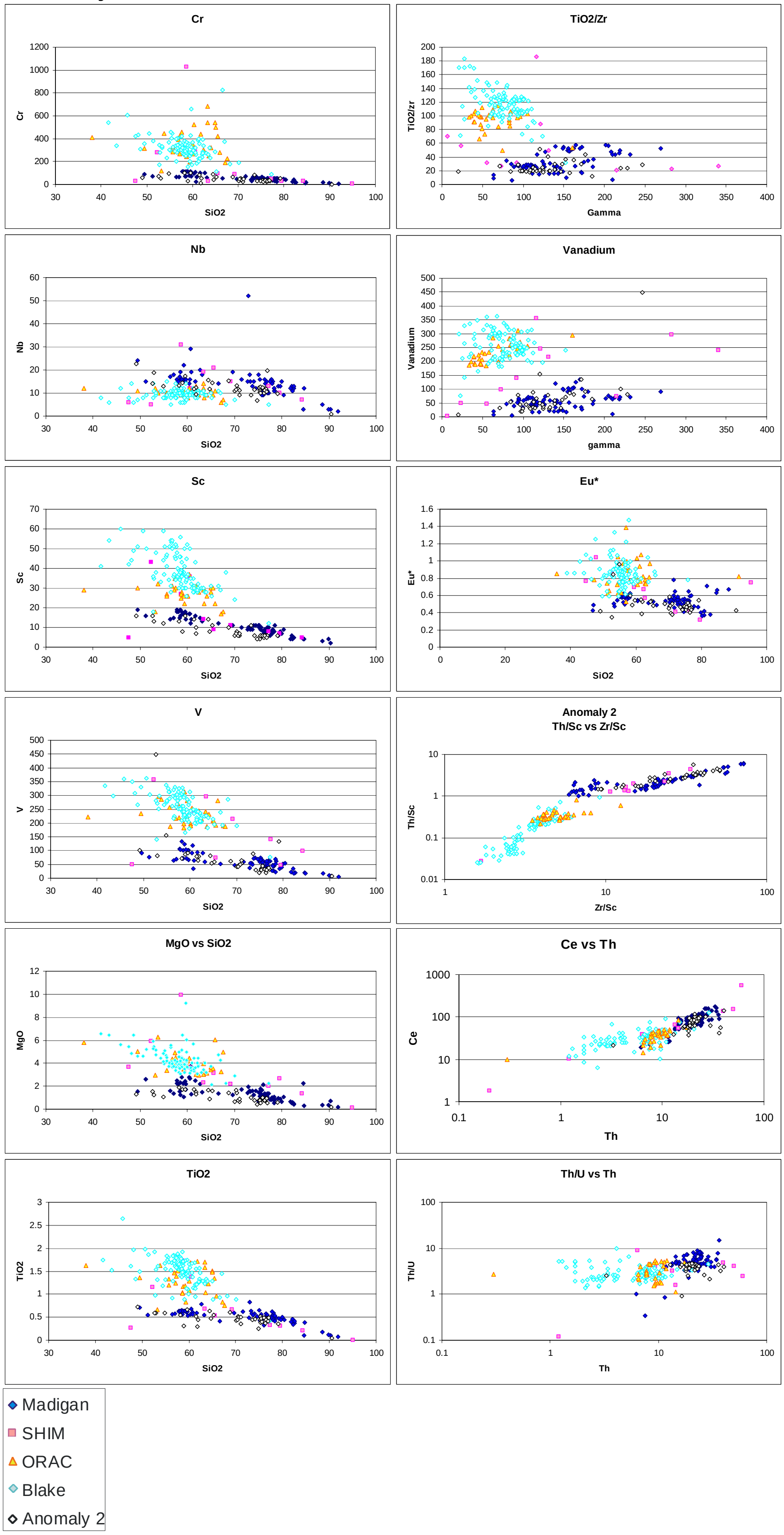
Anomaly 2



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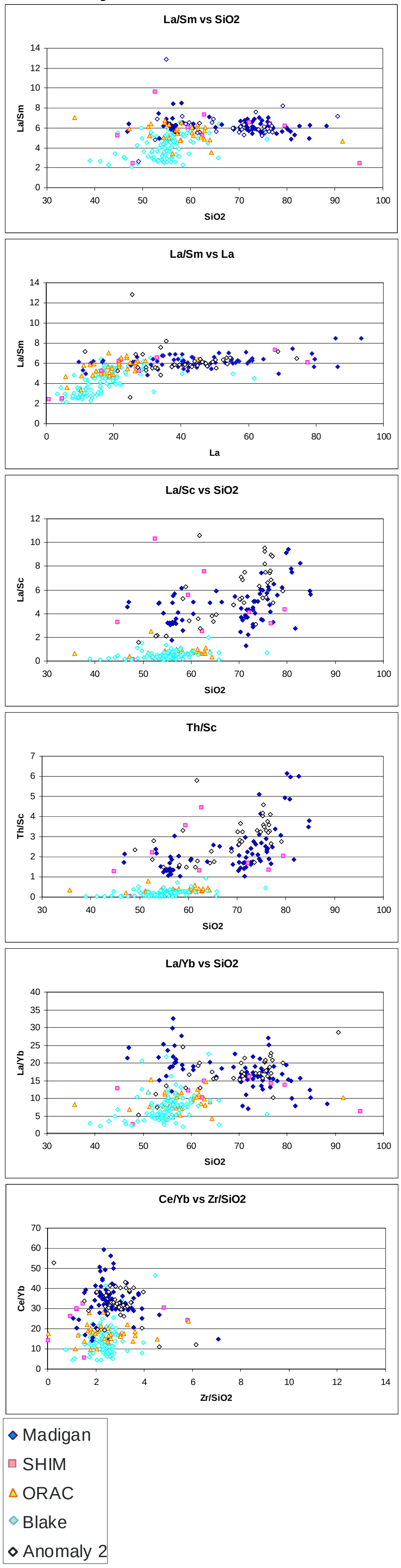

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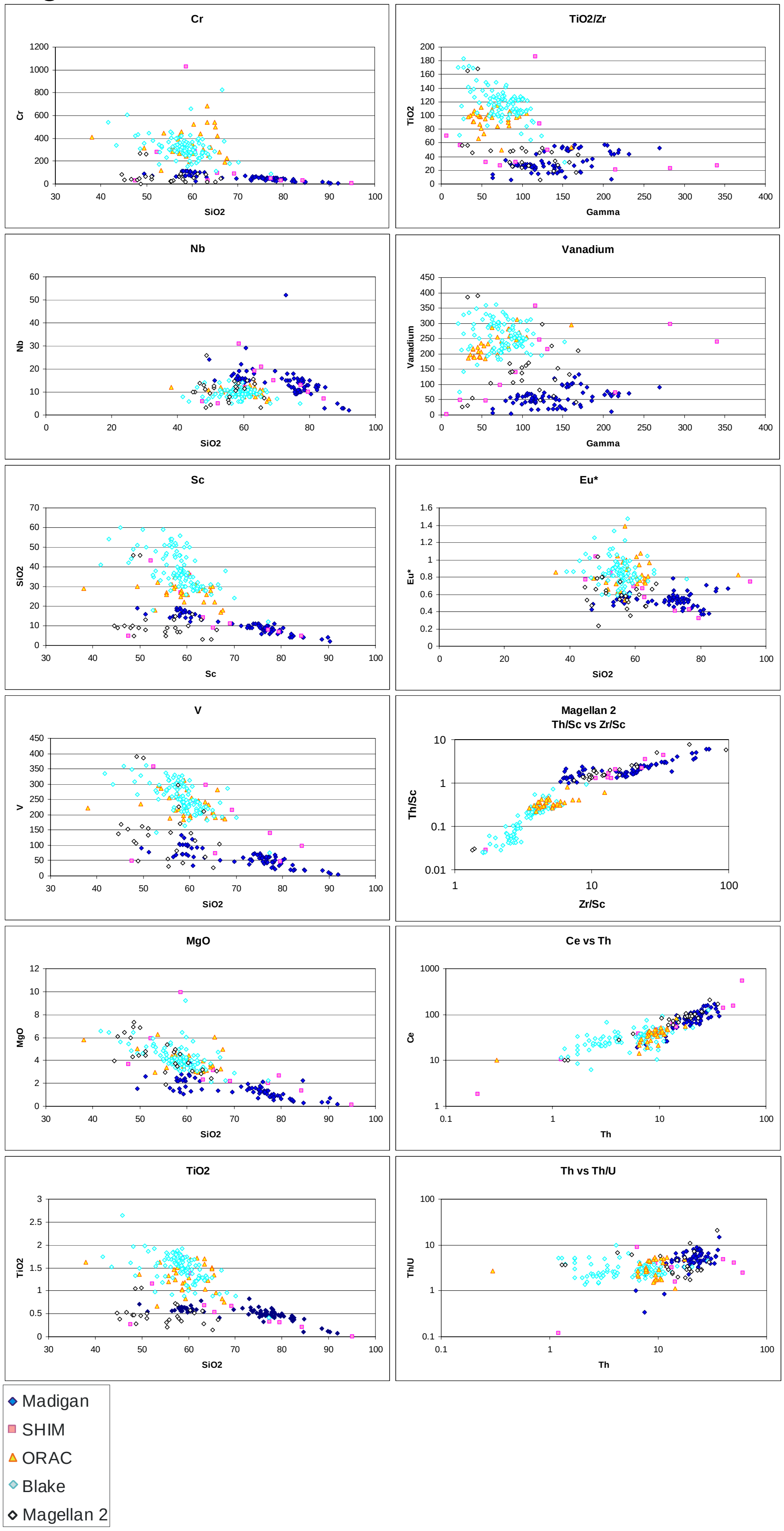
Magellan 2



