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RESEARCH ARISING FROM CSIRO/AMIRA YILGARN REGOLITH GEOCHEMISTRY PROJECTS 1987-1996

In 1987, CSIRO commenced a series of multi-client research projects in regolith geology and geochemistry which were sponsored by companies in the Australian mining industry, through the Australian Mineral Industries Research Association Limited (AMIRA). The initial research program, "Exploration for concealed gold deposits, Yilgarn Block, Western Australia" had the aim of developing improved geological, geochemical and geophysical methods for mineral exploration that would facilitate the location of blind, buried or deeply weathered gold deposits. The program commenced with the following projects:

P240: Laterite geochemistry for detecting concealed mineral deposits (1987-1991). Leader: Dr R.E. Smith.
Its scope was development of methods for sampling and interpretation of multi-element laterite geochemistry data and application of multi-element techniques to gold and polymetallic mineral exploration in weathered terrain. The project emphasised viewing laterite geochemical dispersion patterns in their regolith-landform context at local and district scales. It was supported by 30 companies.

P241: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1987-1991). Leader: Dr C.R.M. Butt.
The project investigated the distribution of ore and indicator elements in the regolith. It included studies of the mineralogical and geochemical characteristics of weathered ore deposits and wall rocks, and the chemical controls on element dispersion and concentration during regolith evolution. This was to increase the effectiveness of geochemical exploration in weathered terrain through improved understanding of weathering processes. It was supported by 26 companies.

These projects represented 'an opportunity for the mineral industry to participate in a multi-disciplinary program of geoscience research aimed at developing new geological, geochemical and geophysical methods for exploration in deeply weathered Archaean terrains'. This initiative recognised the unique opportunities, created by exploration and open-cut mining, to conduct detailed studies of the weathered zone, with particular emphasis on the near-surface expression of gold mineralisation. The skills of existing and specially recruited research staff from the Floreat Park and North Ryde laboratories (of the then Divisions of Minerals and Geochemistry, and Mineral Physics and Mineralogy, subsequently Exploration Geoscience and later Exploration and Mining) were integrated to form a task force with expertise in geology, mineralogy, geochemistry and geophysics. Several staff participated in more than one project. Following completion of the original projects, two continuation projects were developed.

P240A: Geochemical exploration in complex lateritic environments of the Yilgarn Craton, Western Australia (1991-1993). Leaders: Drs R.E. Smith and R.R. Anand.
The approach of viewing geochemical dispersion within a well-controlled and well-understood regolith-landform and bedrock framework at detailed and district scales continued. In this extension, focus was particularly on areas of transported cover and on more complex lateritic environments typified by the Kalgoorlie regional study. This was supported by 17 companies.

P241A: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1991-1993). Leader: Dr. C.R.M. Butt.
The significance of gold mobilisation under present-day conditions, particularly the important relationship with pedogenic carbonate, was investigated further. In addition, attention was focussed on the recognition of primary lithologies from their weathered equivalents. This project was supported by 14 companies.

Most reports related to the above research projects were published as CRC LEME Open File Reports Series (Nos 1-74), with an index (Report 75), by June 1999. Publication now continues with release of reports from further projects.

P252: Geochemical exploration for platinum group elements in weathered terrain. Leader: Dr C.R.M. Butt.
This project was designed to gather information on the geochemical behaviour of the platinum group elements under weathering conditions using both laboratory and field studies, to determine their dispersion in the regolith and to apply this to concepts for use in exploration. The research was commenced in 1988 by CSIRO Exploration Geoscience and the University of Wales (Cardiff). The Final Report was completed in December 1992. It was supported by 9 companies.

P409: Geochemical exploration in areas of transported overburden, Yilgarn Craton and environs, WA.
Leaders: Drs C.R.M. Butt and R.E. Smith.
About 50% or more of prospective terrain in the Yilgarn is obscured by substantial thicknesses of transported overburden that varies in age from Permian to Recent. Some of this cover has undergone substantial weathering. Exploration problems in these covered areas were the focus of Project 409. The research was commenced in June 1993 by CSIRO Exploration and Mining but was subsequently incorporated into the activities of CRC LEME in July 1995 and was concluded in July 1996. It was supported by 22 companies.

Although the confidentiality periods of Projects P252 and P409 expired in 1994 and 1998, respectively, the reports have not been released previously. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authority to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian mineral industry.

PREFACE

The principal objective of AMIRA Project 409 is to develop geochemical methods for mineral exploration in areas of the Yilgarn Craton and environs having substantial transported overburden, through investigations of the processes of geochemical dispersion from concealed mineralisation.

The Safari prospect at Mt. Celia is a new Au discovery in an area dominated by extensive cover of sandy transported overburden. It is situated on the Menzies Line and has features that are transitional between the northern and southern parts of the Yilgarn. Pedogenic carbonates are present in the soils, similar to, though rather deeper, than those generally found farther south, but the vegetation is dominated by Acacia spp., characteristic of areas to the north. The site was investigated briefly early in the project and a possible association between Au and secondary carbonates was noted in a pilot study, although it was suspected that may have been partly due to cross-hole contamination of the drill-cuttings. Further research at the site was undertaken when resources became available and has provided a useful case study of a site where outcrop is rare and geochemical sampling has to be carefully directed.

Four to six metres of transported overburden overlies saprolite in which Au content is high, and lateral dispersion extensive. Gold in the saprolite is moderately to highly soluble, and has been mobilised upwards into the transported overburden associated with the evaporative precipitation of carbonate 0.5 - 4 m from the surface, where the Au is extremely soluble. Targeted for sampling, the calcareous horizon gives extensive Au anomalies up to 800 m across strike of mineralisation, although it should be considered that such impressive dispersion may be limited to environments where shallow overburden (*e.g.* less than 10 m) is in direct contact with a Au-rich source.

C.R.M. Butt
R.E. Smith
Project Leaders
July 1996

ABSTRACT

The distribution and solubility of Au and the distribution of other elements in the upper regolith and the nature and distribution of regolith materials has been studied at and around the Safari deposit, 200 km NE of Kalgoorlie, Western Australia. The deposit has a resource of 1.08 Mt @ 3.3 g/t Au associated with quartz veins within sheared metavolcanic rocks (mainly quartz-chlorite-sericite schists) in the southern extension of the Laverton tectonic zone. The mineralised and country rocks are deeply weathered, and subsequently eroded to the lower saprolite and, in places, fresh rock. They are now covered by up to 9 m of colluvium / alluvium derived from eroding greenstone and granite regolith several km to the ENE. Groundwater at the deposit is approximately 40 m below surface. Much of the regolith, and particularly the upper few metres, shows evidence of widespread and intensive modification associated with arid conditions (namely calcification from approximately 0.5 - 4 m below surface). Samples of regolith (transported overburden and the upper two metres of saprolite) from a drill traverse across the deposit, and selected samples of primary mineralisation and vegetation have been examined to determine element distributions, their relationship to regolith evolution and their significance in exploration. Elements associated with Au mineralisation are W, As, Zn, S, Pb, Si, heavy REE and possibly Sb, though only Pb displays a direct correlation with Au. Of these, (excluding Pb, S and Si, not analysed in the regolith), only Au shows evidence of remobilisation in the regolith, the others being closely confined to the mineralised zones in the weathered Archaean. Plant materials were found to be ineffective in detecting mineralisation.

The distribution and solubility of Au in the regolith suggest that Au has been dissolved from mineralisation in the top of the saprolite and re-precipitated in the transported overburden close to the surface, in association with carbonate minerals. Gold is strongly enriched at the top of the saprolite (10-1000 ppb for 500 m peaking over mineralisation), and solubility is generally high, although appears lower close to mineralisation (<30 % iodide soluble), increasing with lateral distance from mineralisation (up to 80 % iodide soluble), suggesting secondary lateral dispersion around the unconformity. In contrast, Au is anomalous (7-40 ppb), and highly soluble (>70 % iodide soluble) throughout the calcareous horizon, and close to surface, for up to 800 m across strike, peaking directly over mineralisation, suggesting dominantly vertical chemical dispersion. This may be the result of two phases of Au dispersion: the first, prior to sedimentation, resulted in lateral dispersion of Au down the relatively steep palaeo-surface; the second, after sedimentation, resulted from solution of Au from the carbonates in the upper saprolite and vertical dispersion by capillary action and/or evapo-transpiration, resulting in evaporative precipitation with carbonate 0.5 - 4 m from the surface.

It is suggested that a combination of a shallow overburden and a source at the top of the saprolite have contributed to the formation of Au anomalies in the transported overburden. These factors need to be considered if carbonate sampling is to be applied to other depositional landform regimes.

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1. INTRODUCTION

1.1 LOCATION, CLIMATE AND VEGETATION

The Safari prospect is located approximately 200 km NNE of Kalgoorlie. The climate is semi-arid with an average annual rainfall of 200-250 mm. Rainfall throughout the year is variable and results from frontal systems from the west and south-west in winter and from patchy, convectional storms and cyclone-related depressions in summer. The vegetation is a medium to dense woodland of *Acacia* spp. with occasional clusters of *Eucalyptus* spp. throughout (Hall *et. al.*, 1994).
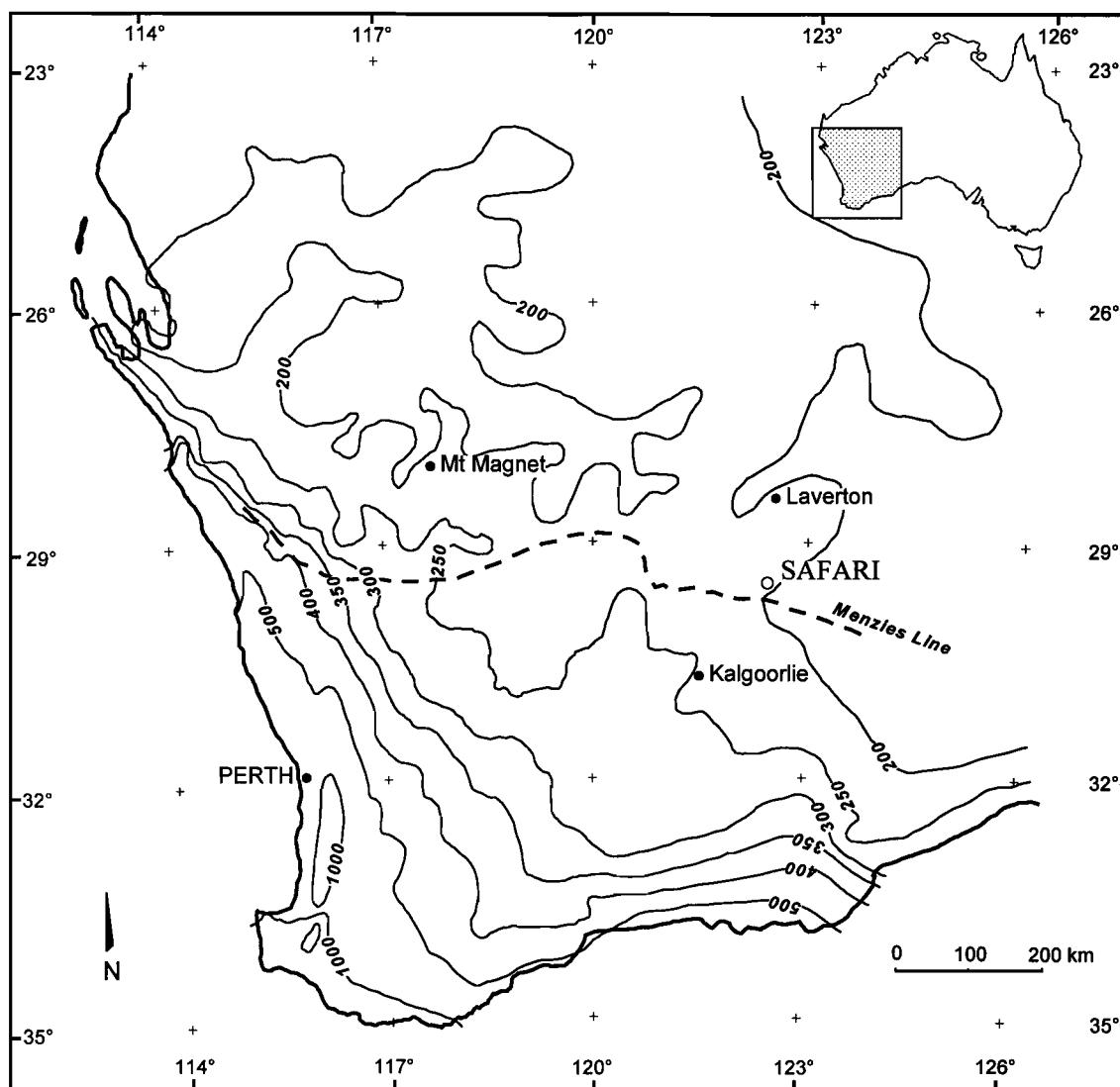

Figure 1: Location of the Safari deposit with annual rainfall isohyets (mm/yr) and the approximate position of the Menzies Line.

1.2 GEOLOGY AND MINERALISATION

The Safari prospect was discovered in 1988 following a regional BLEG survey and subsequent power auger sampling on a 250 m x 50 m grid. Drilling to date indicates a resource of 1.08 million tonnes @ 3.3 g/t Au.

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The prospect lies within the southern extension of the Laverton Tectonic Zone, a major, N-S trending corridor of complex structural deformation, bounded to the E and W by weakly deformed rocks of the Merolia and Murrin-Margaret sectors respectively. The greenstone assemblage in the vicinity of the deposit comprises a wide variety of volcanic and volcaniclastic rocks (komatiite, komatiitic basalt, basalt, andesite, dacite and rhyolite) and minor BIF, chert and argillite. These rocks are heterogeneously deformed, and generally strike NNW, and have a near-vertical to WSW dipping tectonic foliation and a sub-horizontal to down-dip mineral lineation. Plutons of porphyritic syenite and coarse, equi-granular granodiorite and adamellite intrude the greenstones. Supracrustal rocks, adjacent to the larger of these plutons, have been metamorphosed to the amphibolite facies. Elsewhere, the rocks are at the lower greenschist facies.

The greenstone assemblage is dissected by a number of brittle/ductile shears, including the Kangaroo and Mt Hornet faults, which appear to separate distinctly different greenstone domains. The shears parallel the gross NNW striking lithological layering of the volcanic pile and are considered to be strike-slip, reactivated, high-angle thrust faults.

Mineralisation is hosted by andesite to dacite metavolcanic rocks, now largely represented by quartz-chlorite-sericite $\pm$ carbonate schists, bounded to the E and W by talcose schists and serpentinised komatiite. Gold is primarily associated with quartz veins within an anastomosing shear (Kohler, 1996).

1.3   REGIONAL REGOLITH RELATIONSHIPS

Safari is situated on a broad, sandy, colluvial plain approximately 9 km NE of the margin of Lake Raeside. Regional features of the surface regolith have been interpreted from Landsat Thematic Mapper colour composite imagery, using bands 7, 4 and 2 in red, green and blue (Figure 2) and band ratios 5/7 4/7 4/2 (RGB) with limited field checking. (Image processing methodology is described in Section 2.4). The map subdivides the region into 3 units, each warranting a different approach to regolith geochemistry. Drainage trends are highlighted to indicate the current direction of transport of eroded materials.

Residual weathered Archaean materials

This unit represents the surface expression of outcropping or subcropping saprolite or saprock, (and in places truncated or incipient mottled zones), and soils developed from them. These materials may have been exposed by erosion of a pre-existing weathered profile, or may represent the most weathered form of the parent material.

Post-Archaean sedimentary materials

These dominate the region and surficial materials represent the uppermost part of a sedimentary sequence that may be highly variable in genesis, composition and thickness. They include alluvial, colluvial and aeolian sediments and vary from one to many tens of metres thick. They are derived from erosion of fresh and weathered Archaean rocks and the reworking of post Archaean sediments, either locally or from many kilometres away. The sediments themselves may have been subject to extensive post depositional modification by chemical and physical weathering.

Ferruginous materials

This unit depicts the occurrence of highly ferruginous materials, developed in either weathered Archaean bedrock or in younger sediments that have been subject to extreme weathering and/or induration by Fe oxides.

SAFARI PROSPECT
Regional regolith relationships
and drainage trends

Interpreted from
Landsat Thematic Mapper Imagery

Ferruginous materials
Post Archaean sedimentary materials
Residual weathered Archaean materials
Drainage direction
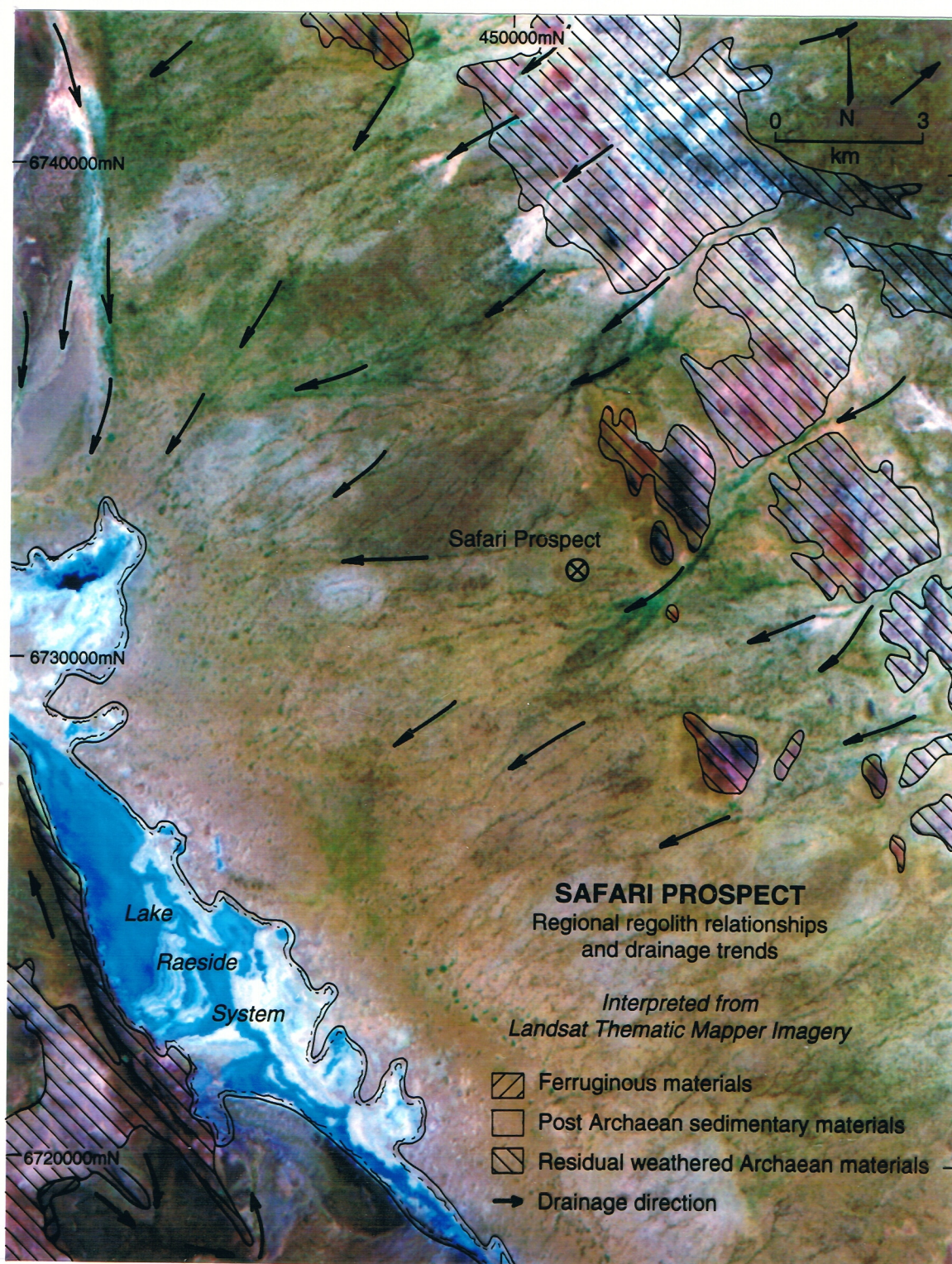
Figure 2: Landsat TM Bands 742 (RGB) with regional interpretation of key regolith relationships.