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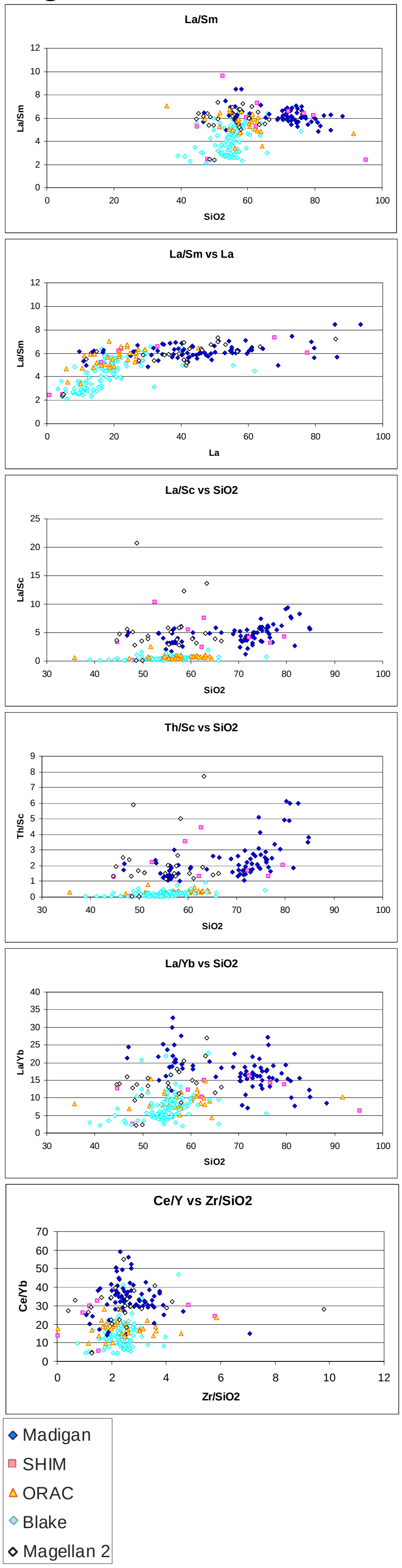
Magellan 2



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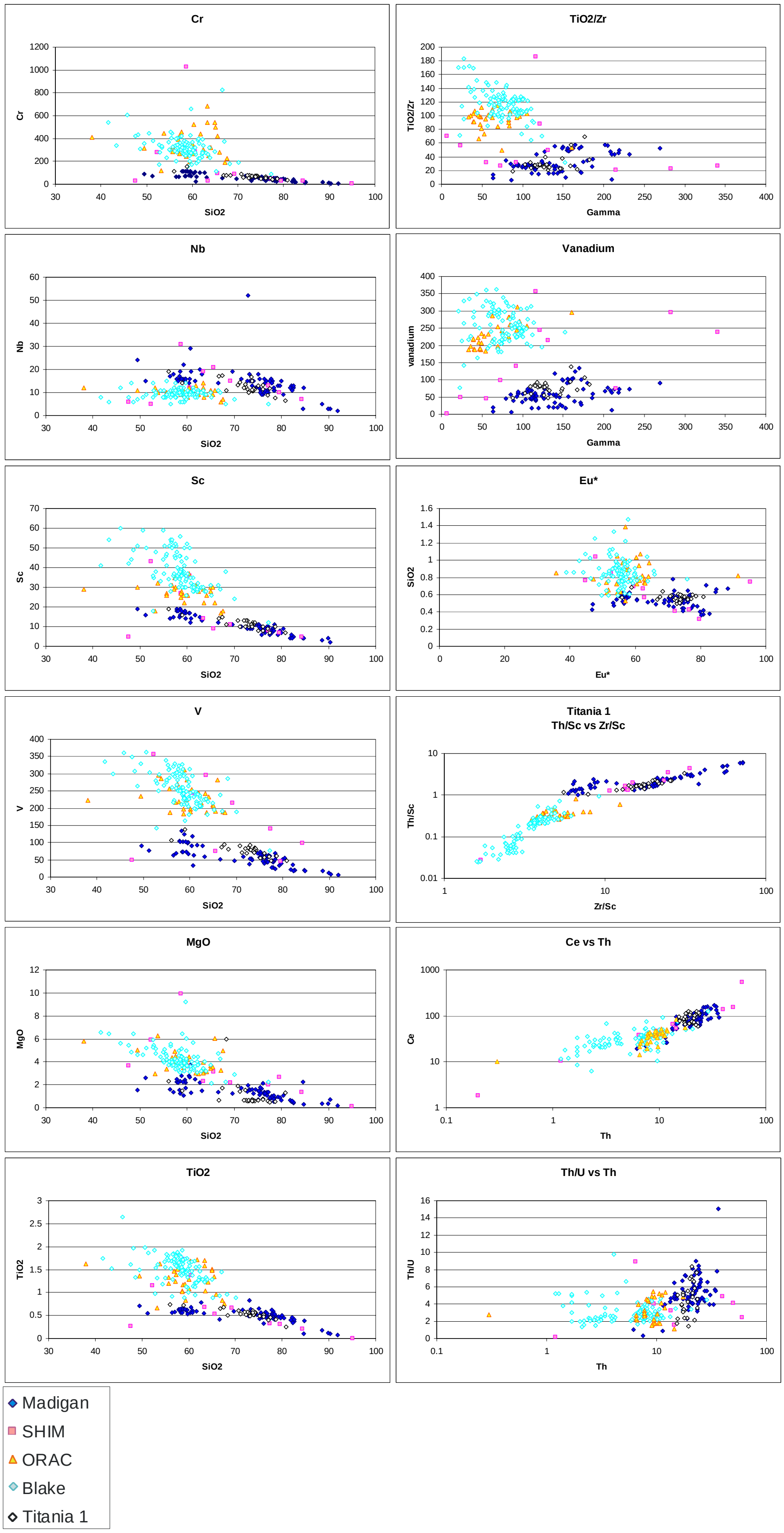
Titania 1



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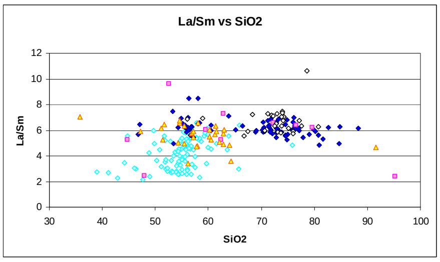
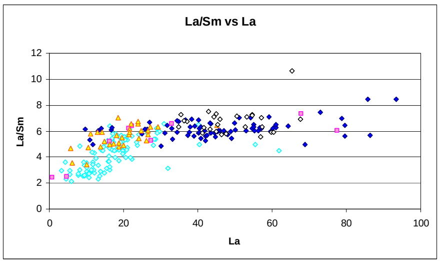
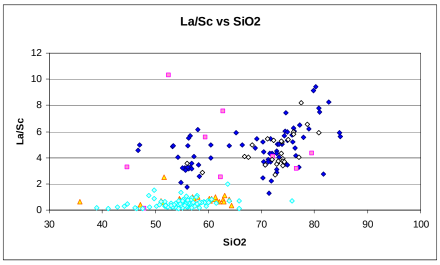
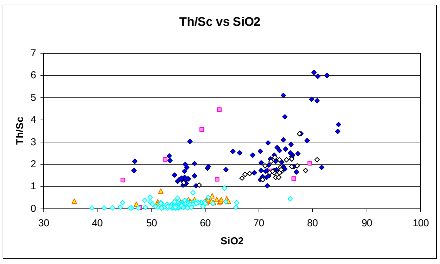
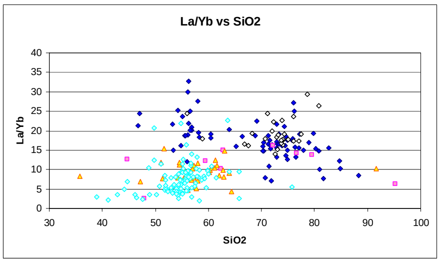
Titania 1