2. METHODS

2.1 SAMPLING

Samples used in this research were obtained from:

- A rotary air blast (RAB) drilling program. This was specifically undertaken by Pancontinental Mining Limited and CSIRO for this research. Twenty five holes were drilled over a 1.1 km traverse along 6732300 mN through mineralised and unmineralised lithologies. A 3 m hole was drilled prior to each hole sampled so that the possibility of cross-hole contamination was minimised. Conditions at the time of drilling facilitated the collection of high quality samples as the ground was slightly moist, thus minimising hole collapse. Holes were drilled to approximately 2 m below the base of the transported overburden, which varied from 4 to 9 m below surface. Samples were taken in 0.5 m intervals and riffle split to approximately 2 kg after drilling (hereafter referred to as "unpulverised sample"). Approximately 150 g was then riffle split from these and pulverised to <75 μm in a hardened Mn steel (Ketos K1045) ring mill (hereafter referred to as "pulverised sample").

- A soil profile sampled from a drill sump. Samples were collected to represent 100 mm intervals to a depth of 0.8 m.

- Spoil from existing drilling on two sections through mineralisation. Bulk samples and selected materials from some of the spoil were collected.

- Six samples of *Acacia* spp. leaves and 6 samples of mull were collected across the site.

2.2 ANALYTICAL PROCEDURES

2.2.1 Gold analysis

Gold analysis at Safari was done by encapsulation of 10 g of pulverised sample by CSIRO staff and analysis by instrumental neutron activation analysis (INAA) at Bequerel laboratories, giving a detection limit of 5 ppb. Extraction studies involved the following procedures (*e.g.* Gray and Lintern, 1993 and Lintern and Gray, 1995):

Sequential partial extraction

This procedure gives the water-, iodide- and cyanide-soluble Au components of a single aliquot of sample.

1. 25 g of sample is mixed with 50 ml of deionised water and 1 g of activated carbon (in a plastic mesh sachet) in a screw-cap polyethylene plastic bottle, and then gently agitated for one week. The carbon sachet is removed from the sample, washed with deionised water, and analysed for Au by INAA.

2. 1 ml of 5M KI solution is added to the bottle and a new carbon sachet is added and the above procedure is repeated.

3. 5 ml of cyanide solution (0.15M KCN, 1M NaOH) is added to the bottle and a new carbon sachet is added and the above procedure is repeated.

Iodide-soluble Au partial extraction (buffered)

Twenty five grams of sample is mixed with 50 ml of buffered iodide extraction solution (0.1M KI, 1M NaHCO$_3$, pH 7.4 with HCl) and 1 g of activated carbon (in a plastic mesh sachet) in a screw-cap polyethylene plastic bottle, and then gently agitated for one week. The carbon sachet is removed from the sample, washed with deionised water, and analysed for Au by INAA.

A selection of samples were analysed in duplicate by the sequential and the buffered iodide-soluble Au partial extraction procedures to examine the repeatability of analyses and the effect of buffering the iodide reagent on Au solubility (Section 2.2.4).

2.2.2 Calcium and Mg analysis

A one gram aliquot of each pulverised sample was digested in cold 5M HCl, diluted to 1M after approximately 5 minutes. The digest was analysed by AAS for dissolved Ca and Mg. Detection limits (in the solid) were 0.0025% and 0.001% respectively.

2.2.3 Analysis of other elements

A 10 g aliquot of pulverised sample was encapsulated by CSIRO staff and analysed by Bequerel Laboratories for 28 elements using (INAA). Detection limits were as follows (ppm): K (2000); Fe (500); Na, Ba, Zn (100); Rb (20); Ag, Cr, Se, Mo (5); Br, Ce, U, W (2); As, Co, Cs, Ta (1); La, Eu, Yb, Hf, Th (0.5); Sb, Sm, Lu (0.2); Sc (0.1); Ir (0.02); Au (0.005).

X-Ray fluorescence spectroscopy was performed by CSIRO staff on fused disks (0.7 g sample and 6.4 g lithium borate) using a Philips PW1480 instrument by the method of Norrish and Hutton (1969). Detection limits (in ppm) were as follows: Si, Al, Mg, Na (100); Fe (50); Ti (30); Mn, P (20); Ca, K (10); Ba (30); Ce, Cl (20); Cr, Co, Cu, La, Ni, S (10); Pb, Rb, Sr, V, Y, Zn, Zr (5); Nb (4); Ga (3).

2.2.4 Evaluation of partial extraction procedures

Sixteen contiguous pulverised samples, each representing a half metre interval from a drill hole over mineralisation (SB7), were analysed in duplicate by each of the partial extraction procedures described in Section 2.2.1 (sequential water, iodide and cyanide extractable Au and buffered iodide extractable Au). This section examines variability between duplicates by each technique and the effect of buffering the pH of iodide extraction reagent to 7.4 on the ability of iodide extraction reagents to dissolve Au.

Duplicate analyses

Repeatability of Au dissolved by the sequential extraction technique is good, with duplicates generally showing less than 5 % variability (Figure 3). A notable exception was one sample where the total cyanide extractable component varied by more than 150% possibly due to nugget effects.

pH buffering of iodide extractant

Gold extracted by buffered and unbuffered iodide reagent both repeated well (Figure 3 and Figure 4). Duplicate buffered iodide extractions of Au from pulverised material also repeated well. Despite this apparent robustness, more Au is extracted by the buffered iodide solution in all samples. This seems particularly significant when the iodide extractable Au content is greater than 15 ppb (Figure 5). Closer examination of this phenomena suggests that depth and type of sample may be the cause of this variation rather than Au content (Figure 6).
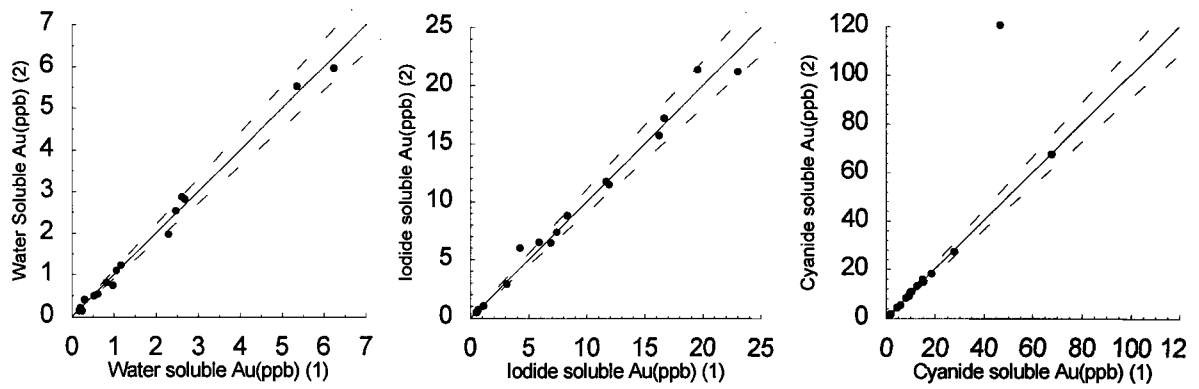
Figure 3: Comparison of duplicate sequential extraction data, 0% and ± 5% deviation lines shown.
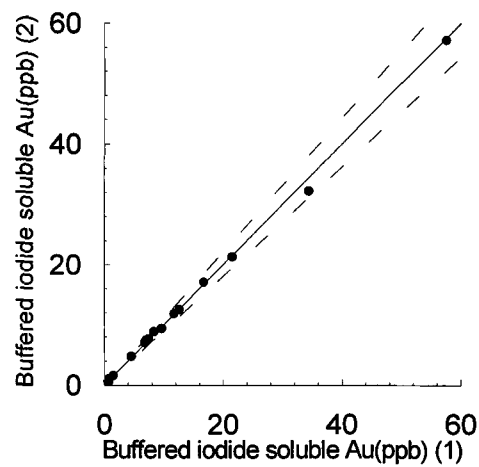
Figure 4: Comparison of duplicate buffered iodide extraction data, 0% and ± 5% deviation lines shown.
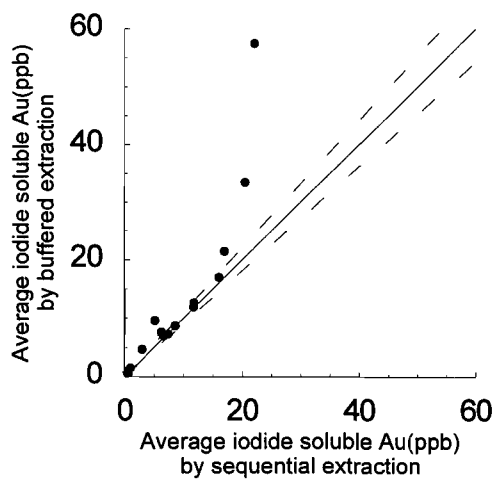
Figure 5: Comparison of Au extracted by buffered and unbuffered iodide solution, 0% and ± 5% deviation lines shown.
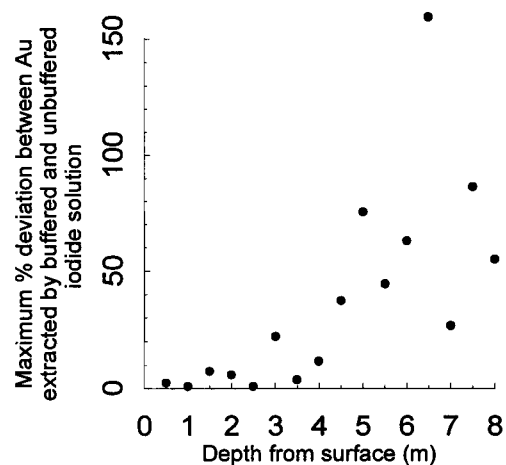
Figure 6: The deviation between Au extracted by buffered and unbuffered iodide solution as it increases with depth.

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Deviations between buffered and unbuffered iodide soluble Au are not directly related to any other element analysed, though Ca/Mg does show a weak association (Figure 7) and the amount of calcite compared with dolomite may be affecting buffering in some samples. However, it is possible that other, undetermined, factors are also affecting the ability of the unbuffered iodide solution to dissolve Au.
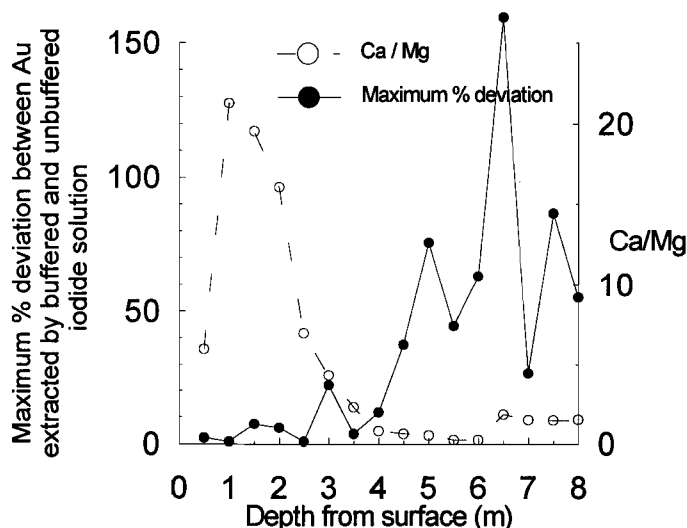
Figure 7: The deviation between Au extracted by buffered and unbuffered iodide solution as it increases with depth, compared with the Ca/Mg ratio.

2.3   REGOLITH DATA COLLECTION AND PROCESSING

Two hundred and four RAB and RC drill holes were logged specifically for regolith-related features in the area surrounding Safari. Regolith information was predominantly in the form of descriptive logs of drill spoil. In the case of the RAB holes drilled for this project, the spoil was wet sieved at the time of logging. No wet sieving of the other holes was necessary, as the spoil had been washed thoroughly by rain. Surface RL for each drill hole was calculated from a level survey undertaken by CSIRO staff, referenced to a digital elevation model provided by Goldfields Exploration and the RL of the palaeosurface (top of weathered Archaean) then calculated from logging.

2.4   IMAGE PROCESSING

Landsat Thematic Mapper data were processed for the interpretation of regional surface regolith relationships (Section 1.3). ERMapper v4.2 to v5.2 and ENVI v1.1 were used at various stages of processing. A subset of the Laverton scene was rectified using ten ground control points taken from 1:250000 topographic maps. The data were corrected for atmospheric interference by dark subtraction. Hardcopy was produced of two different band combinations, 742 (RGB) and $^5/_7\,^4/_7\,^4/_2$ (RGB). Each band was stretched manually to provide the most suitable local area contrast for interpretation. Interpretation was based on contrasting spectral response and textural features highlighted by in the imagery.

3.   REGOLITH STRATIGRAPHY

3.1   TOPOGRAPHY AND PALAEOTOPOGRAPHY

The present land surface around Safari forms a broad valley sloping gently SW (Figure 8), with a much steeper and variable palaeosurface. The most prominent features of the palaeosurface are a palaeohigh at around 6732000 mN 451100 mE, where the palaeosurface meets the present land surface, and the valley draining west in the northern part of the area.
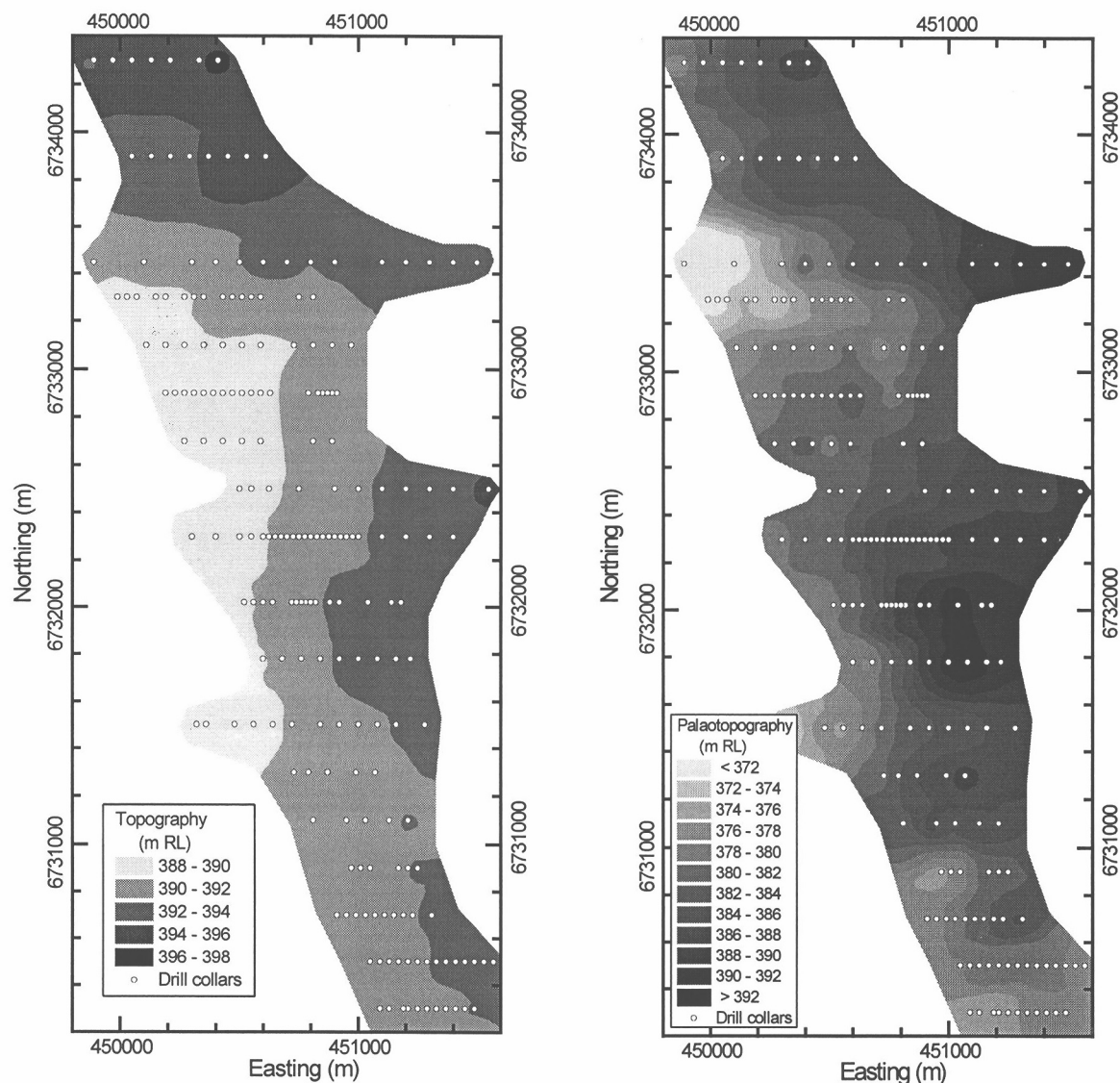
Figure 8:   Surface topography and palaeotopography in the area surrounding Safari.