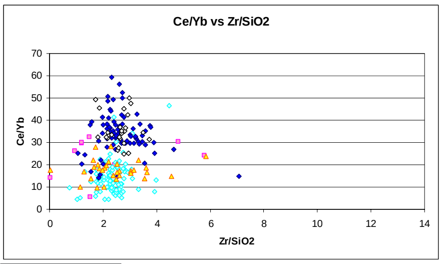








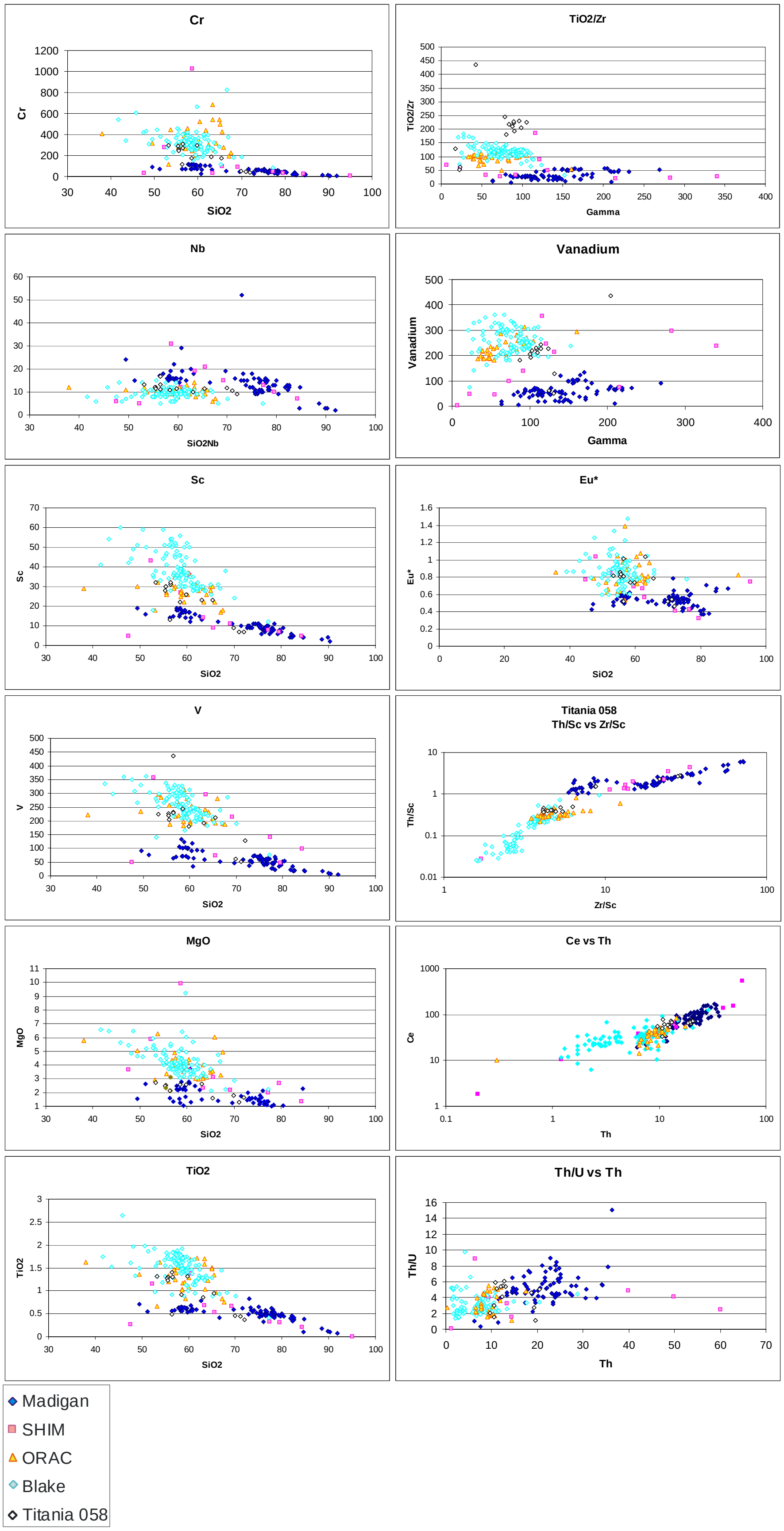




Appendix A

Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

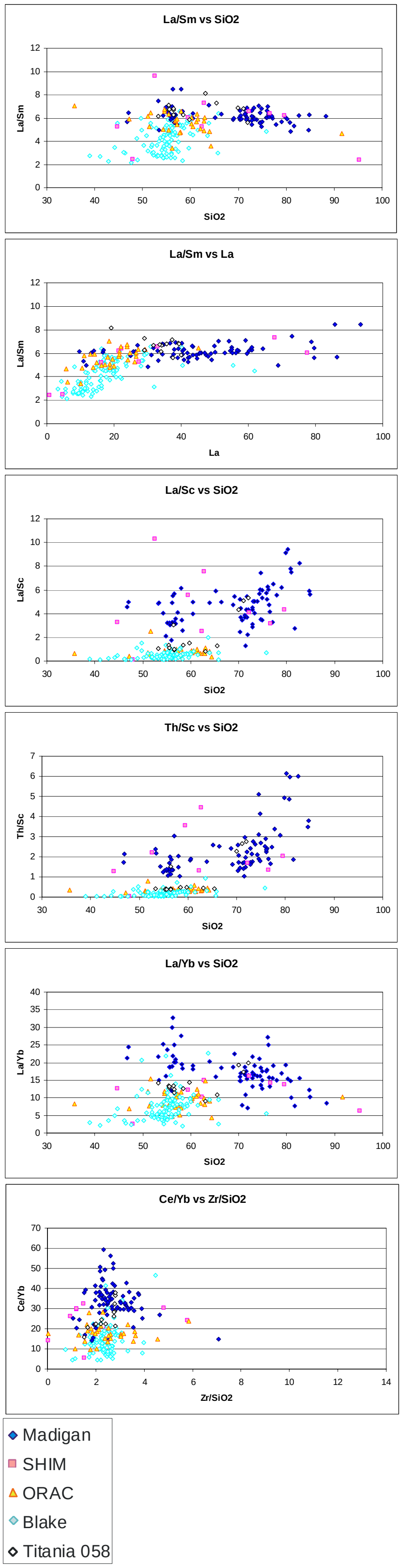
Titania 058



Appendix A

Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

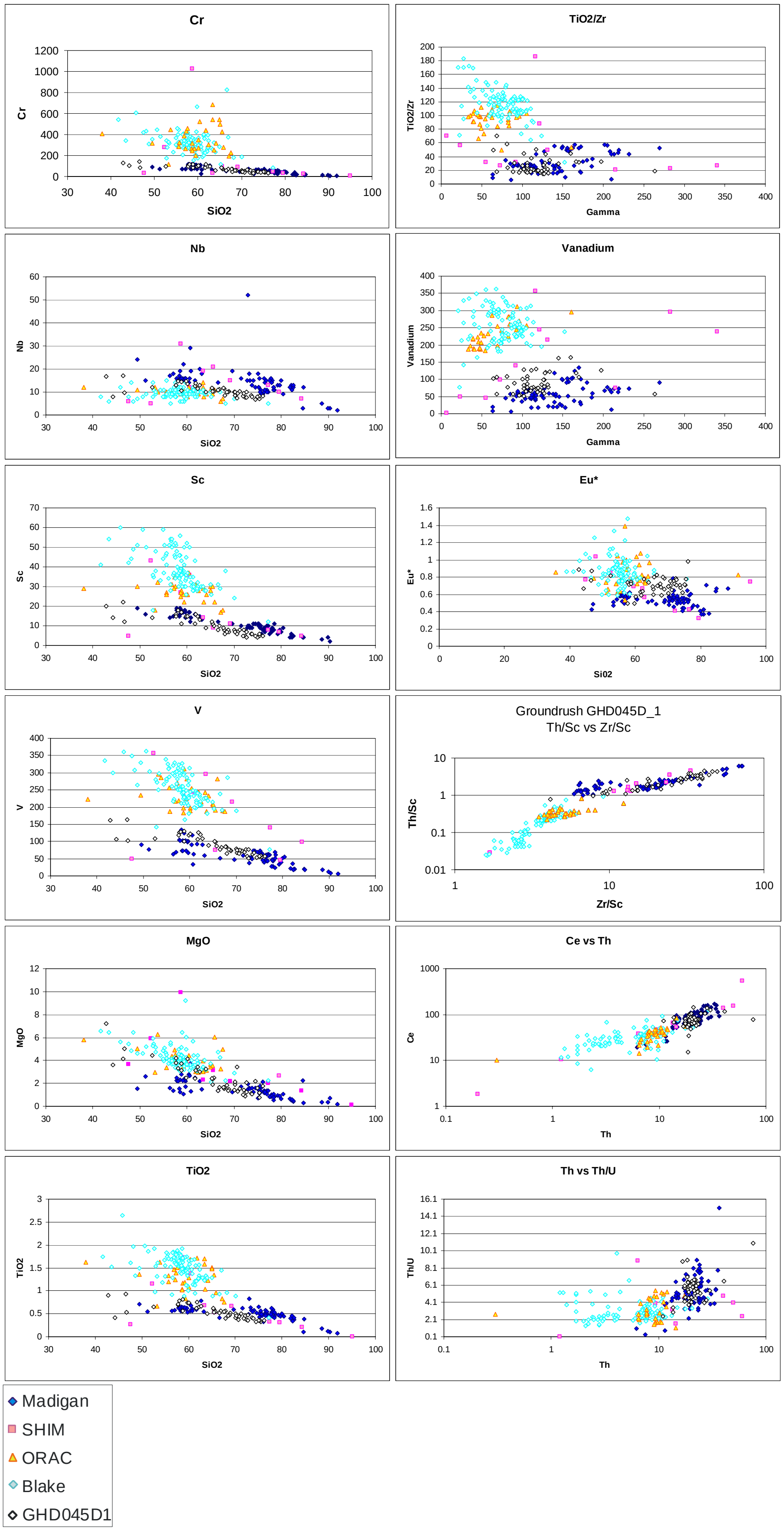
Titania 058



Appendix A

Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

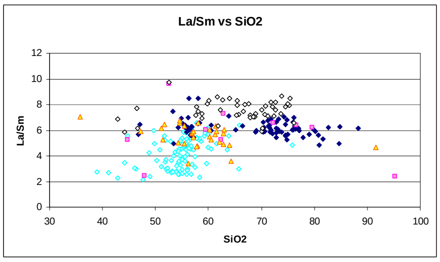
GHD045D_1

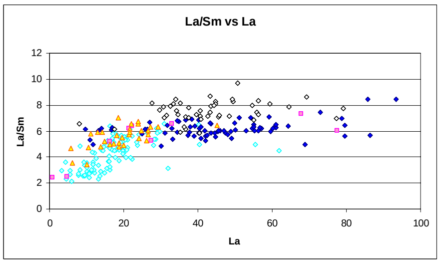


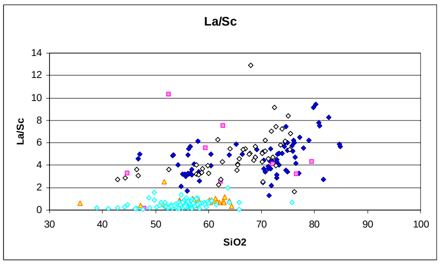
Appendix A

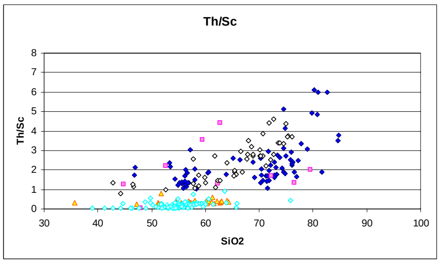
Geochemical plots displaying a bipartite distribution complementary to Th/Sc-Zr/Sc plots detailed in the report.

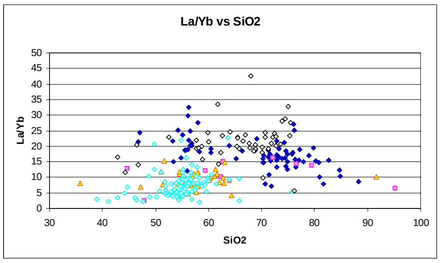
GHD045D1

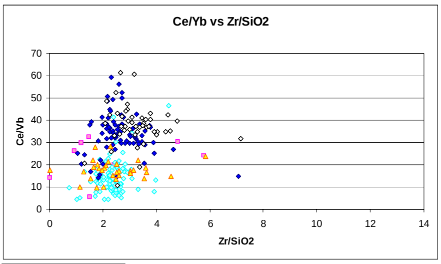




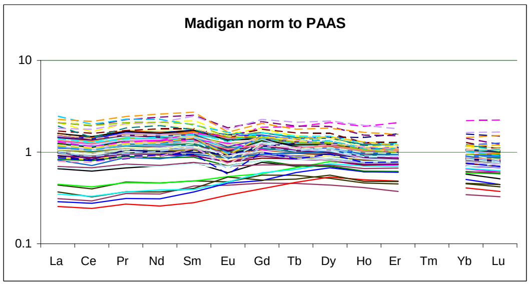


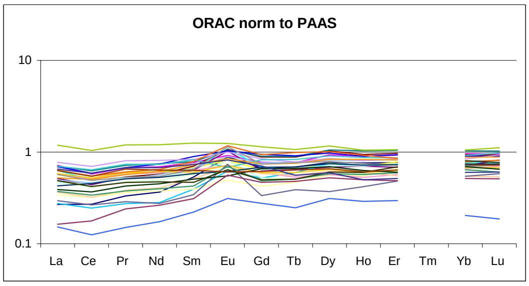


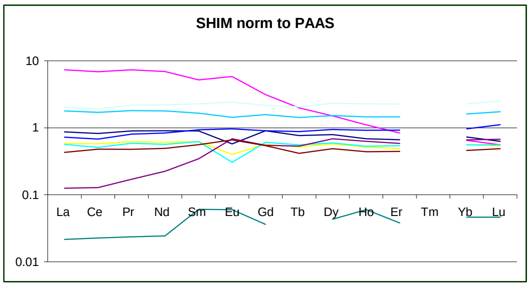


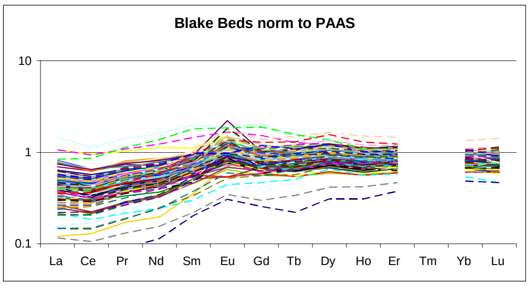


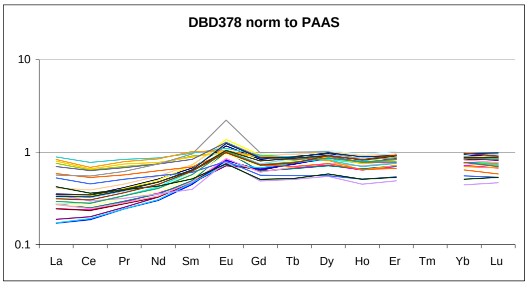
Appendix B
Geochemistry normalised to PAAS
DBD378