3.2   TRANSPORTED OVERBURDEN

The study area is completely blanketed by transported overburden except for a small area around 6732000 mN 451100 mE, where weathered Archaean rocks subcrop.   The thickness and composition of the transported overburden varies, although the material at the surface is uniformly distributed, comprising up to 1 metre of sheetwashed and aeolian sand that tends to be more clay-rich in local drainage depressions. The distribution of various regolith materials across the mineralised zone is summarised in Figure 9.

Including sheetwash, the sediments are generally 5-10 m thick, although up to 20 m infill the palaeovalley in the north. Below the sheetwash, the sediments are polymictic with 2 - 20% coarse material, (commonly towards the base), in a matrix of sand, silt and, in places, clay. Over the majority of the study area, and near to the mineralised zone, the coarse fraction includes angular fragments of nearly fresh rocks, whereas a mixture of ferruginous pisoliths, nodules and lithorelics infills the palaeovalley in the north. In a few places, drilling intersected discontinuous, or narrow, coarse, alluvial sand and gravel at various depths.
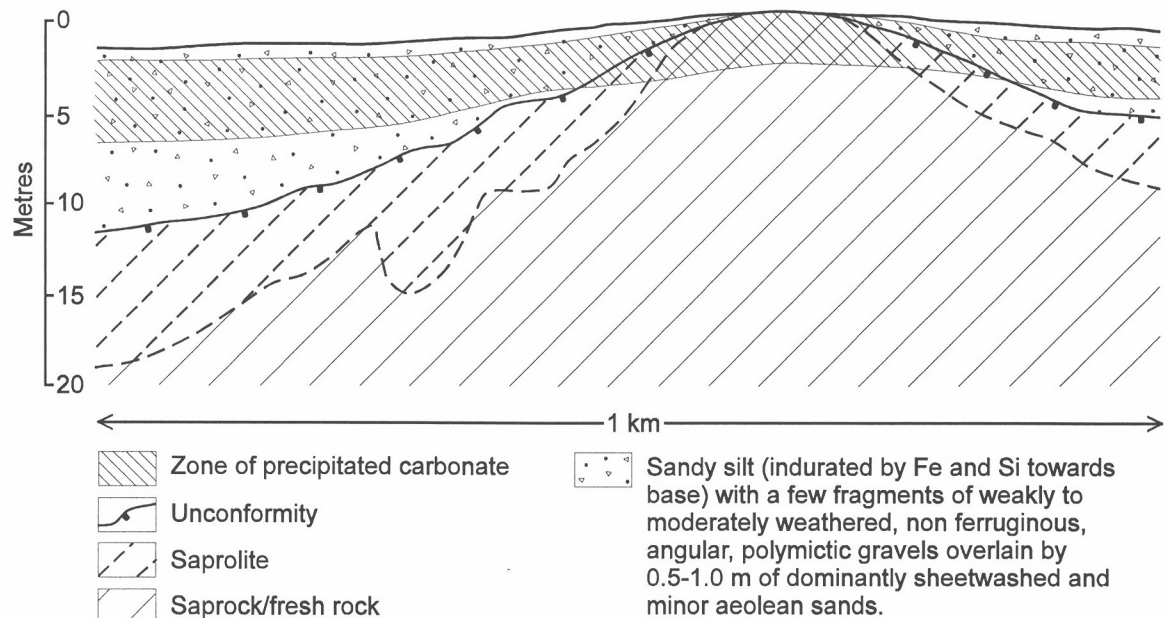
Figure 9: Cross section summarising the key features of the regolith in the vicinity of mineralisation at Safari.

Post-depositional modification of the sediments is widespread, the most significant being intense calcification from approximately 0.5 to as much as 5 m below surface. Drill sumps expose mottles of carbonate (up to tens of mm in diameter) as little as 200 mm below surface. The morphology of the carbonate below 1 metre is uncertain, as it is only seen as drill cuttings, but appears more nodular and powdery than laminar. Below the zone of intense calcification, the sediments are commonly moderately to strongly indurated by silica and Fe oxides. The sediments at the base of the overburden are in places calcified, associated with that in the underlying saprolite.

3.3   WEATHERED ARCHAEAN

There are isolated areas in the north where the Archaean has been weathered to deep, highly ferruginous profiles. However, most of the residual regolith consists of saprolite with a variable clay content, becoming fresh within 10-20 m of the unconformity. There is minor incipient mottling throughout, and the upper few metres are commonly indurated by silica and/or carbonate. Where subcropping, the Archaean is reasonably fresh, but brecciated by carbonate in the upper few metres, with large (up to 100's of millimetres) nodular structures at surface. The processes of calcification of the subcropping Archaean appear to be similar to those affecting the transported material (Figure 9).

4.   GEOCHEMISTRY

4.1   PRIMARY MINERALISATION

The highest Au concentration was 31 ppm. The only element directly associated with Au is Pb (maximum 1100 ppm). The correlation with actual grade is not particularly good, but maxima of the two elements commonly correspond. Gold is probably also specifically associated with quartz veining or intense silicification. Zinc is enriched (maximum 1300 ppm) in one of the intersections (Table 1). Arsenic, S and W are generally enriched in the mineralised zone but are not specifically related to Au grade (maxima 1000 ppm As, 10530 ppm S and 79 ppm W - Table 1).

Table 1:   Gold and associated elements in samples of primary mineralisation. All values are ppm; Au, Sb, As and W were analysed by INAA; Zn, S and Pb were analysed by XRF; n.d.- not determined.

Au	Sb	As	W	Zn	S	Pb
2.7	2.6	150	68	n.d.	n.d.	n.d.
4	2.9	150	5	n.d.	n.d.	n.d.
0.098	1.8	95	10	n.d.	n.d.	n.d.
<0.005	0.3	52	<2	87	570	14
0.083	0.4	130	7	71	3640	9
0.025	0.4	66	<2	82	2600	10
0.039	1.2	13	<2	70	2180	14
0.018	1.0	13	<2	81	210	10
0.049	0.8	55	<2	57	3360	15
3.4	0.9	1000	12	160	8620	86
12	1.0	99	12	1300	8130	1150
4.4	2.4	86	15	180	9650	156
0.57	0.7	90	8	320	9850	130
0.46	0.7	120	11	65	8690	40
26	3.5	110	13	150	9800	510
0.89	0.8	130	8	70	10530	50
0.69	0.6	30	<2	85	1840	17
0.007	0.8	12	13	85	3730	18
0.007	1.1	7	<2	94	1420	16
0.84	0.7	240	18	82	1140	20
0.028	1.4	11	<2	72	1420	4
0.290	0.7	26	22	61	7630	14
<0.005	1.4	9	<2	92	980	13
17	0.3	44	15	24	4540	190
31	0.3	490	9	93	2870	28
0.25	3.0	680	13	120	2460	29
0.11	2.6	470	12	110	1180	10
0.03	2.7	460	5	110	3400	26
0.025	1.5	930	<2	160	1740	22
<0.005	1.9	880	<2	160	300	32
0.014	0.6	42	<2	63	4910	10
0.11	1.0	99	79	87	570	14

4.2 DISTRIBUTION OF AU IN THE REGOLITH ON 6732300 mN

Hole SB9 intersected quartz veining in the top two metres of saprolite, with a maximum of 1200 ppb Au (Figure 10). This directly overlies primary mineralisation intersected at depth by previous RC drilling. Holes SB6, SB7, SB8 and SB17 are also enriched in Au just below the unconformity, similarly overlying primary mineralisation at depth. Anomalous Au contents are also present in the carbonate horizon directly overlying deep mineralisation and the enrichment below the unconformity. Lesser Au contents, though still above background, are present in the calcareous horizon along most of the section. Even with the detection limits of INAA (5 ppb), Au contents of the top 0.5 m give a broad anomaly (over 350 m @ >7 ppb Au), with good contrast, peaking directly over mineralisation (Figure 10). The top 0.5 m samples were subject to more detailed examination discussed below (Section 4.4.1).
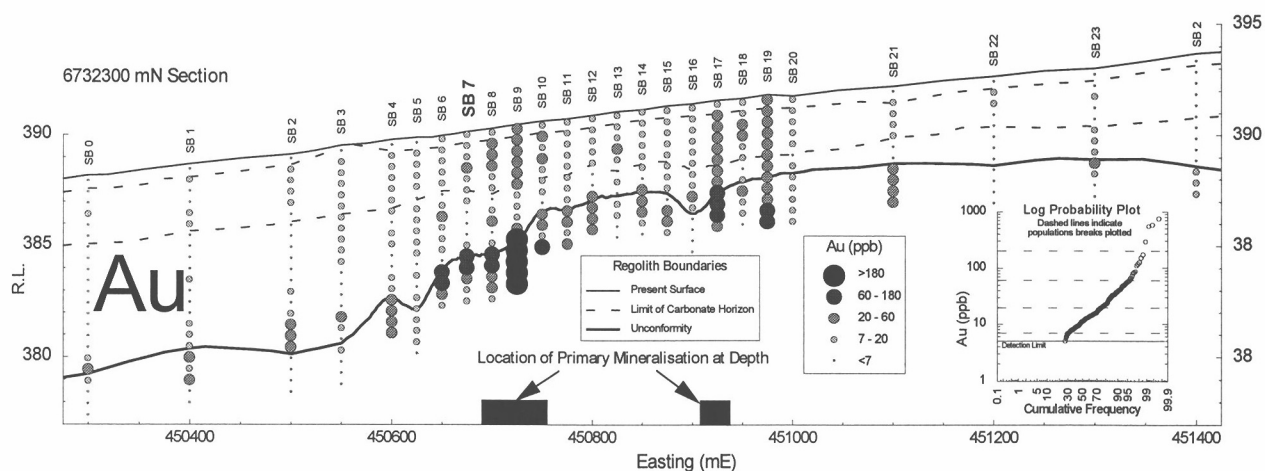
Figure 10: Distribution of Au in the regolith on section 6732300 mN.

Gold is also enriched just below the unconformity. The mean Au content of the top 1 m of residual regolith gives a very strong anomaly, peaking over mineralisation, but with an elevated and noisy background of 10-50 ppb (Figure 11).
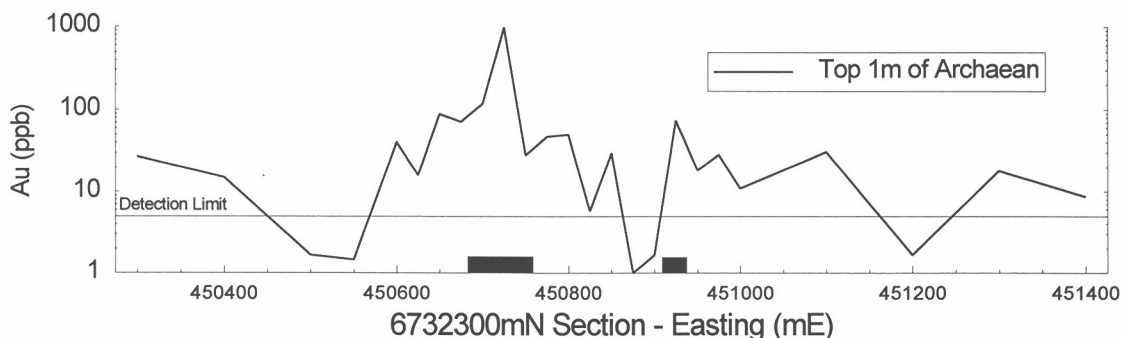
Figure 11: Average Au concentration in the first metre of Archaean (2 x 0.5 m samples).

4.3 DISTRIBUTION OF CA AND MG IN THE REGOLITH ON 6732300 mN

Calcium is strongly enriched in the calcareous horizon, from approximately 0.5 m to 3 m below surface (Figure 12). Carbonate induration and Ca enrichment also occur at the top of the saprolite.
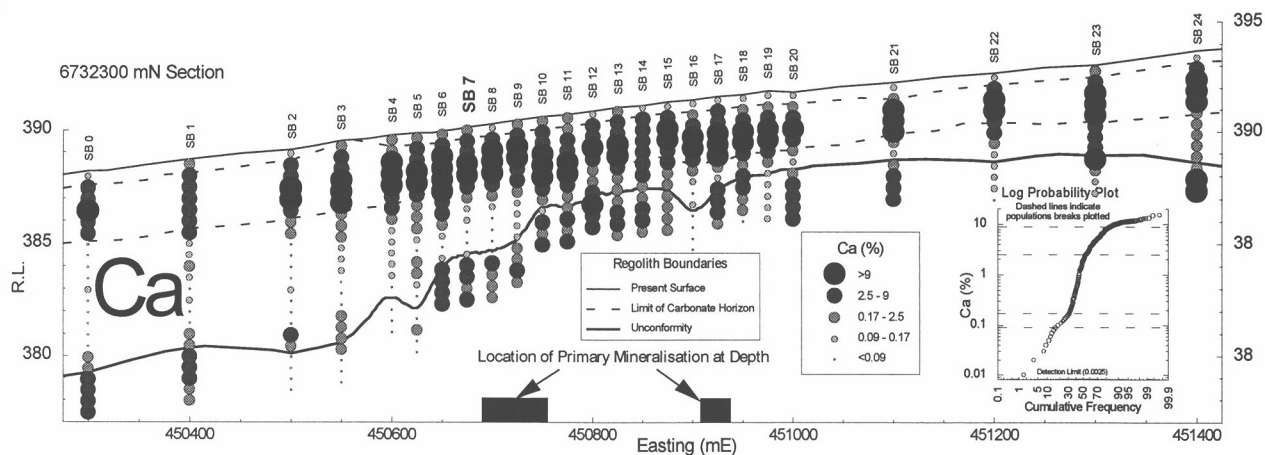
Figure 12: Distribution of Ca in the regolith on section 6732300 mN.

The distribution of Mg (Figure 13) mainly reflects its occurrence as dolomite, which dominates the carbonate deeper in the regolith, becoming less common closer to the surface. The bimodal distribution of the Ca/Mg ratio (Figure 14) gives a good indication of the presence of two mineral phases; their distributions are best shown by a plot of the Ca/Mg ratio of samples containing over 1% Ca (Figure 15).
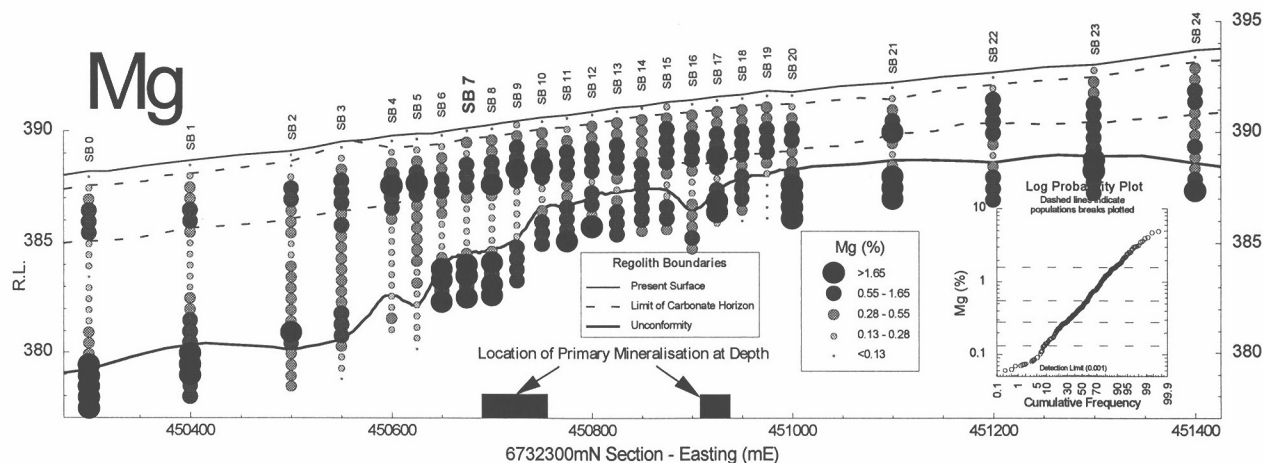
Figure 13: Distribution of Mg in the regolith on section 6732300 mN.
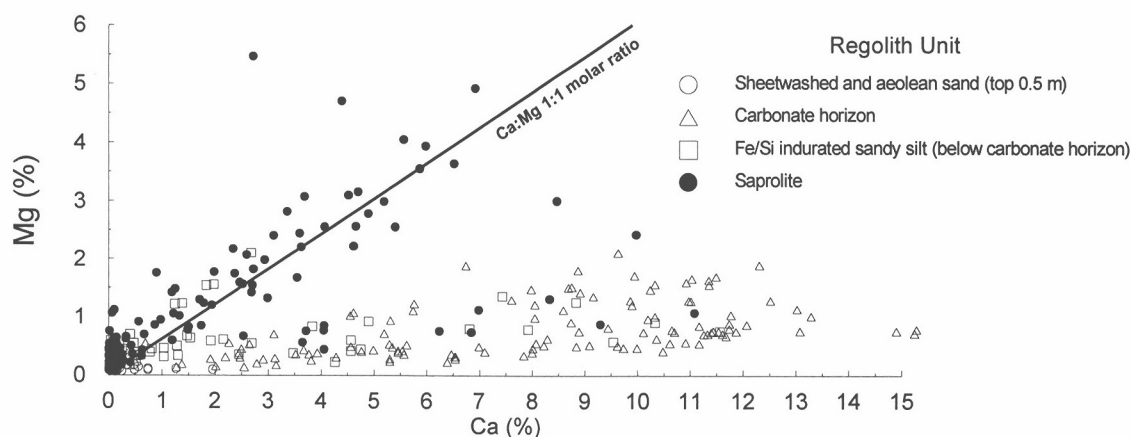
Figure 14: Scatterplot of Ca vs Mg showing a bimodal distribution reflecting the occurrence of both calcite and dolomite.
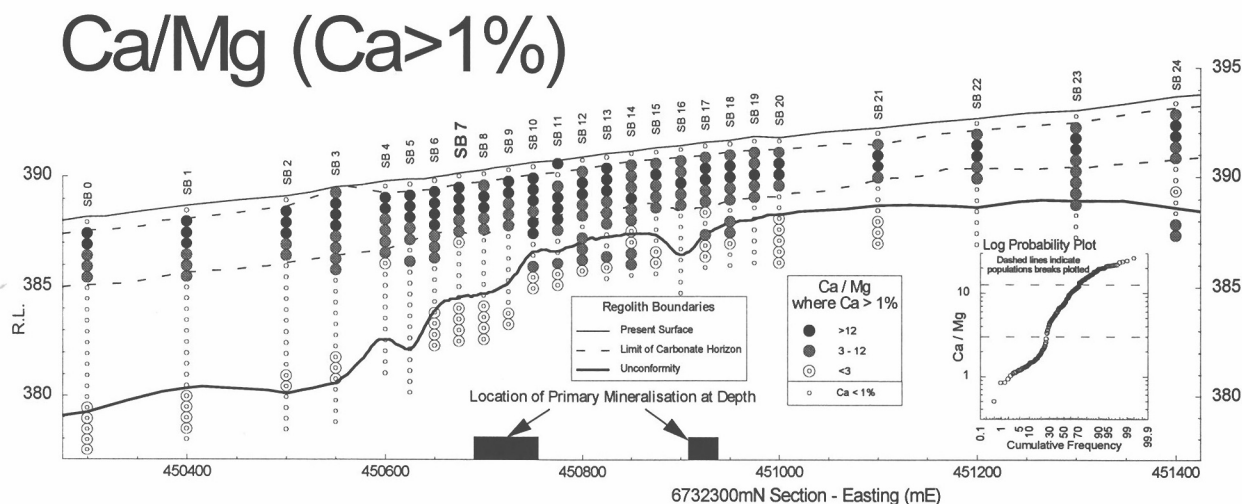
Figure 15: Distribution of Ca/Mg where Ca > 1 %. The likely distribution of carbonate as calcite and dolomite are represented by Ca/Mg >12 and <3, respectively, with Ca/Mg ratio of 3-12 indicating a mixture.