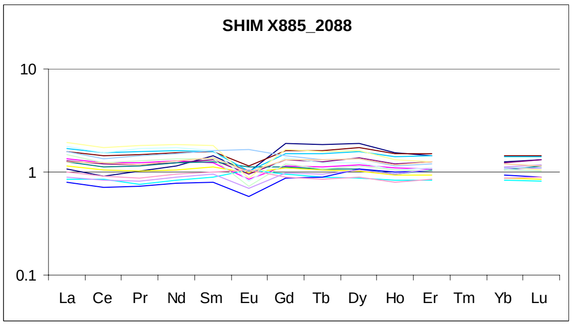


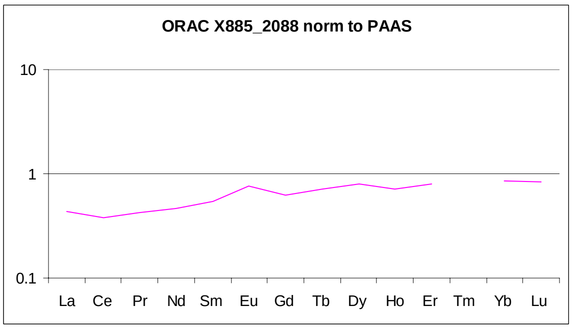


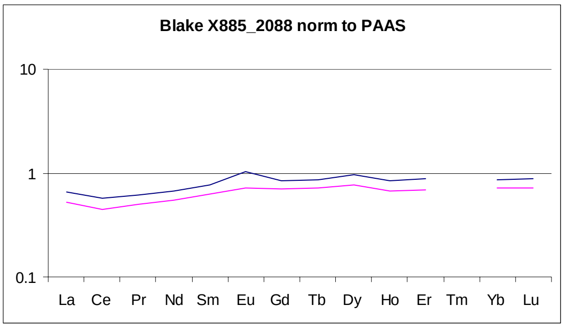


Appendix B

X885_2088 normalised to PAAS

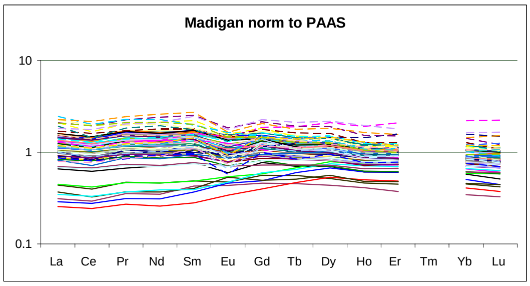


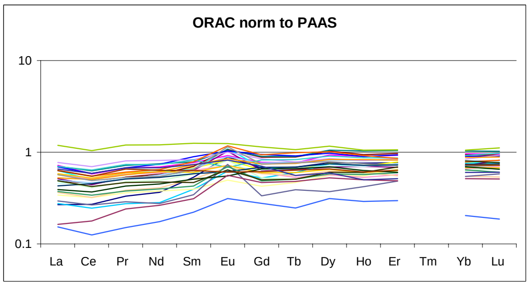


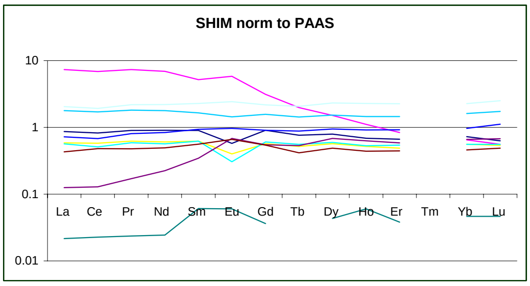


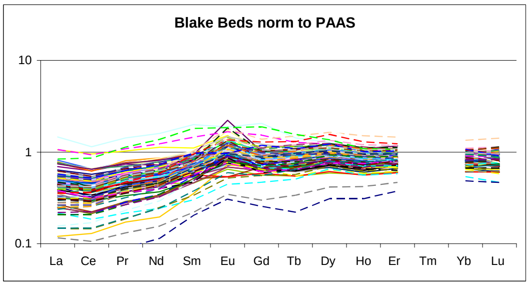
Appendix B

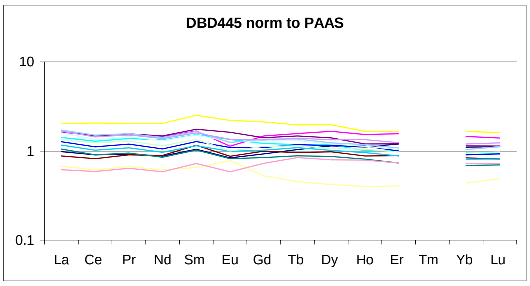
DBD445 normalised to PAAS



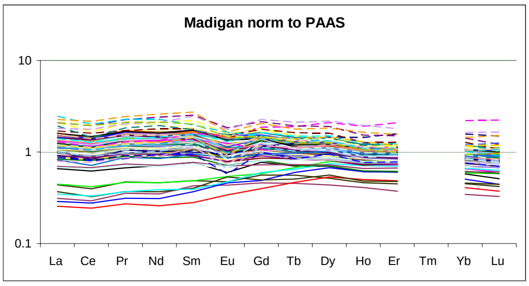


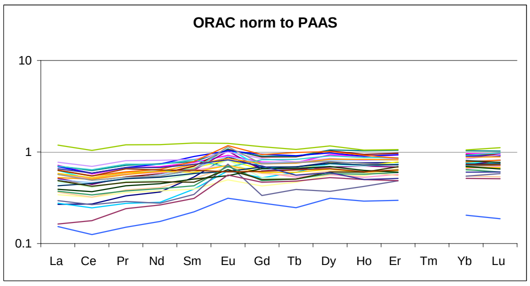


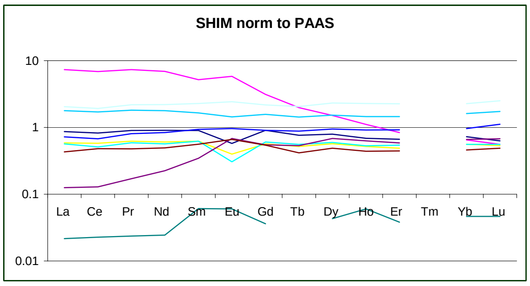


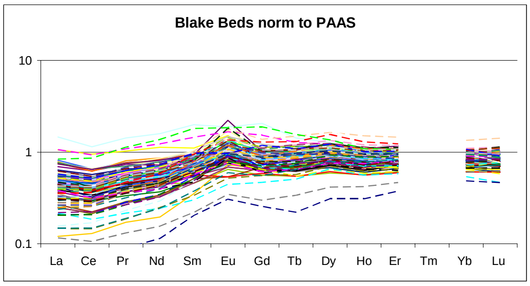


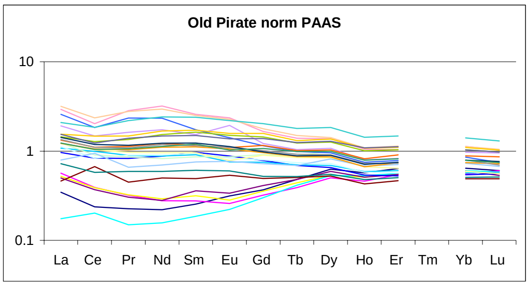
Appendix B
OPD_1 normalised to PAAS



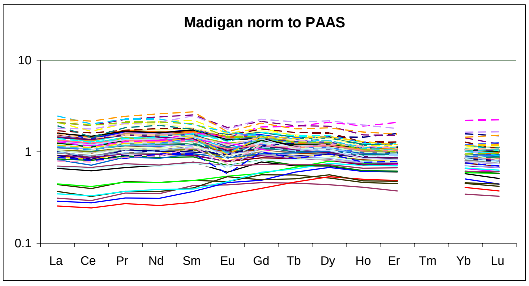


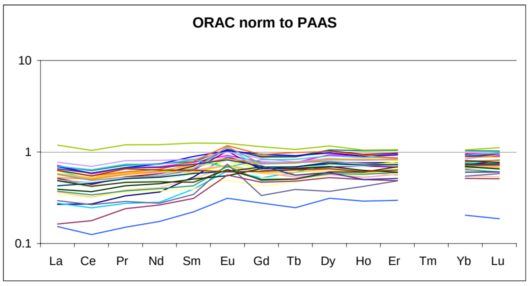


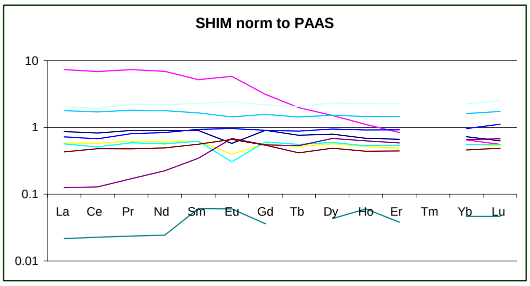


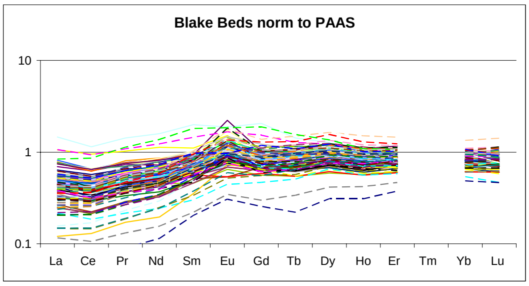


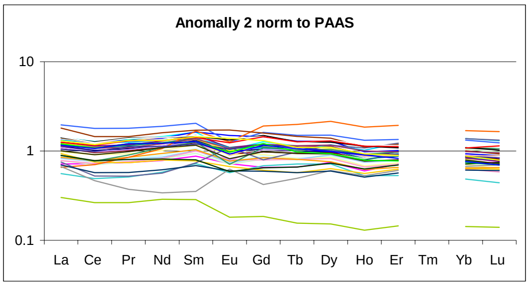
Appendix B
Anomaly 2 normalised to PAAS





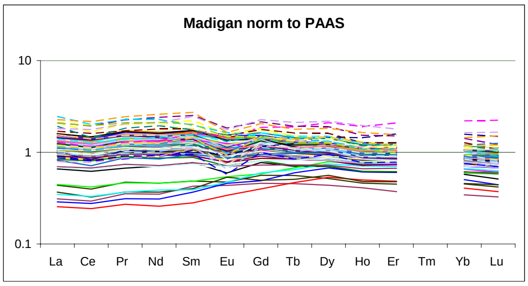


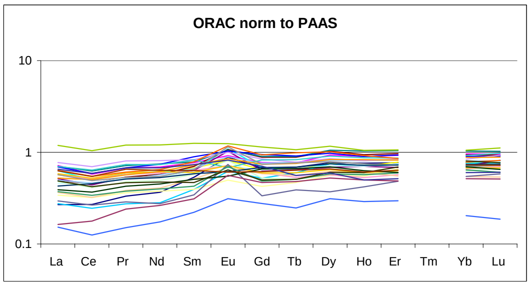


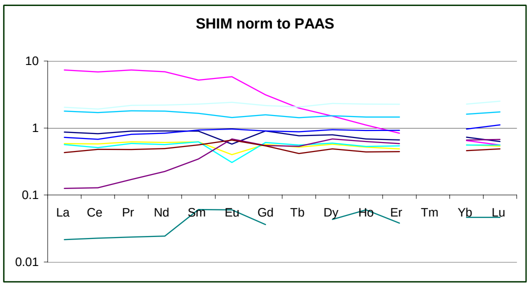


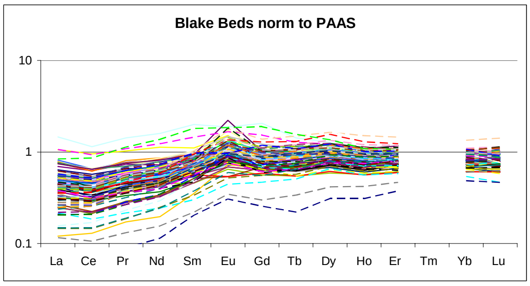
Appendix B

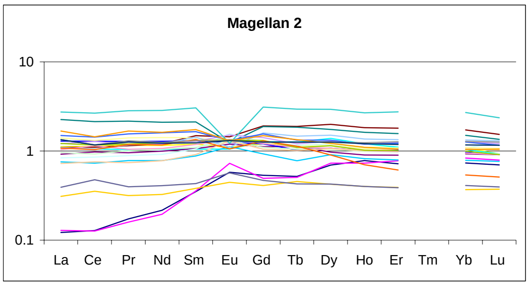
Magellan 2 normalised to PAAS





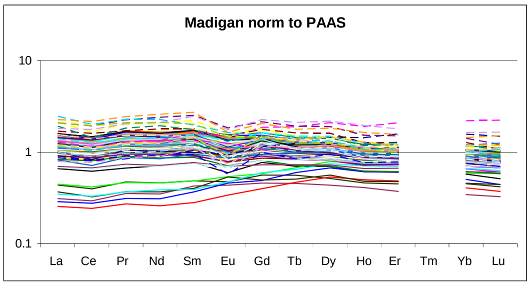


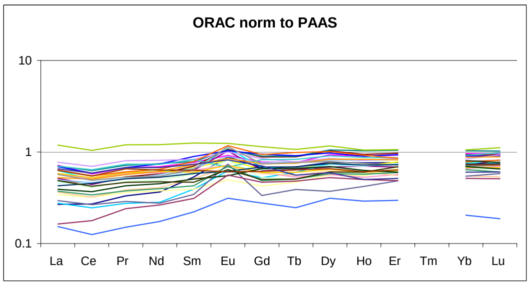


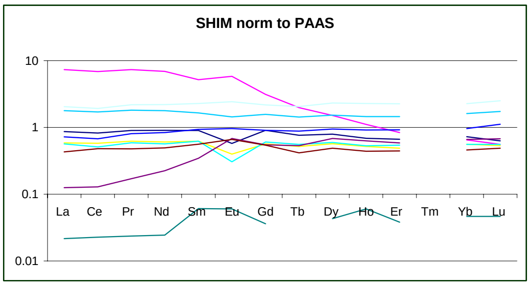


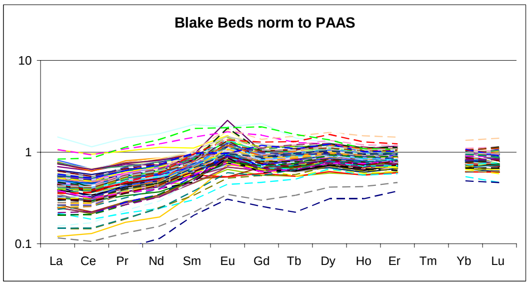
Appendix B

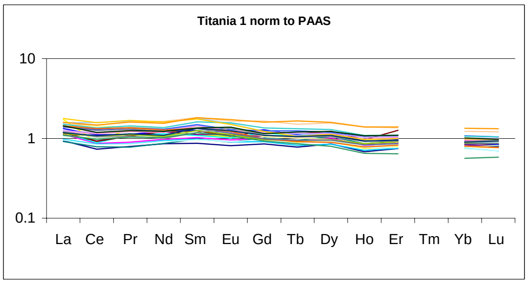
Titania 1 normalised to PAAS





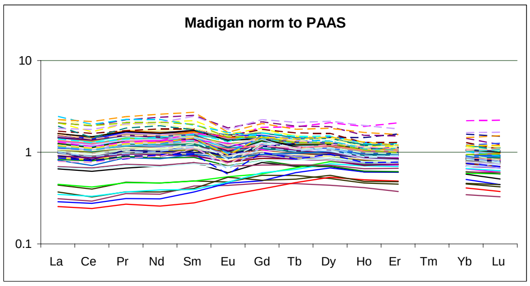


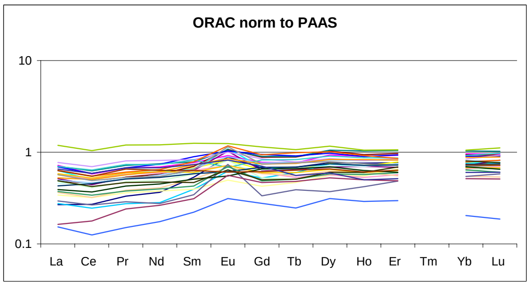


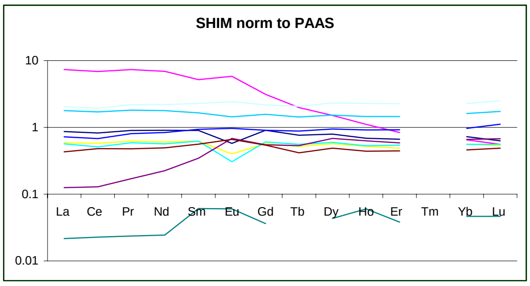


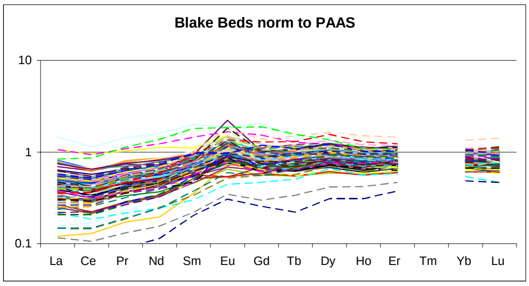
Appendix B

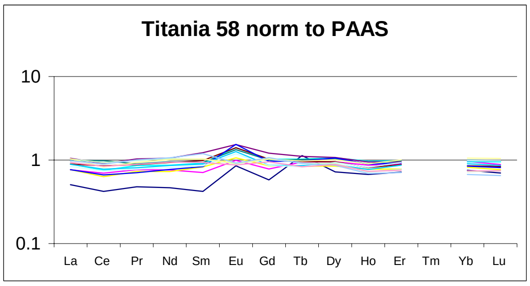
Titania 058 normalised to PAAS





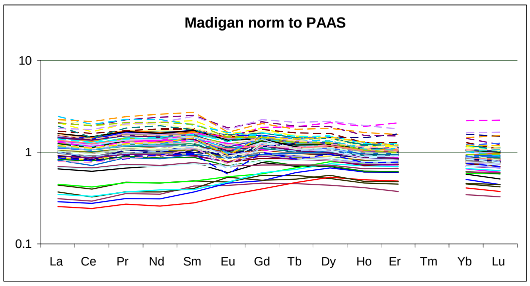


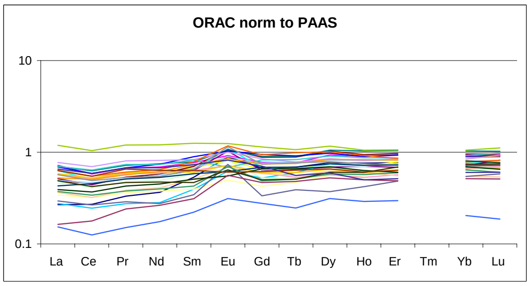


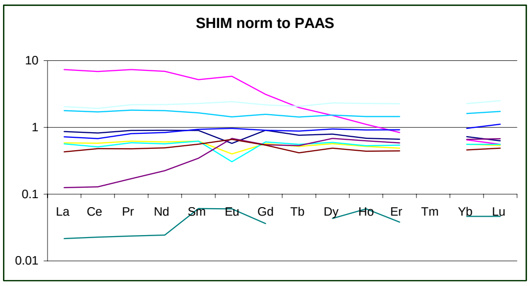


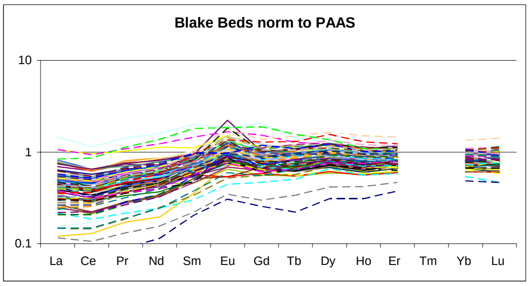
Appendix B

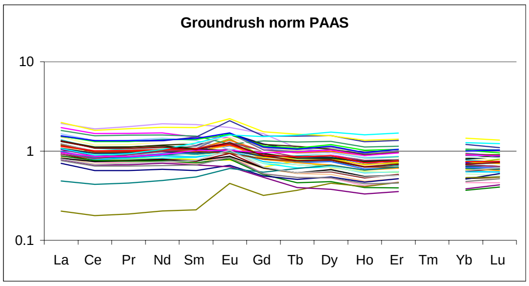
GHD045_D1 normalised to PAAS



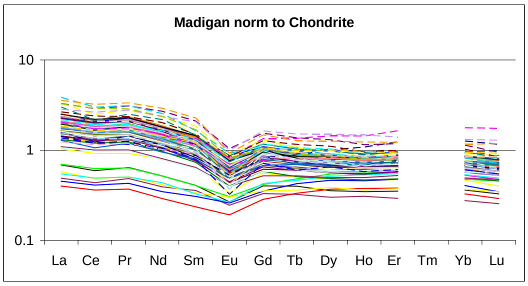


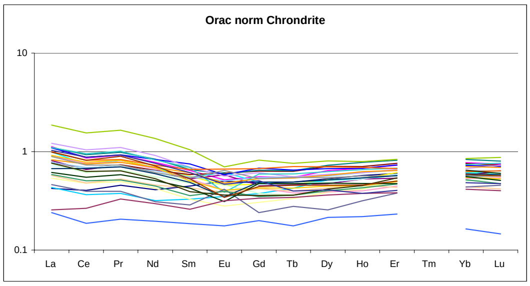


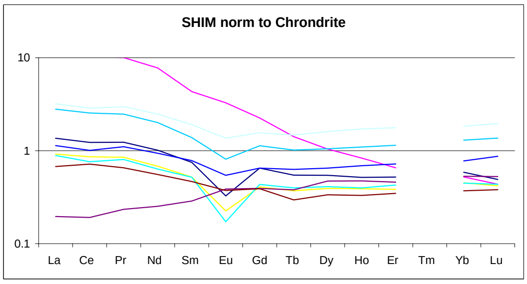


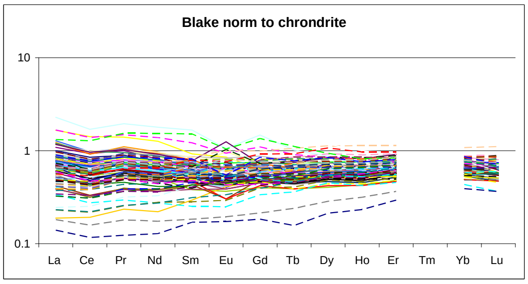


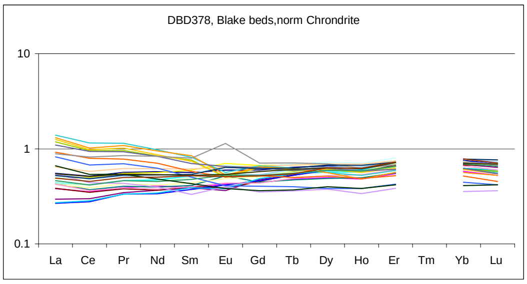
Appendix C
Geochemical data normalised to Chrondrite
DBD378