4.4   GOLD SOLUBILITY IN THE REGOLITH ON 6732300 mN

4.4.1   Gold in the top 0.5 m

Gold is highly soluble in the top 0.5 m of the regolith at Safari (consistently around 70 % is soluble in iodide solution). There is an anomaly with good contrast directly overlying primary mineralisation in the water-, iodide- and cyanide-soluble Au components. The lower detection limits of the sequential extraction procedure provide much better anomaly contrast compared with the INAA Au (Section 4.2), with a good anomaly of >5 ppb total cyanide-soluble Au extending 600 m across mineralisation. The proportion of water- and iodide-soluble Au in each sample shows some random variability, but is essentially constant. Variations in the proportions of water-, iodide- and cyanide-soluble components do not indicate the presence of underlying mineralisation (Figure 16).

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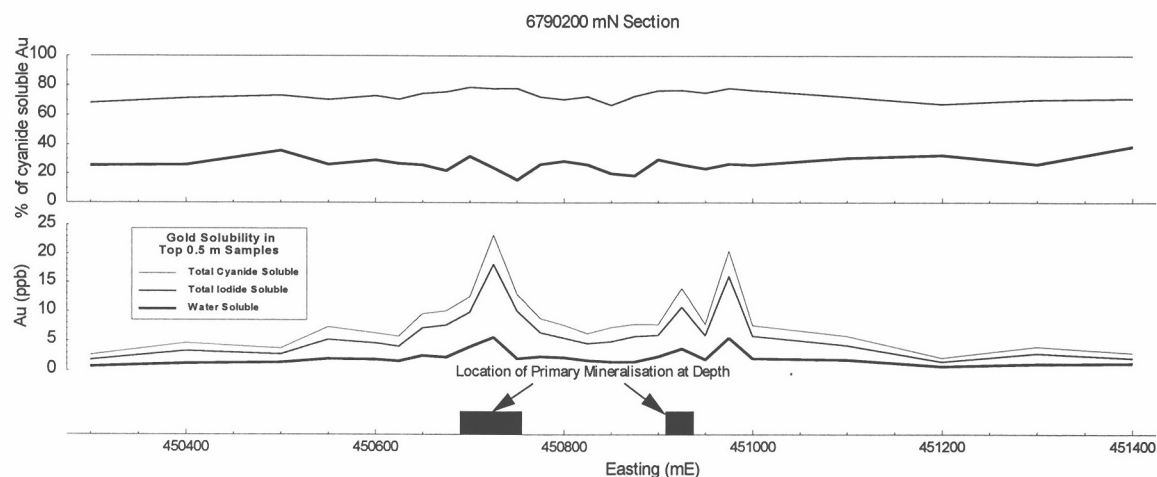
Figure 16:   Absolute and relative Au solubility in top 0.5 m of regolith at Safari.

One sample, (the top 0.5 m of SB7), was analysed by all the partial extraction procedures in pulverised and unpulverised form. Gold solubility in water and iodide solutions appears constant regardless of pulverising, or in the case of iodide, pH buffering (Figure 17). The concentration of Au soluble in cyanide solution (total soluble Au) was higher in the pulverised samples, probably due to exposure of Au otherwise occluded in coarse material.
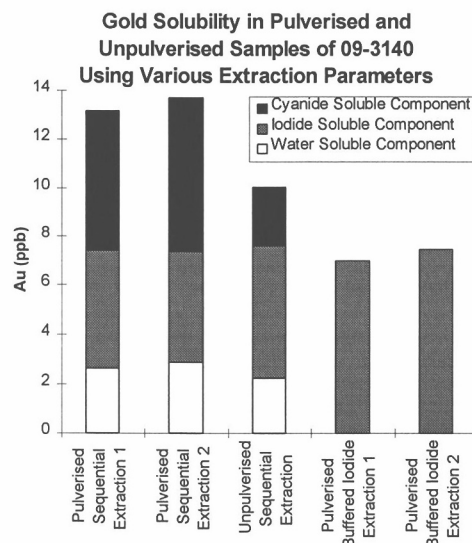
Figure 17:   Comparison of different experimental parameters undertaken on sample 09-3140.

It appears that pulverising liberates any small amounts of occluded Au for access by cyanide solution. This may indicate that samples are better left unpulverised, as highly soluble, chemically precipitated Au may give higher anomaly contrast over mineralisation if occluded, (probably physically transported), Au is excluded from the analyses.

4.4.2   Sub-surface Au solubility

The solubility of Au in deeper regolith materials was examined in 16, contiguous, 0.5 m samples from surface close to mineralisation (Hole SB7) and in 11 other samples taken to examine key features of the overall Au distribution in section 6732300 mN (Figure 18). The data presented for

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the 16 contiguous samples are means of duplicate sequential extractions; the other 11 samples were subjected to a single sequential extraction only.

Gold distribution is spatially associated with secondary carbonate in the transported overburden and is highly soluble, with proportions of iodide-soluble Au commonly being up to 80% (Figure 18). Deeper in the regolith, solubility appears to depend on proximity to primary mineralisation; gold in samples further from mineralisation tends to be more soluble, (eg. SB0, SB12 and, to a lesser extent, SB7). Saprolite in holes SB17 and SB19, have very different proportions of soluble Au.

Other than the broad spatial association of Au (and soluble Au) with Ca in carbonate, variations in Au solubility are not related to the distribution of any other element.

4.5   RELATIONSHIP BETWEEN GOLD AND CALCIUM

There is a close, though imperfect association between Au and Ca with depth (eg. Hole SB7 - Figure 18). Maxima in water- and iodide- soluble Au just below the unconformity correspond to a maximum in Ca, whereas the total cyanide-soluble Au peaks higher, at the unconformity.
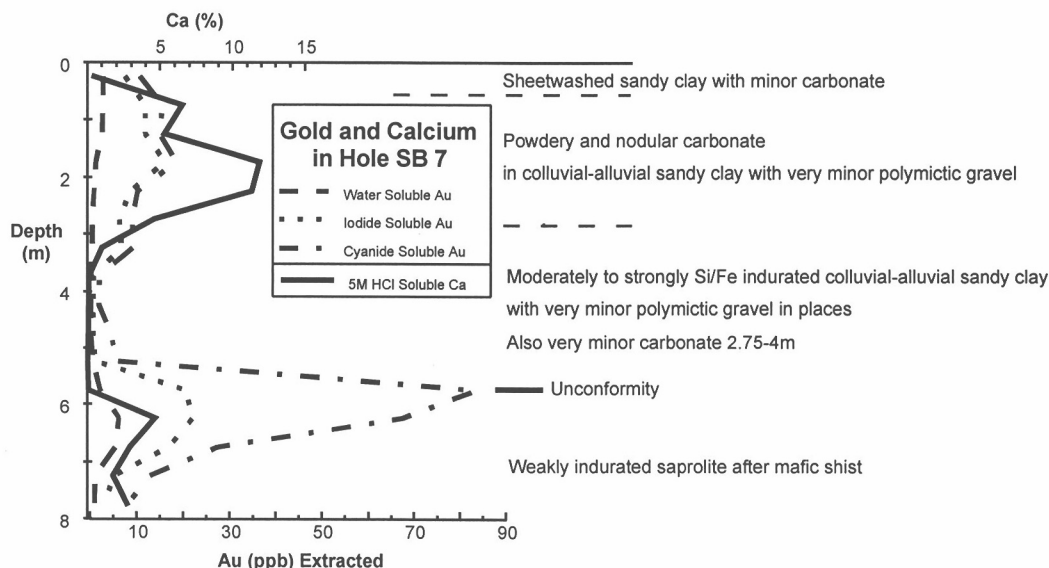
Figure 18:   Comparison of Au (sequential extraction components) with Ca in hole SB7.

The detailed relationship in the top 0.8 m is also imperfect, although concentrations of both elements are extremely low in the top 0.2 m and increase with depth (Figure 20). Similarly, there is no direct correlation in the surface (0-0.5 m) or subsurface (0-8 m in SB7) samples (Figure 21 and Figure 22). This implies that the processes by which Au and Ca are precipitated are similar, but independent.
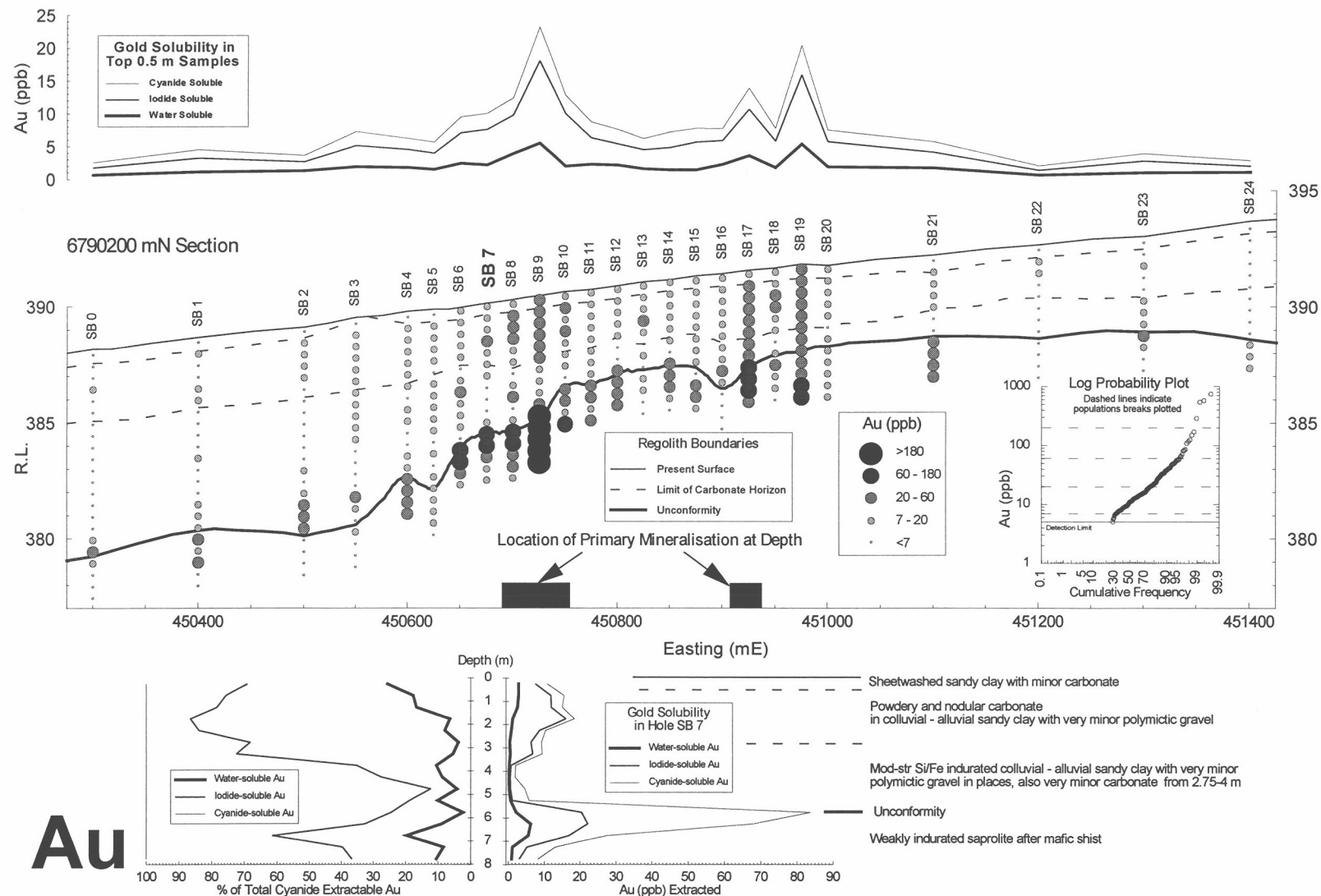
Figure 19: Gold distribution and solubility in sub-surface regolith materials at the Safari Prospect. Shaded circles represent total Au content measured by INAA, stacked bar graphs represent Au solubility in samples indicated.
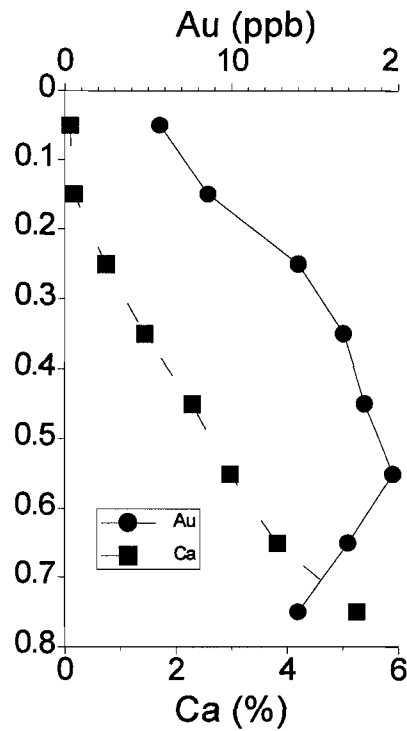
Figure 20:   Gold and Ca in the soil over mineralisation.
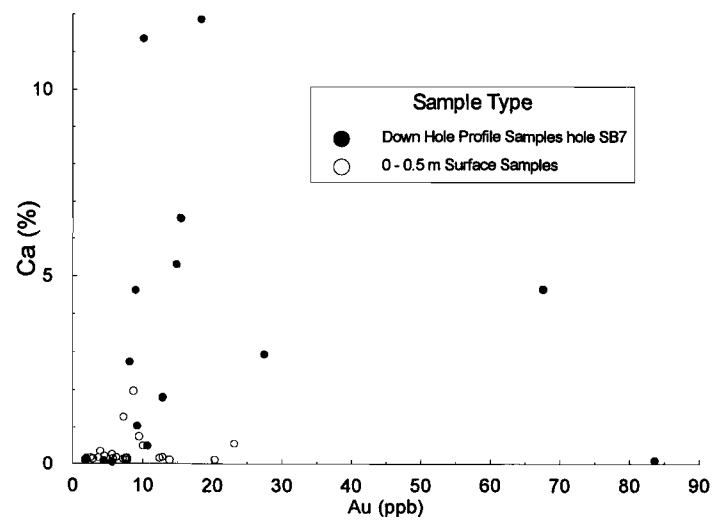
Figure 21:   Scatterplot of Au vs Ca showing no direct correlation in surface or down hole samples.
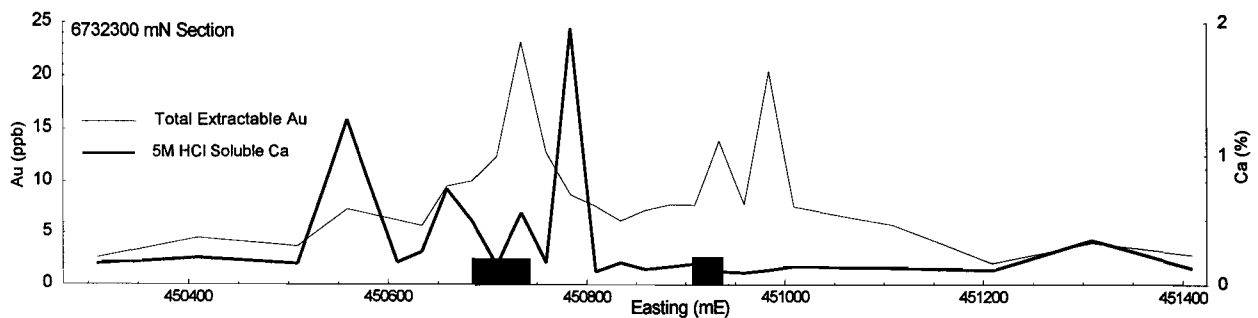
Figure 22:   Total extractable Au (by sequential extraction) compared with Ca in top 0.5 m samples on section 6732300 mN. Dark blocks indicate the position of mineralisation at depth.