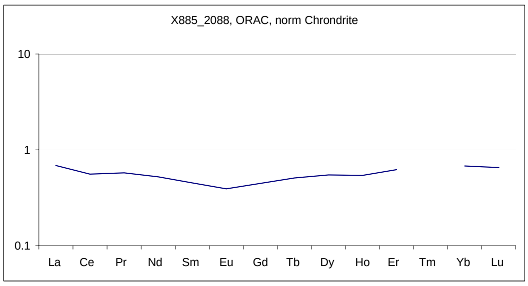


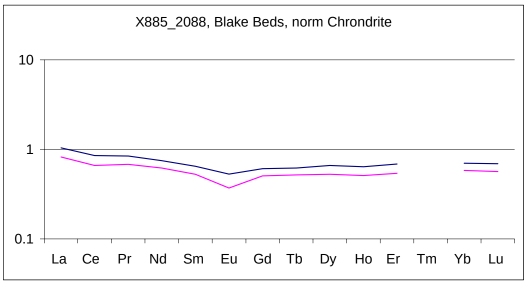


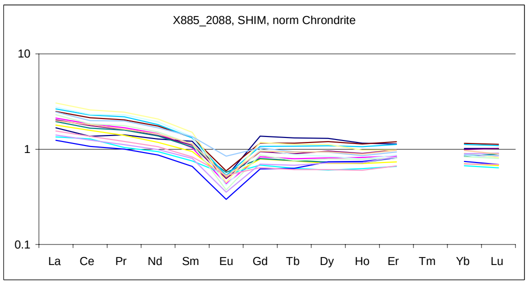


Appendix C

X885_2088 normalised to Chrondrite

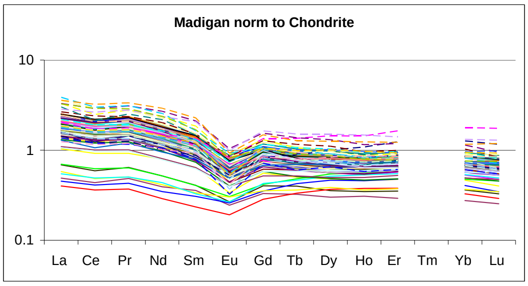


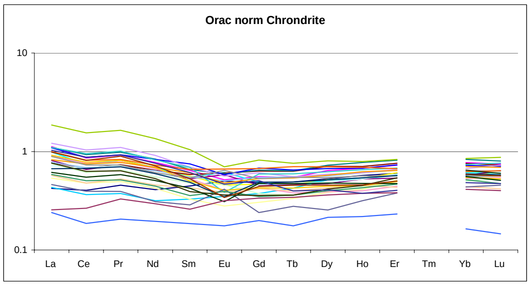


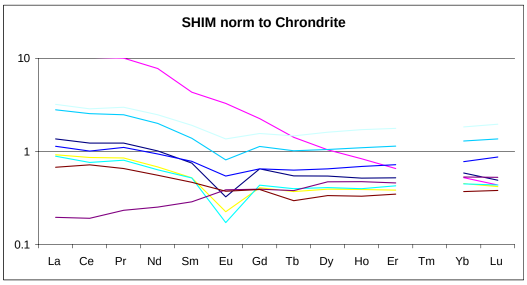


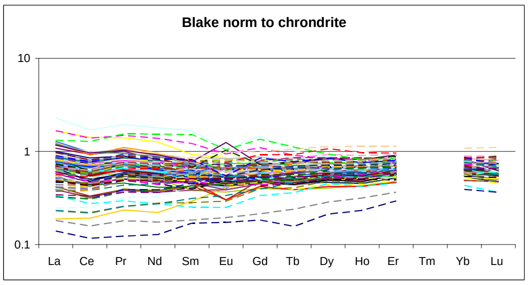
Appendix C

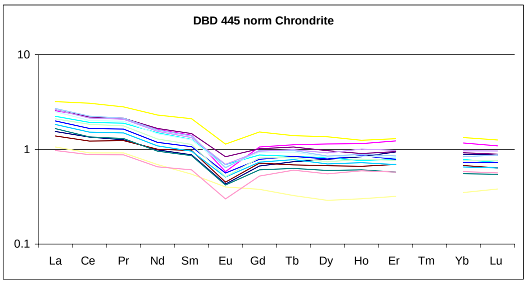
DBD445 normalised to Chrondrite





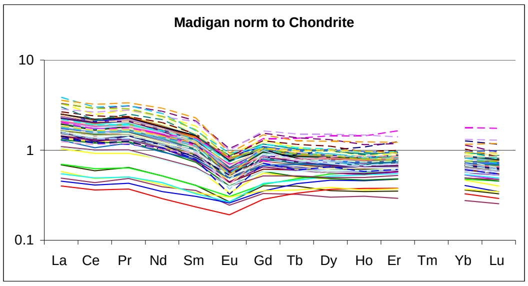


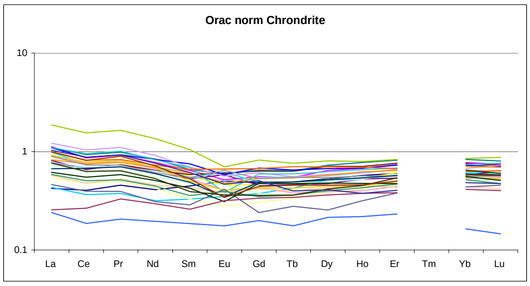


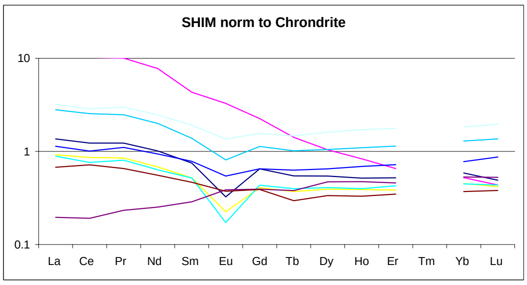


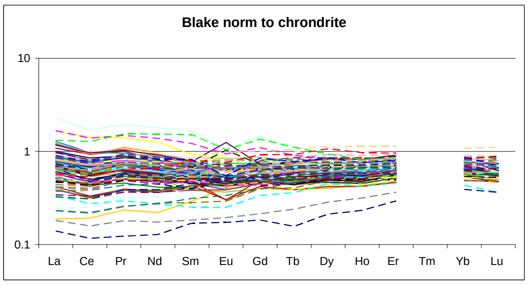
Appendix C

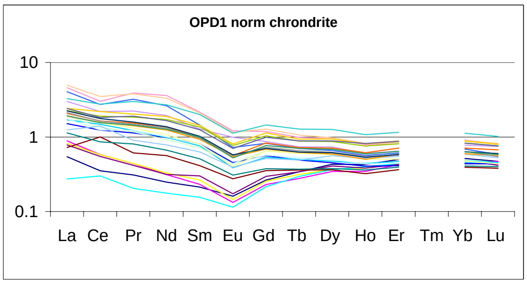
OPD1 normalised to Chrondrite





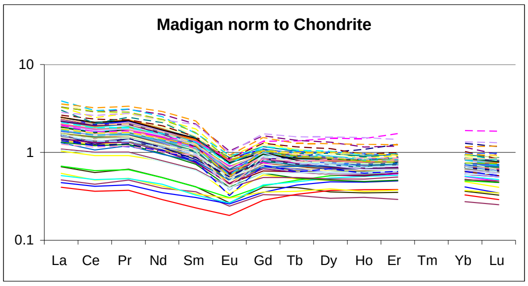


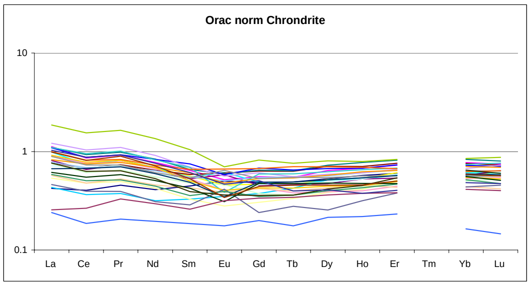


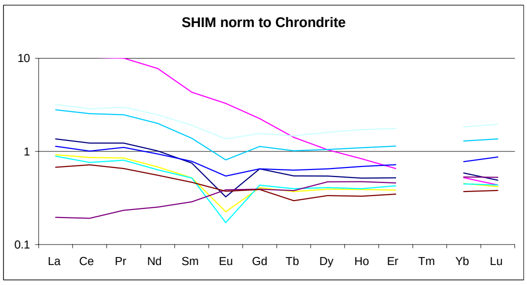


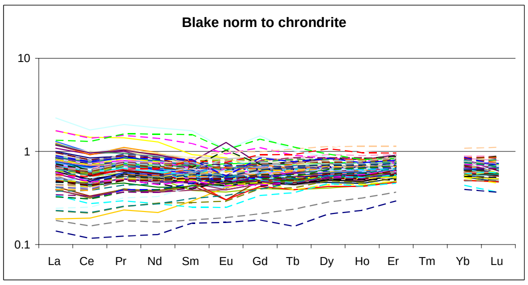
Appendix C

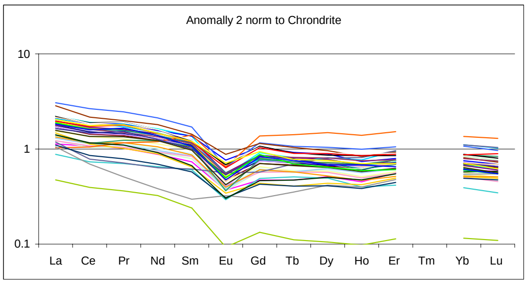