The distribution of Ca and associated Au in the regolith at Safari differs from that at other sites. In most of the southern Yilgarn, maximum carbonate accumulation is within 1.0 - 1.5 m of the surface, whereas at Safari, it is deeper (between 1.5 - 2.5 m). Nevertheless, the association itself resembles that at other sites in the transported overburden (e.g. Argo: Lintern and Gray, 1995) in being poorer than that found in erosional sites (e.g. Bounty: Lintern, 1989). These features are illustrated in Figure 23.
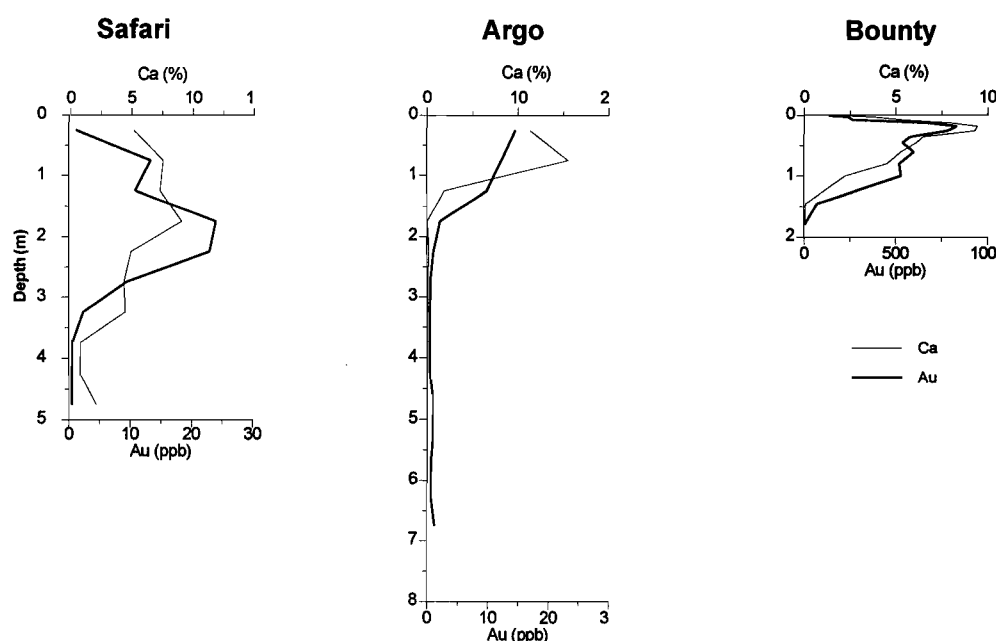
Figure 23:   Comparison of Ca and Au distribution with depth at Safari, Argo and Bounty.

The optimum sampling depth of the calcareous horizon at Safari is between 0.5 and 2.5 m. Anomaly size and contrast would be compromised by sampling outside this range with this detection limit (Figure 24). In general, sampling is optimised by targeting the carbonate horizon, not a specific depth. However preferential selection and analysis of highly calcareous fragments does not increase anomaly contrast across mineralisation, despite the absolute concentrations of Au being higher. The Au/Ca ratio is consistently lower in the calcareous fragments than the bulk samples from the same interval. Similar results have been recorded for carbonates in the Southern Yilgarn at Bounty and Mulline (Lintern, 1989; Lintern and Butt, 1991).

4.6   OTHER ELEMENTS IN THE REGOLITH ON 6732300 mN

Seven of the total 25 holes across 6732300 mN were selected for multi-element analysis to determine dispersion characteristics. The data are presented in Appendix 1 (Figure A1.1 to Figure A1.27) and listed in Appendix 2.

Tungsten and As show a low to moderate enrichment in the upper saprolite (>10 and >35 ppm respectively) associated with mineralisation. Antimony also shows a discernable anomaly, although the concentrations are very low (<3 ppm). Although enriched in some of the primary mineralisation (Section 4.1), Zn on 6732300 mN is not apparently anomalous over mineralisation, though the high detection limit of Zn by INAA (100 ppm) may be a problem (Figure A1.1 through Figure A1.4).

Arsenic (and possibly Zn) are the only elements to exhibit some enrichment in the transported overburden over mineralisation. This appears to be associated with the sediments below the carbonate horizon and, more specifically, with the Fe distribution in this part of the profile (Figure A1.12).
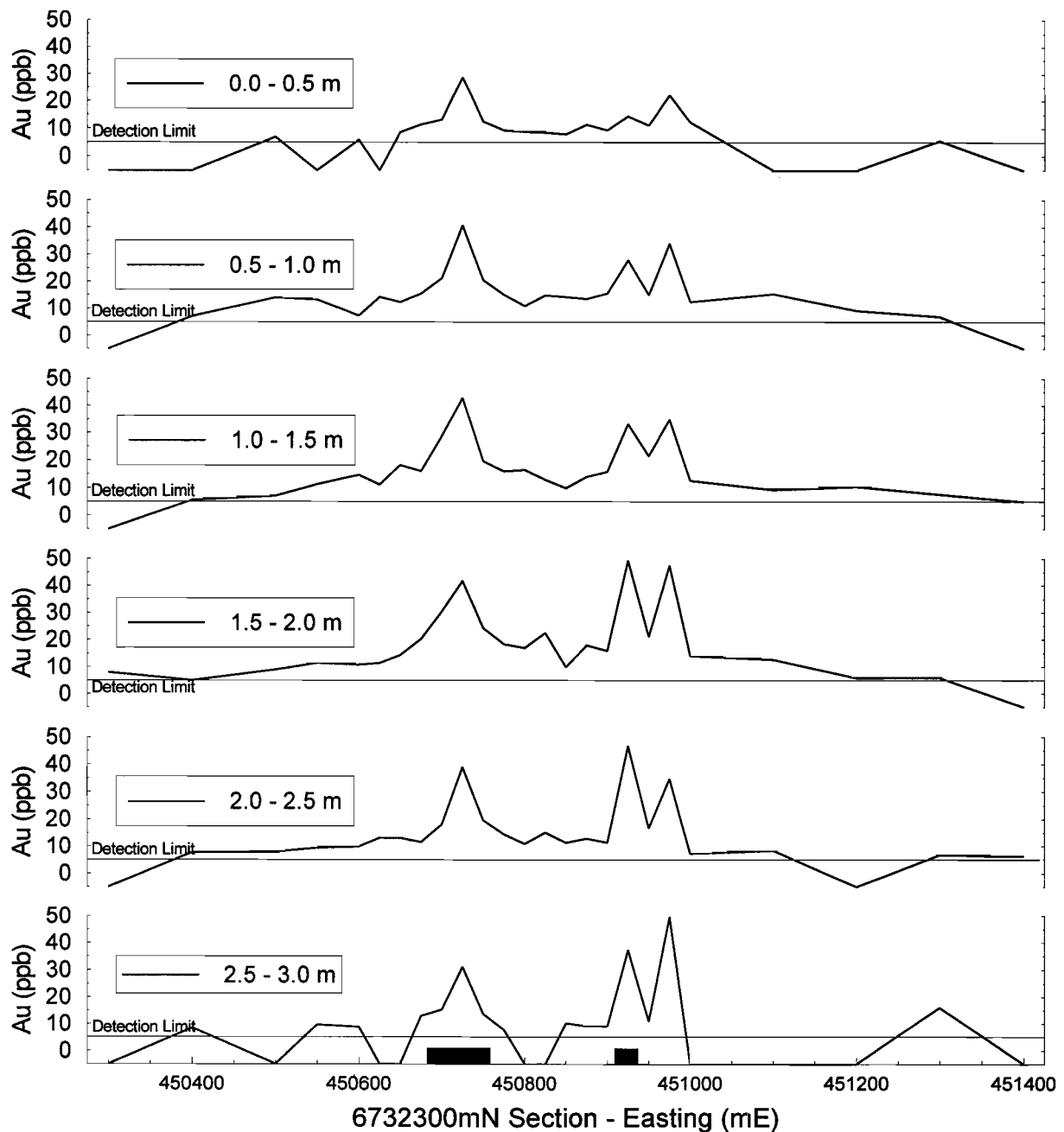
Figure 24: Examination of the effect of sample depth on anomaly definition. The dark blocks indicate the position of mineralisation at depth.

The distributions of light REE (La, Eu, Ce and Sm) do not appear to indicate the position of mineralisation. In contrast, the heavy REE (Yb and Lu), despite having very low concentrations generally, do indicate the position of mineralisation in the upper saprolite (Figure A1.6 through Figure A1.11).

Many of the other elements tend mainly to highlight the different element abundances between the transported overburden and the weathered Archaean. Most show consistent increase in the transported overburden below the carbonate horizon compared with that of the carbonate horizon and the top 0.5 m, possibly due to dilution by the carbonate.

4.7   BIOGEOCHEMISTRY

Biological material was sampled at six sites, four over background and two over mineralisation. At each site, one sample of leaves from *Acacia* and one sample of mull were taken from beneath the sampled shrub. All samples were washed, dried and analysed using INAA. At two sites (one over background, one over mineralisation) seven sub-samples of mull and one sub-sample of leaves were ashed after drying and analysed by INAA and results compared with the dried samples. The extra sub-samples of mull were used to investigate repeatability of the sampling.

Despite the limited number of samples the following observations could be made:

- All elements were present in very low concentrations, with the exception of Br. Bromine contents up to 160 ppm occur in *Acacia* over mineralisation, against a background of around 20 ppm. The highest Br response in samples of primary mineralisation was just over 5 ppm. Bromine was low in mull and its concentration was diminished by ashing of both leaves and mull.

- Despite the very low concentrations, one mull sample had elevated concentrations of several elements over mineralisation (Au, As, Ce, Co, Cr, Fe, La, Na, Sc, Sm, W, Yb). Most of these are lithophile elements and/or associated with mineralisation and the enrichment is probably due to contamination from drill dust.

- Poor repeatability of Au results for the sub-samples of ashed mull suggests an inhomogeneous distribution of Au in the larger sample. A possible explanation of this inhomogeniety is contamination from drilling dust that was not removed by washing.

5.   DISCUSSION AND CONCLUSIONS

5.1   DISPERSION MODEL FOR AU

There are two key features of the Au solubility in the regolith:

- Gold solubility close to mineralisation in the saprolite is moderate (generally 1% - 30% iodide-soluble) and increases to >70 % iodide-soluble with increased distance from mineralisation (Section 4.4.2). This suggests that much of the Au in the wall rocks is secondary, dispersed laterally from mineralisation during weathering.

- Gold solubility (where Au is anomalous) is consistently high (generally >70 % iodide-soluble) throughout the transported overburden regardless of its lateral distance from mineralisation. In addition, variations in Au concentration in the overburden are closely associated with those dispersed into the saprolite. This implies Au has been dispersed into the transported overburden with little or no lateral movement.

Two separate periods of Au dispersion are suggested:

1. **Dispersion of Au in the upper saprolite.** This appears to have occurred prior to sedimentation and to be associated with soil formation on the palaeo-surface. The palaeo-slope is steep relative to the present surface, and the distribution of Au in the upper saprolite suggests downslope dispersion. The carbonate in this material may indicate that the overlying transported overburden has been deposited after the onset of aridity, the carbonate having possibly formed at the palaeo-surface under arid conditions. The composition of the sediments perhaps supports this, as the clasts in the basal gravels are generally fresh to weakly weathered, indicating they were eroded after any stripping of deeply weathered material, and/or have not been in place long enough to be

weathered since deposition. The association of Au with carbonate in saprolite at the palaeo-surface near mineralisation may date from this period.

2. **Dispersion into the transported overburden.** This probably occurred under conditions similar to those at present. Gold in the upper saprolite is quite soluble (Figure 18) and could be mobilised during periods of saturation or near saturation following (seasonal) rainfall. It may be dispersed by capillarity, through the silty matrix of the sands, or cycled by evapo-transpiration by plants, to accumulate with carbonates as the overburden dries out. The greater depth of carbonate at Safari, compared to most other sites in the southern Yilgarn in which there is an association between Au and Ca, may simply be a function of the coarse texture of the transported overburden.

This process is believed to be effective in mobilising Au at Safari because of shallow transported overburden (approximately 4-5 m) over mineralisation and the presence of significant Au concentrations in the saprolite. These features are similar to those at other sites in that surface anomalies associated with carbonate are present in overburden within a few metres of a possible source eg. Panglo (Lintern, 1996a), Runway (Lintern, 1996b), Steinway (Lintern and Craig, 1996) and Higginsville (Lintern et al., 1996). At each of these sites however, the "sources" of Au are free particles in ferruginous granules in the deep transported overburden, rather than mineralisation in sapolite.

5.2 IMPLICATIONS FOR EXPLORATION

Characteristics of Au distribution in the regolith directly relevant to exploration in similar situation are:

- Sampling the top 0.5 m gives a broad anomaly peaking directly over mineralisation. Using cyanide extractions with low detection limits on unpulverised samples (rather than a total analysis of pulverised samples) provides greatly improved anomaly contrast and a broader anomaly at low thresholds. Detailed examination of Au in the top 0.8 m of the transported overburden suggests sampling shallower than 0.2 m depth are probably ineffective. These results reflect the association between Au and carbonates and the distribution of carbonates in the top metre.

- Samples from between 0.5 to 2.5 m below surface provided the broadest anomalies with the greatest contrast overlying buried mineralisation, indicating that the calcareous horizon should be targeted rather than a specific depth. Sampling outside this range in the transported overburden was less effective.

- Selecting carbonate-rich fragments appears not to enhance the Au anomalies in calcareous profiles.

- The strong vertical association of Au in the transported overburden with Au in the underlying Archaean suggests that this Au was not mobilised a significant distance laterally *in the plane of this section*. Thus, peak Au concentrations in the calcareous horizon may accurately locate mineralisation in the saprolite at this site.

- Sampling the top 1 m of the saprolite gives a very strong anomaly directly overlying mineralisation, but the background is high and variable; thus, careful selection of thresholds would be necessary to outline broad anomalies found by initial wide-spaced sampling.

These implications may be limited to a very specific range of prospective tenements because of the shallow overburden and proximity of Au in saprolite. As such, careful assessment of regolith conditions is necessary before relying fully on carbonate sampling in areas of transported overburden. Reconnaissance drilling may assist in targeting appropriate areas.

ACKNOWLEDGEMENTS

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APPENDIX 1 - SYMBOL PLOTS OF ALL ELEMENTS ANALYSED ON 6732300 mN
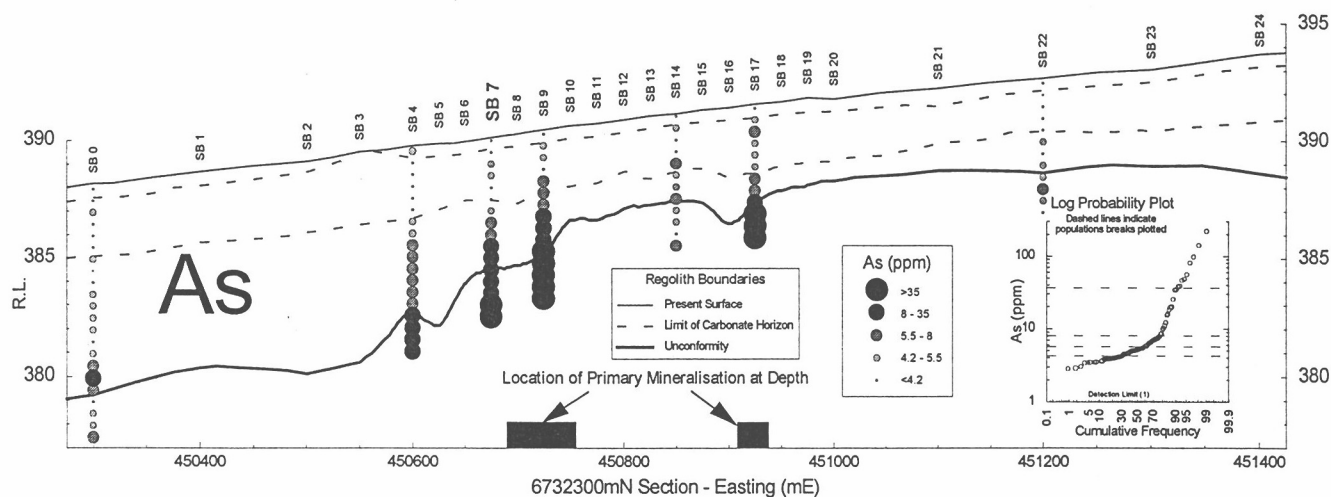
Figure A1.1: Distribution of As in the regolith on 6732300 mN.
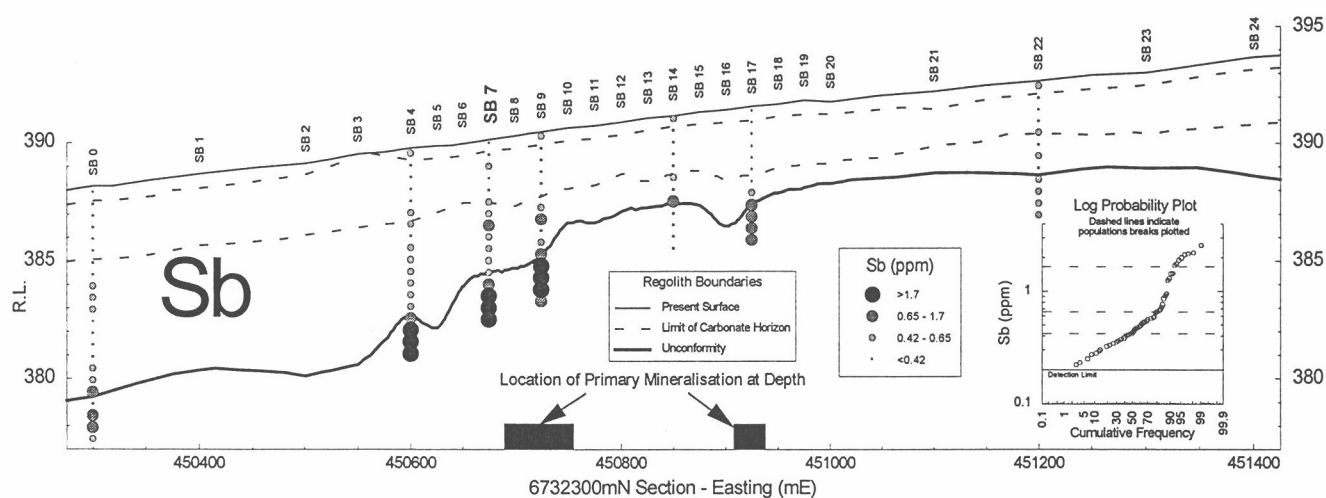
Figure A1.2: Distribution of Sb in the regolith on 6732300 mN.
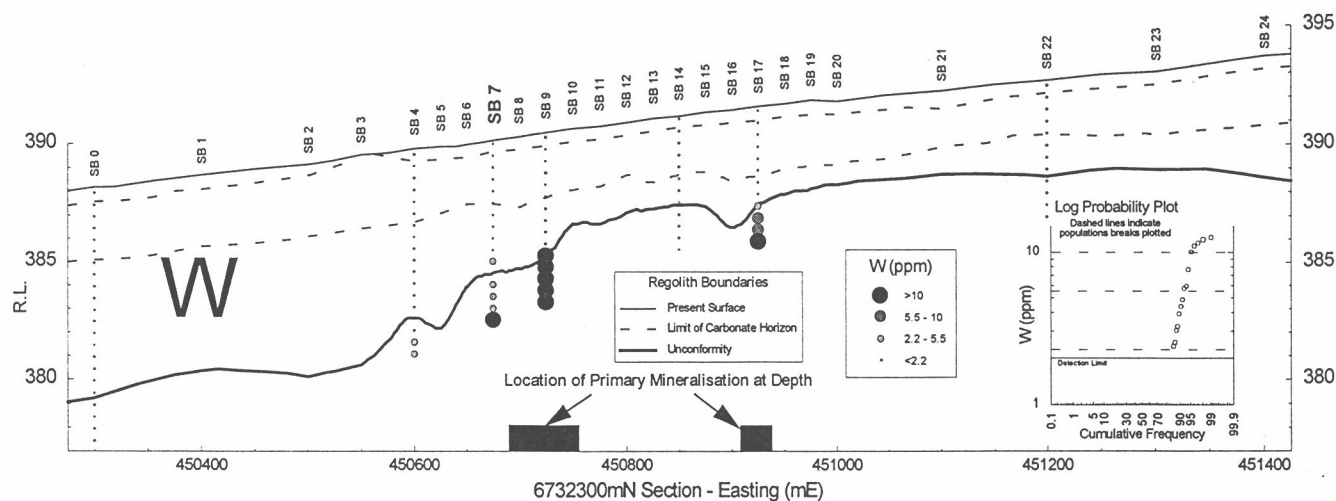
Figure A1.3: Distribution of W in the regolith on 6732300 mN.