Anomaly normalised to Chrondrite



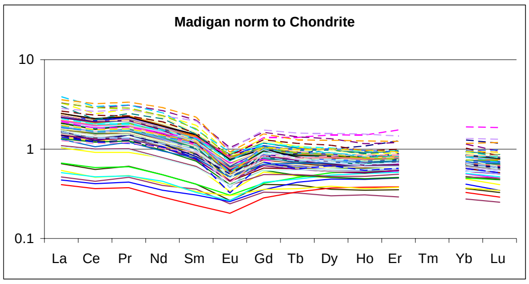


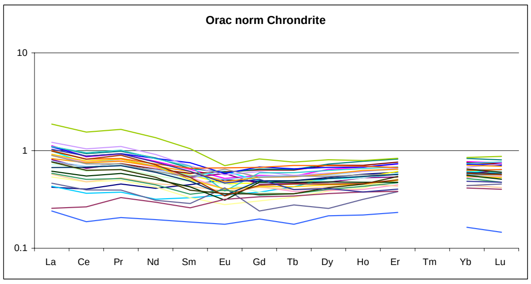


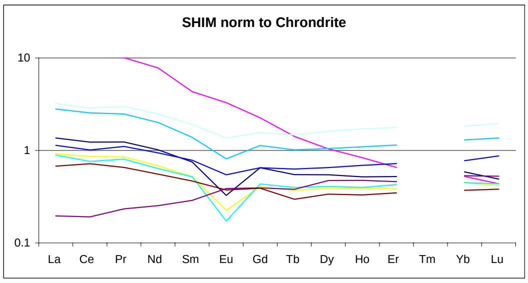


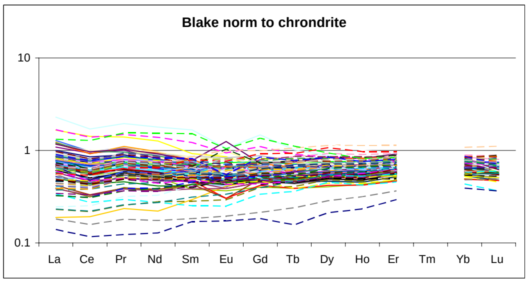


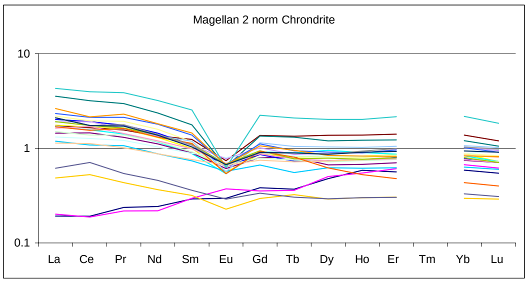
Appendix C
Magellan 2 normalised to Chrondrite





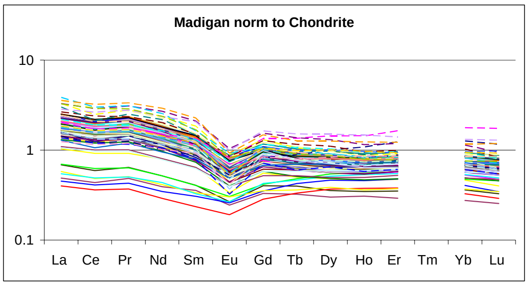


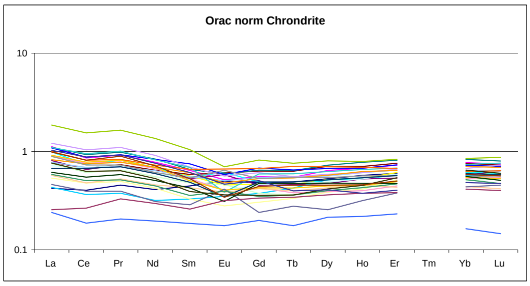


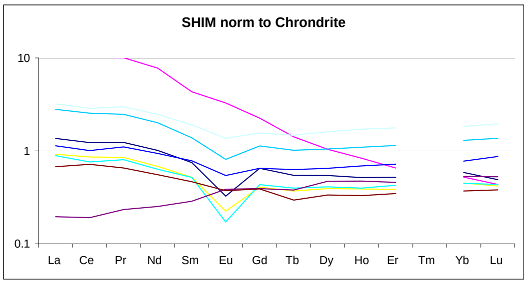


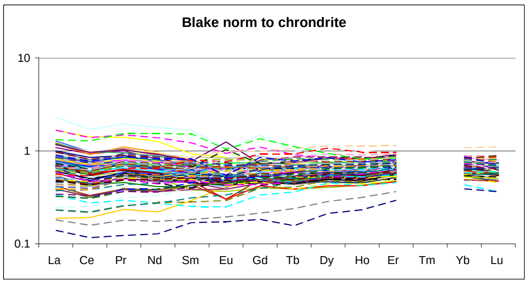
Appendix C

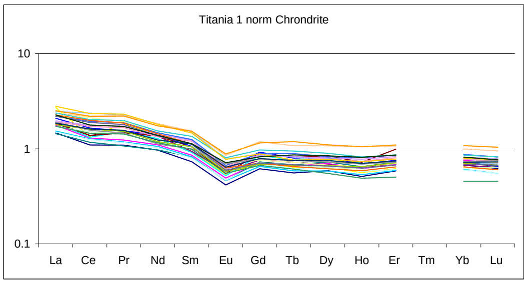
Titania 1 normalised to Chrondrite





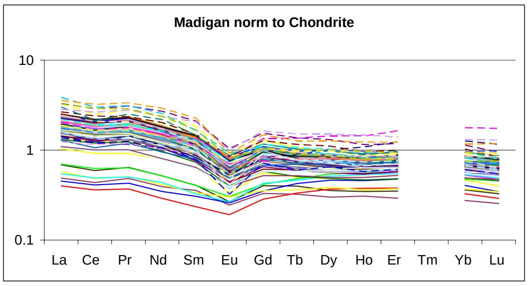


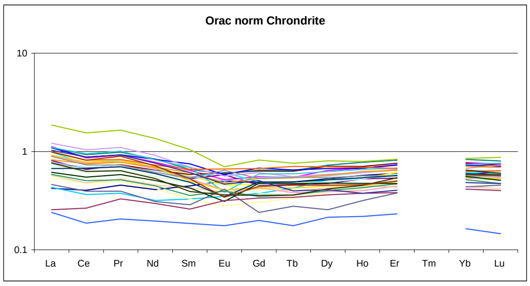


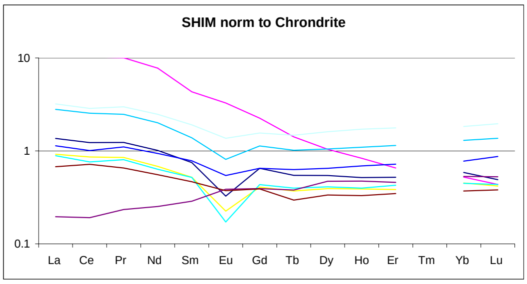


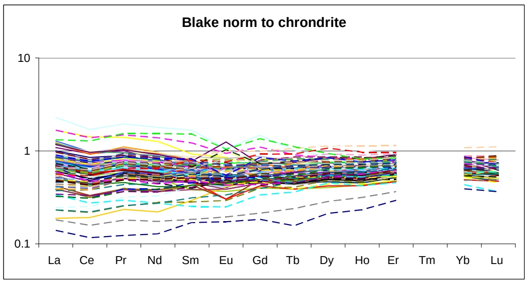
Appendix C

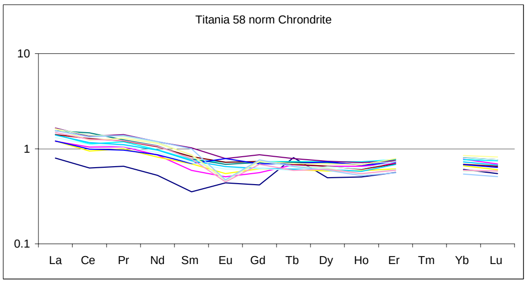
Titania 058 normalised to chrondrite











Appendix C

GHD45_D1 normalised to chrondrite