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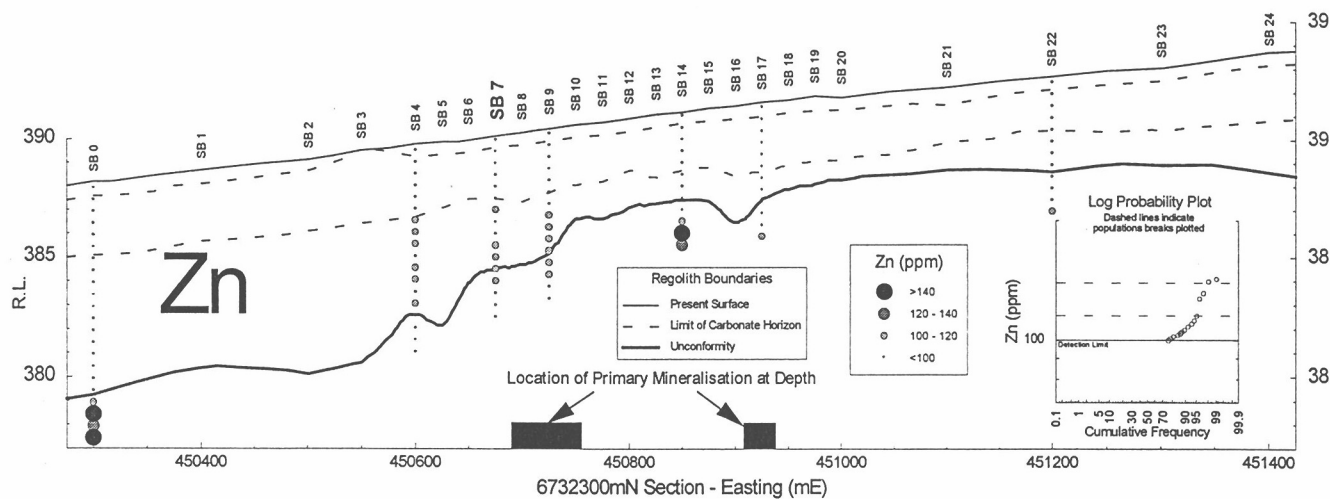
Figure A1.4:   Distribution of Zn in the regolith on 6732300 mN.
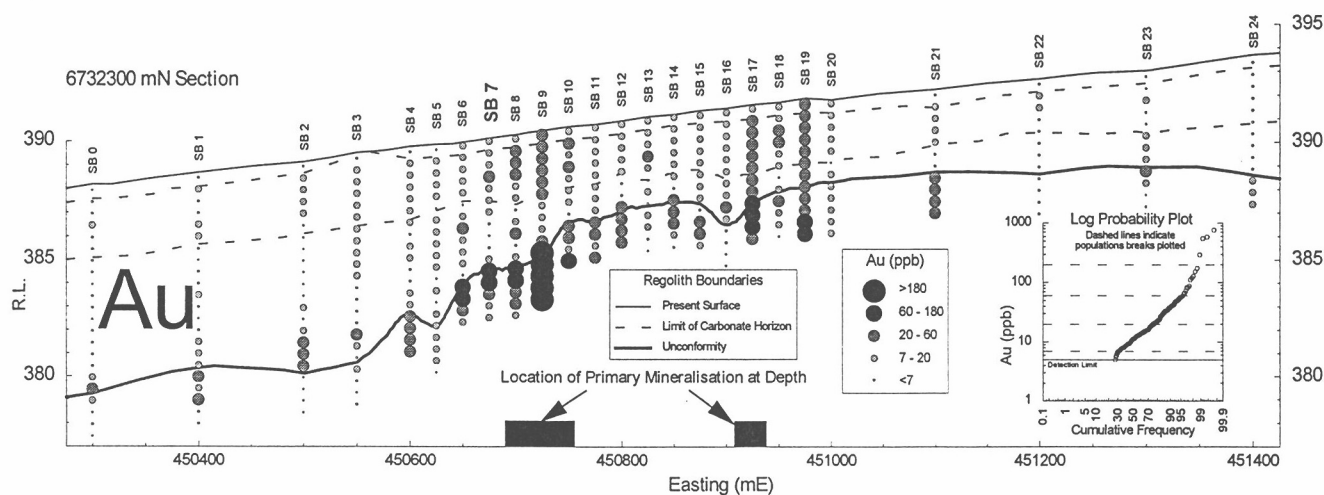
Figure A1.5:   Distribution of Au in the regolith on 6732300 mN.
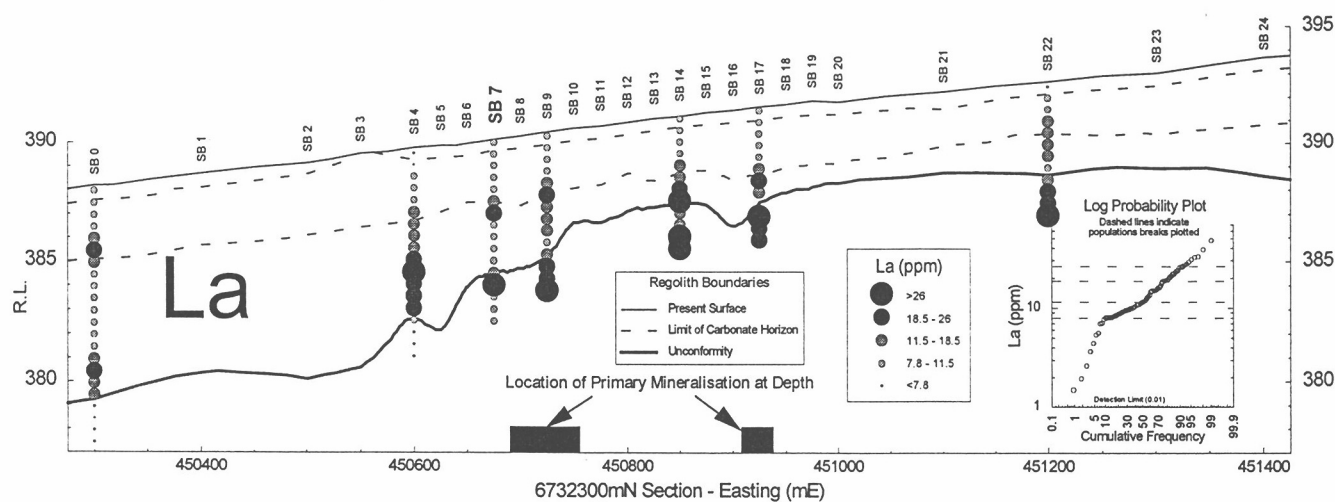
Figure A1.6:   Distribution of La in the regolith on 6732300 mN.
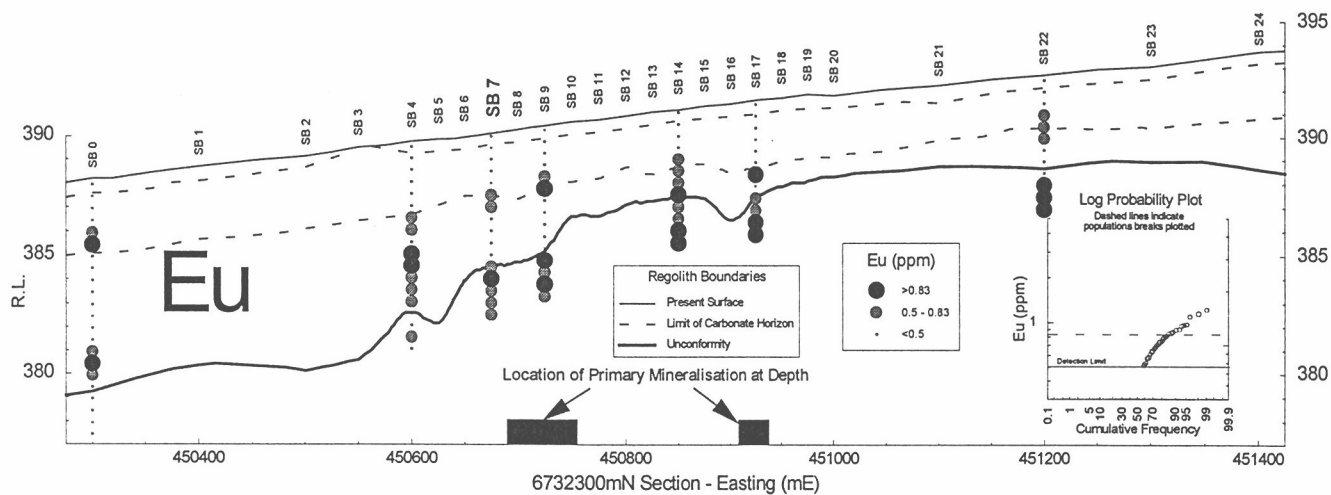
Figure A1.7:   Distribution of Eu in the regolith on 6732300 mN.
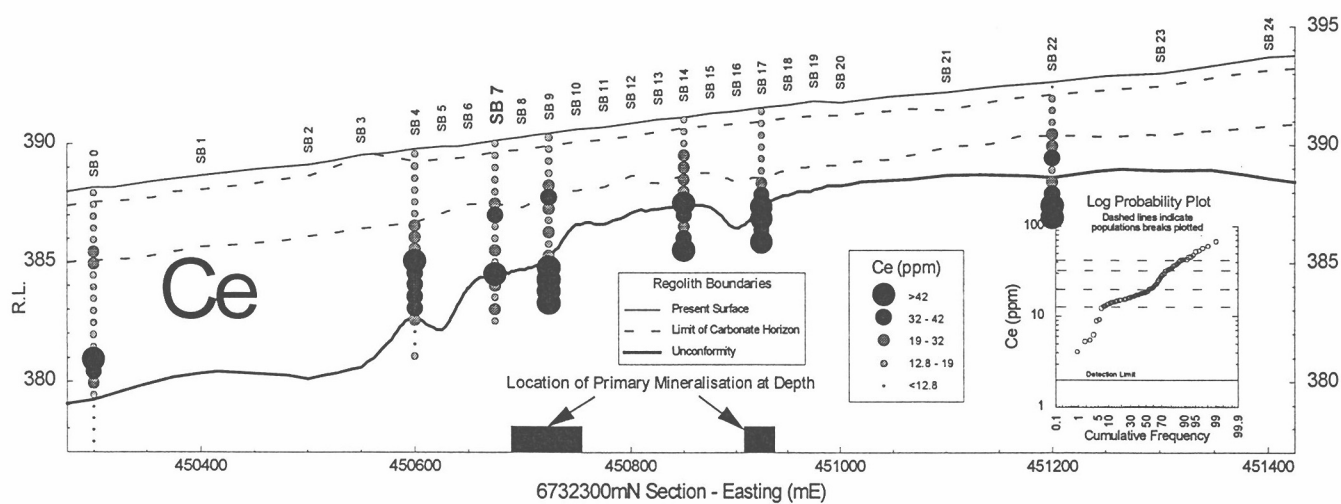
Figure A1.8:   Distribution of Ce in the regolith on 6732300 mN.
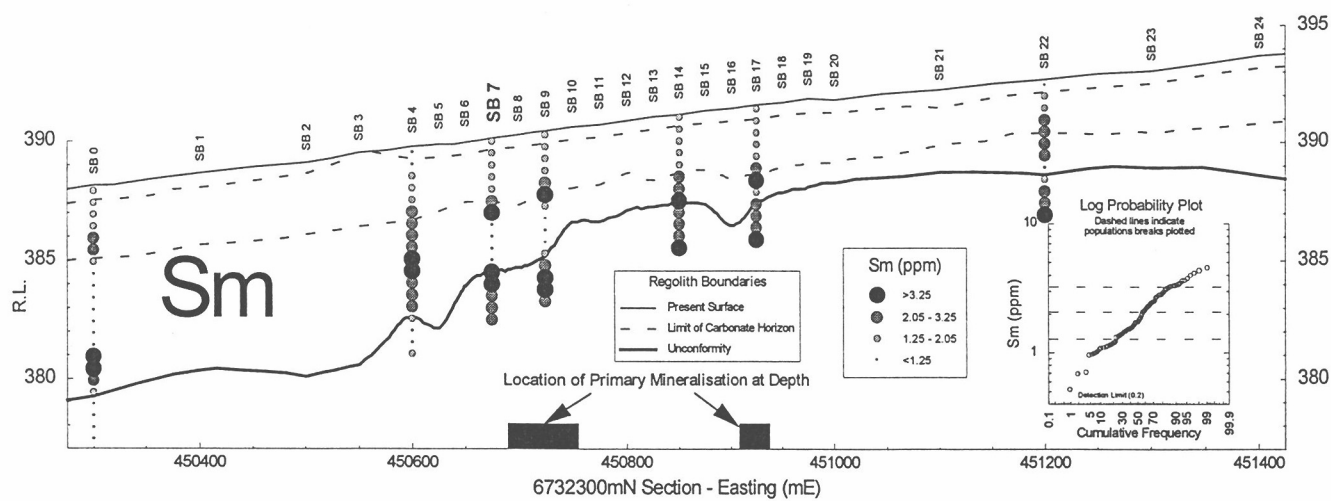
Figure A1.9: Distribution of Sm in the regolith on 6732300 mN.
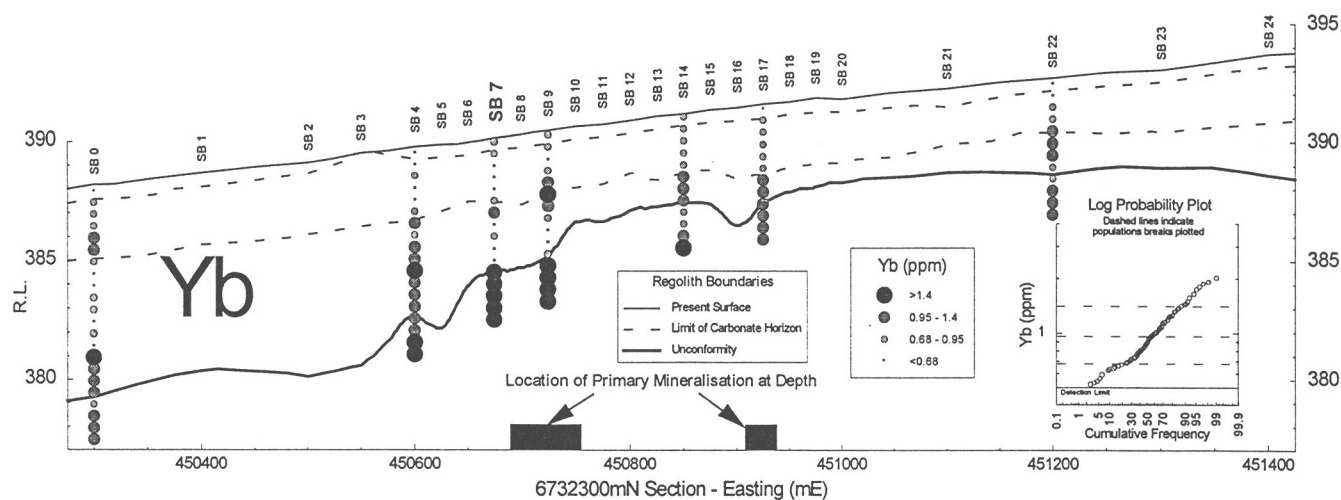
Figure A1.10:   Distribution of Yb in the regolith on 6732300 mN.
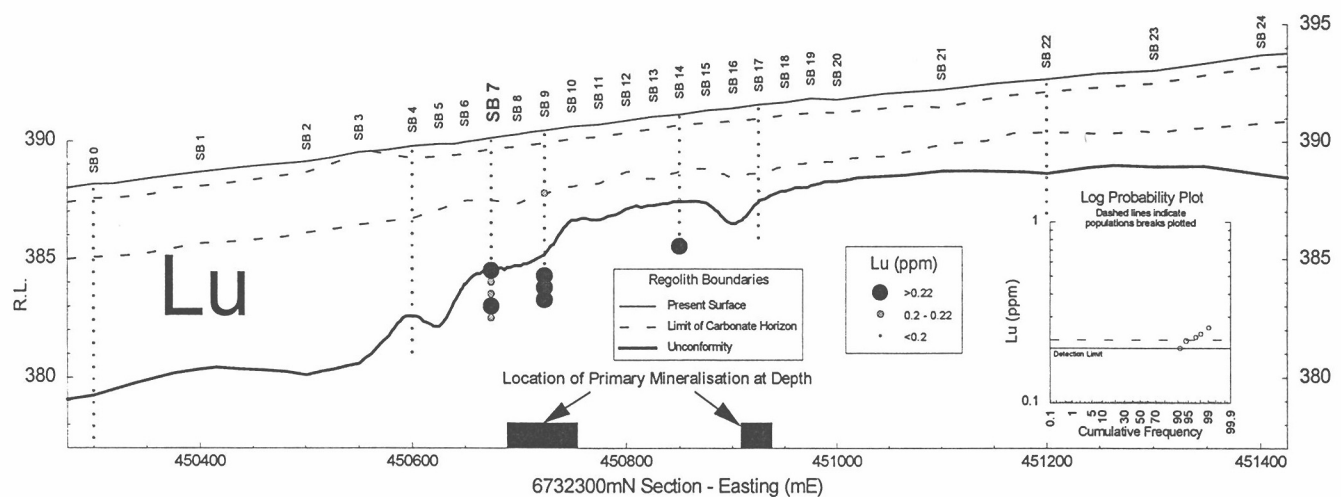
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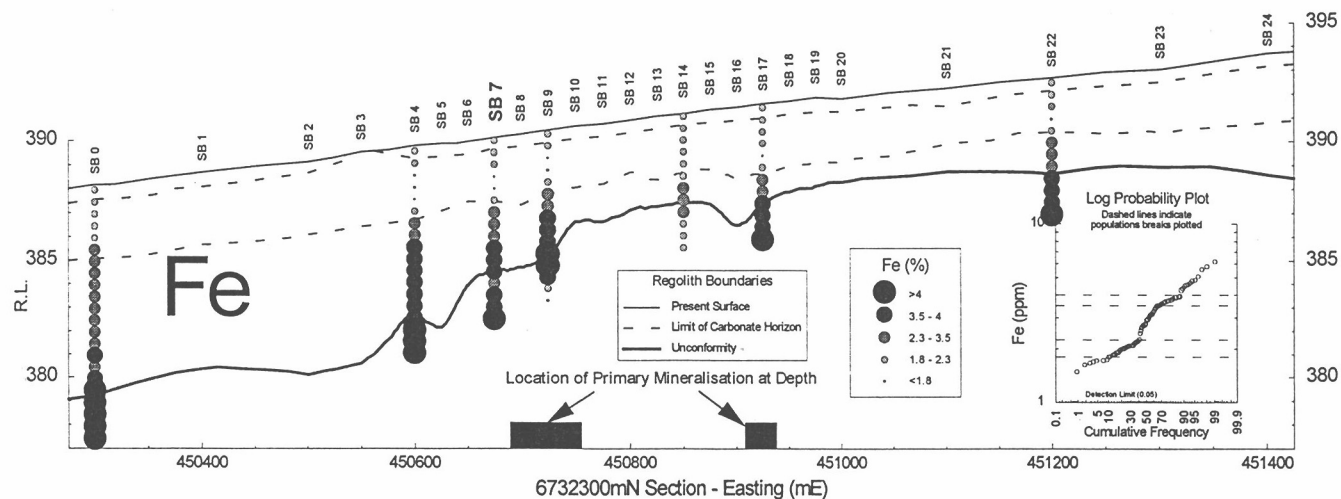
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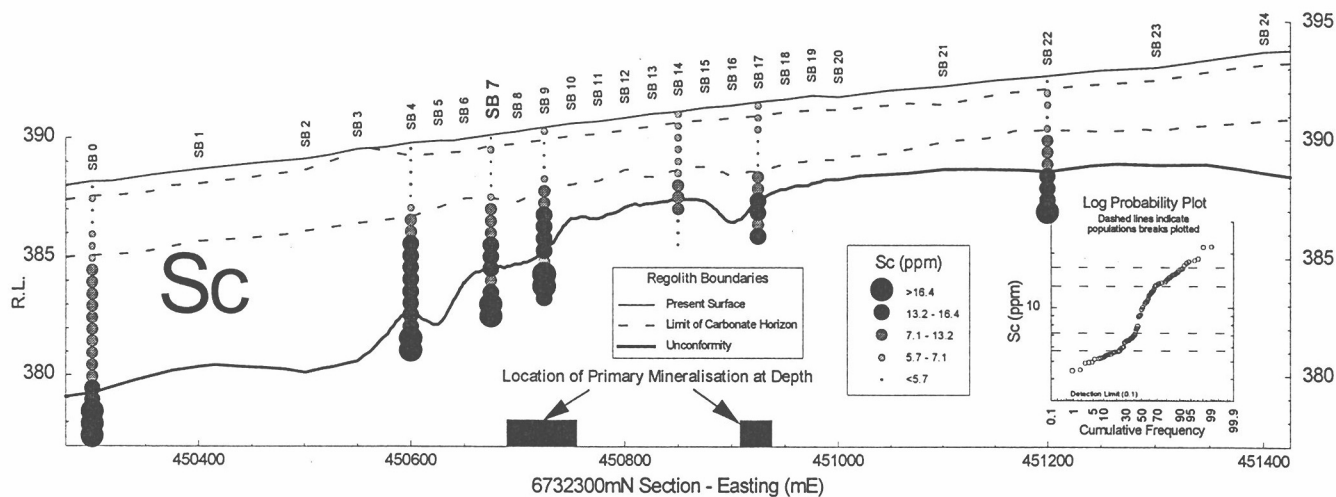
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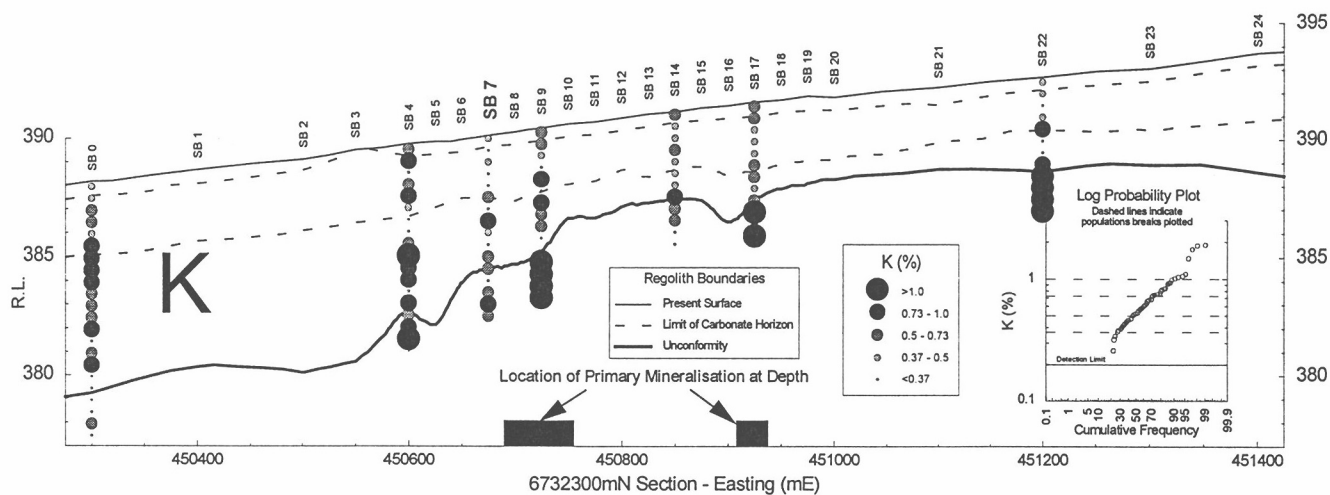
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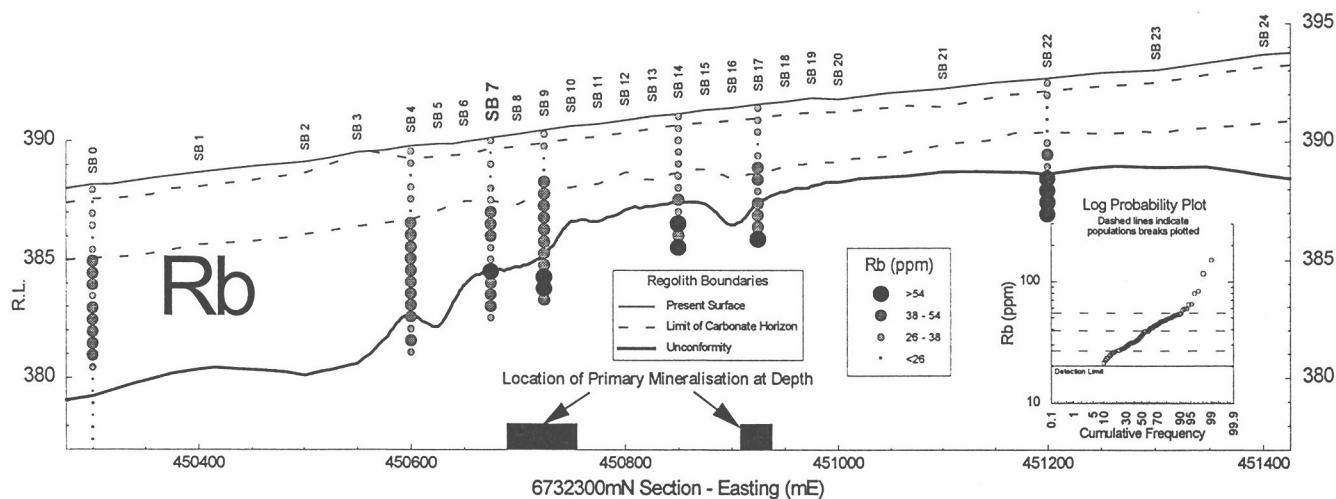
Figure A1.15:   Distribution of Rb in the regolith on 6732300 mN.

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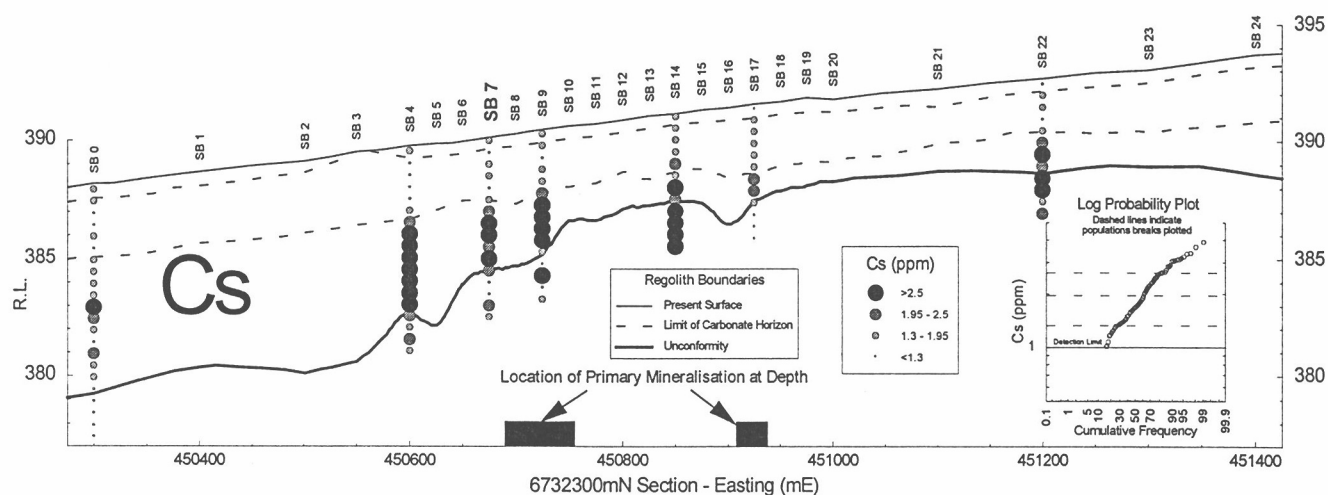
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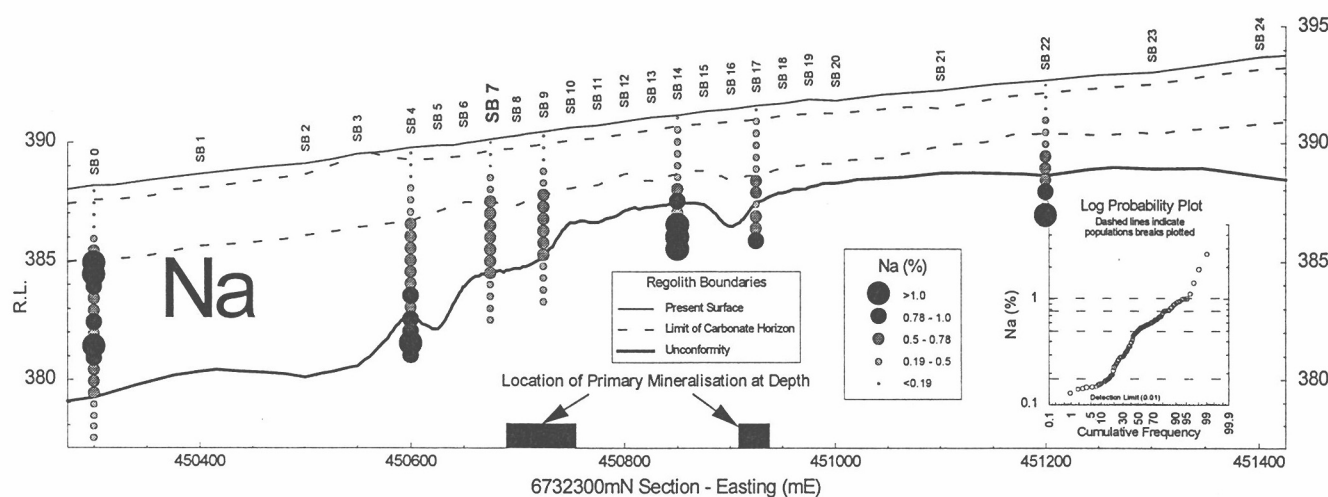
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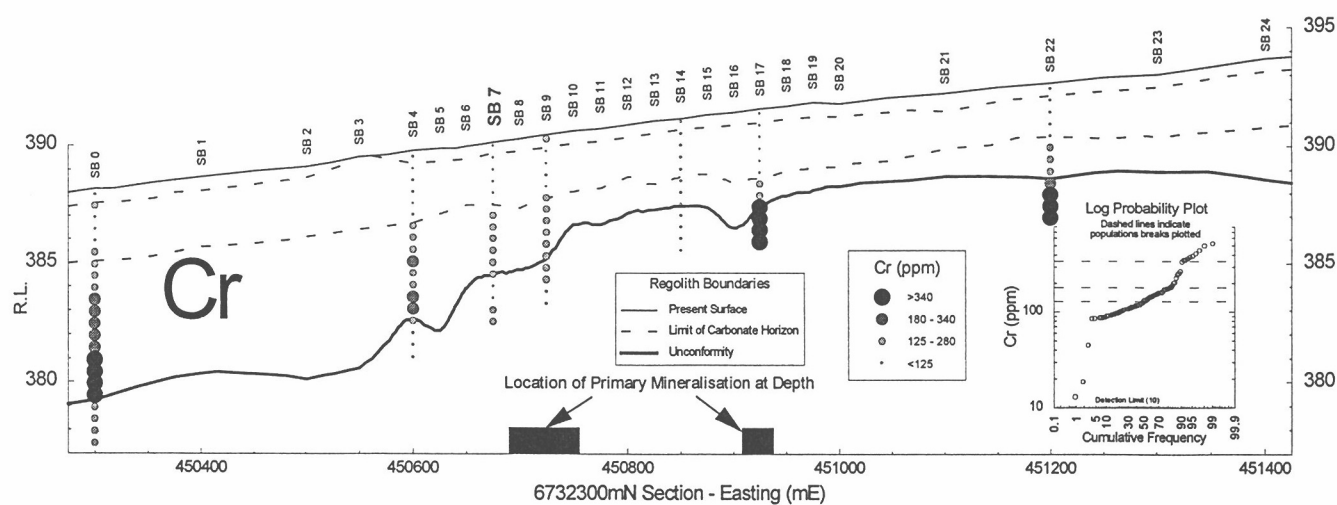
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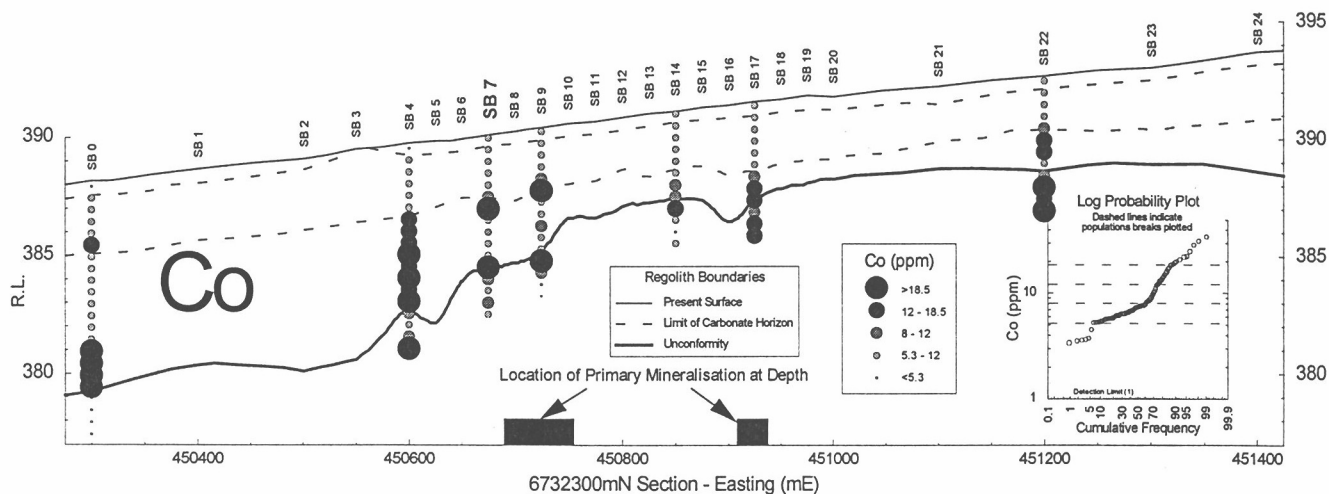
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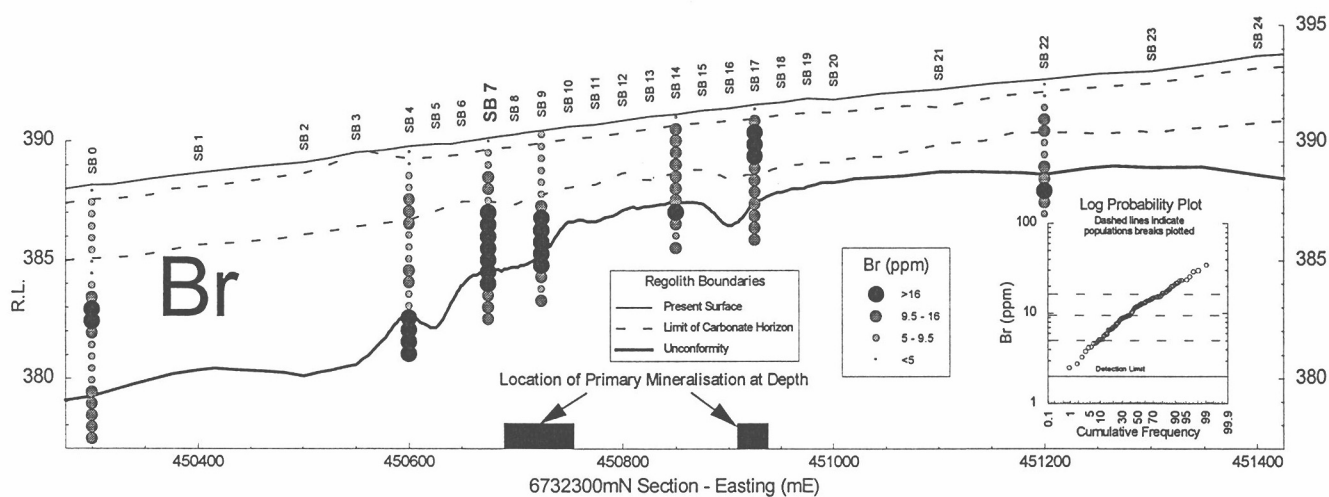
Figure A1.20: Distribution of Br in the regolith on 6732300 mN.
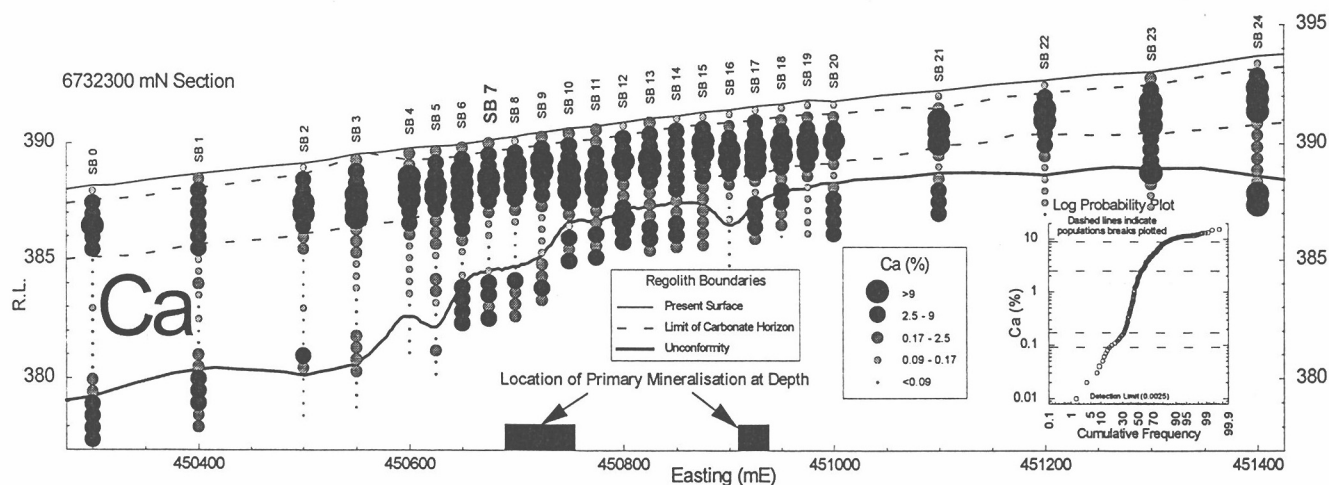
Figure A1.21: Distribution of Ca in the regolith on 6732300 mN.
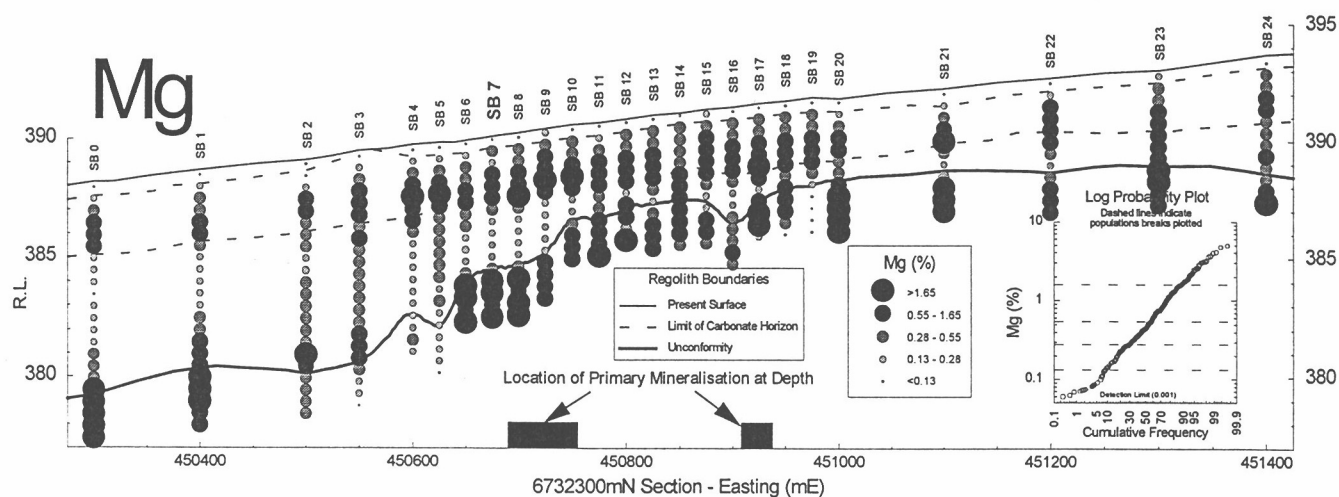
Figure A1.22: Distribution of Mg in the regolith on 6732300 mN.
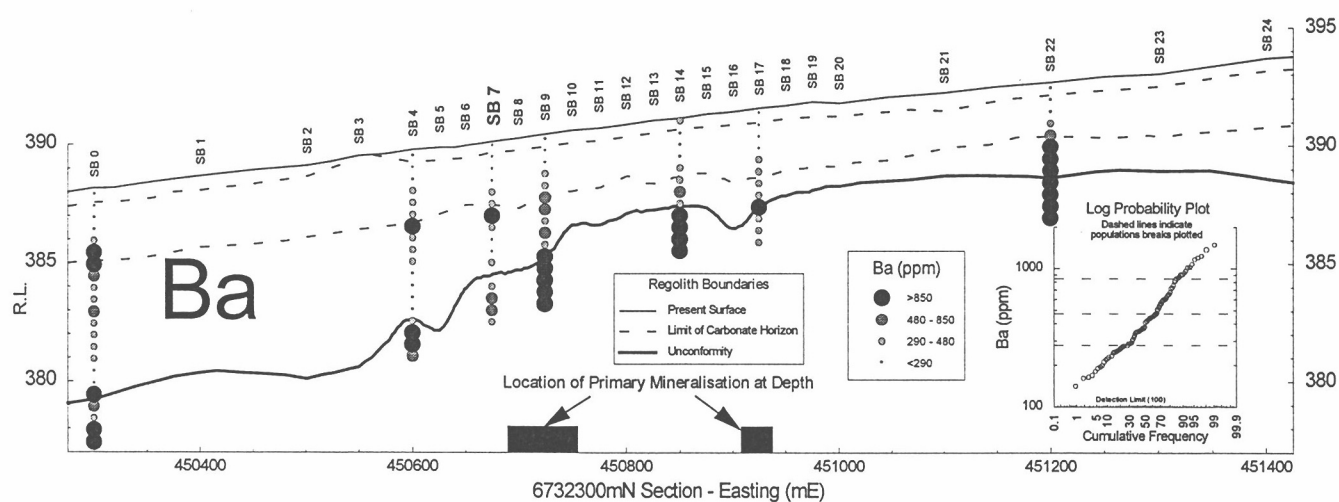
Figure A1.23: Distribution of Ba in the regolith on 6732300 mN.
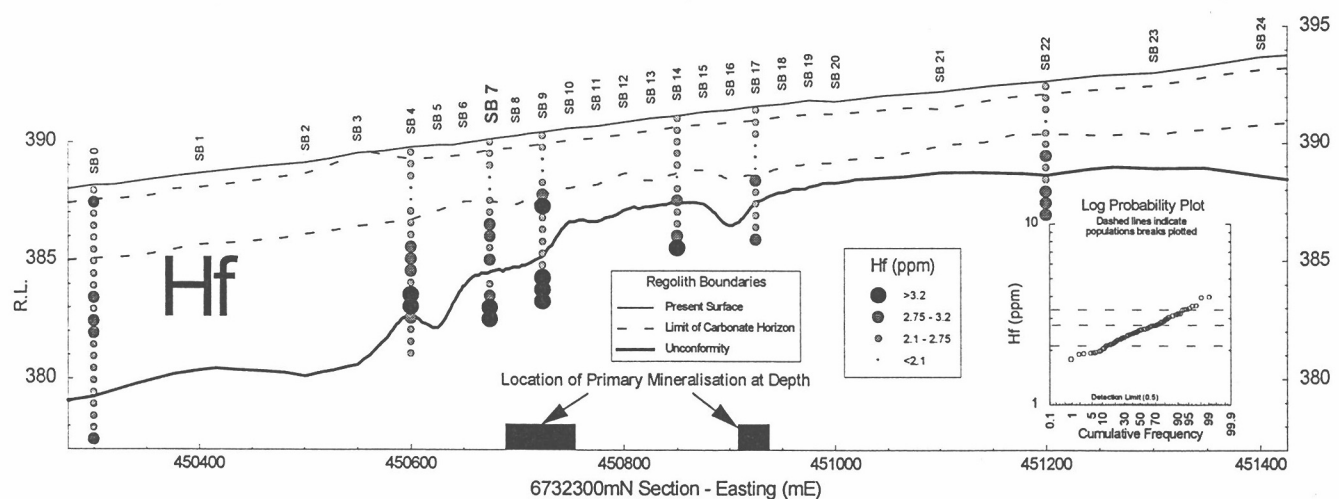
Figure A1.24: Distribution of Hf in the regolith on 6732300 mN.
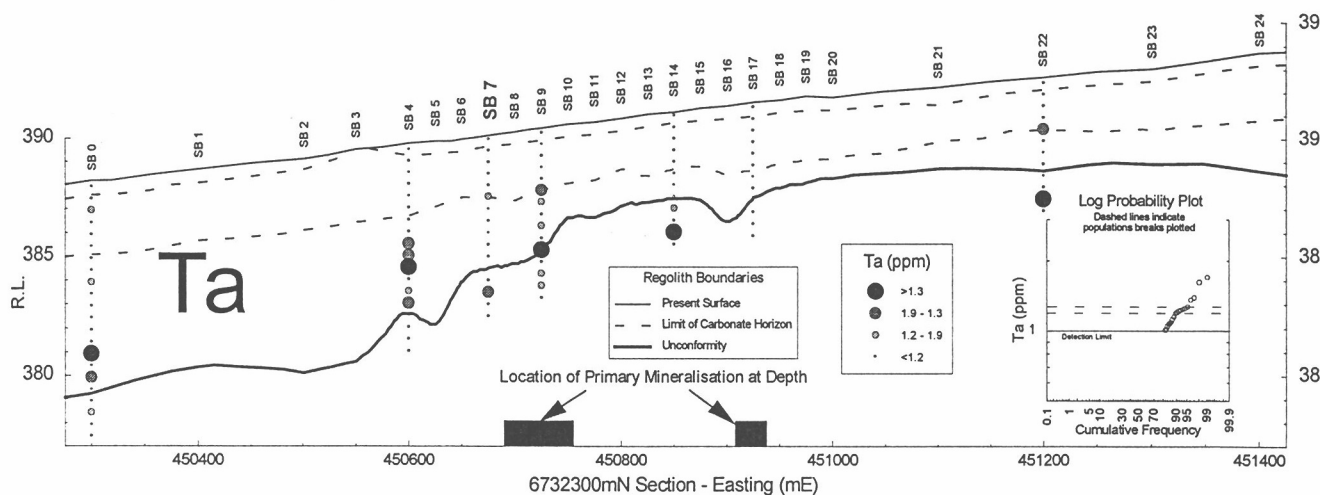
Figure A1.25:   Distribution of Ta in the regolith on 6732300 mN.
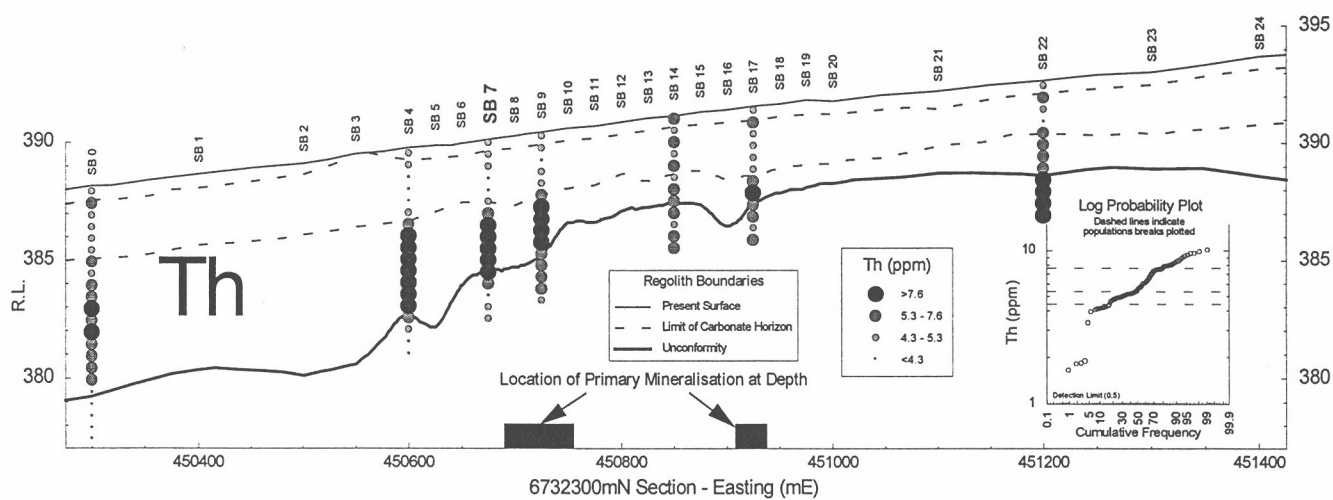
Figure A1.26:   Distribution of Th in the regolith on 6732300 mN.
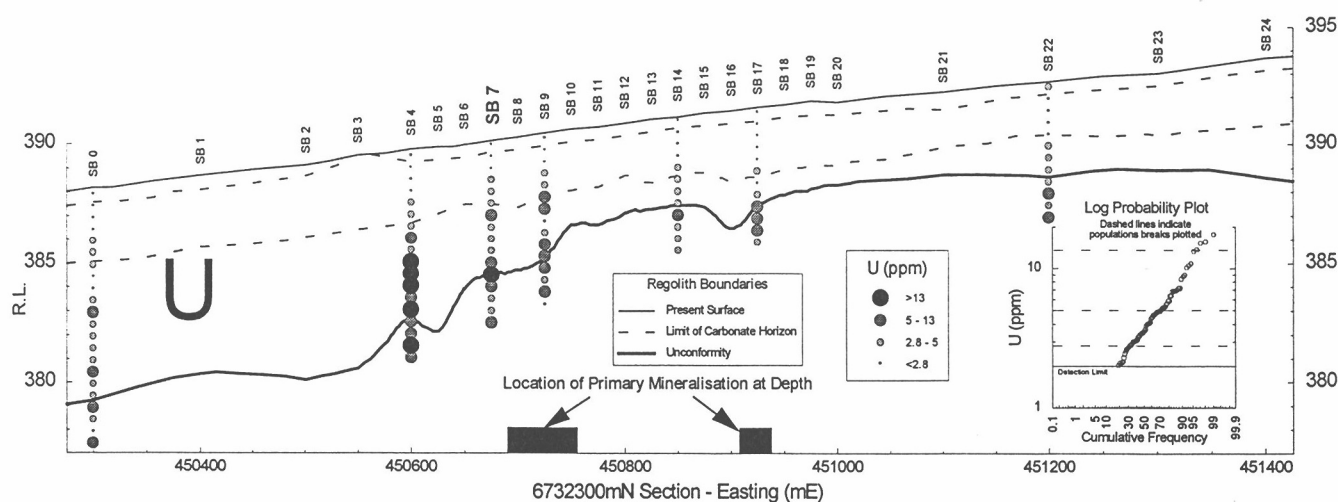
Figure A1.27:   Distribution of U in the regolith on 6732300 mN.

APPENDIX 2 - RAW GEOCHEMICAL DATA FROM DRILLING ON 6732300 mN

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB0	0	0.5	3	<5	230	3	0.16	15	5	120	1.4	<0.5	2.1	2.7	0.5	8.0	<0.2	0.072
SB0	0.5	1	4	<5	180	7	2.79	17	7	120	1.4	<0.5	2.3	2.8	0.4	9.9	<0.2	0.194
SB0	1	1.5	4	<5	220	8	6.53	17	7	110	1.3	<0.5	2.0	2.6	0.7	9.0	<0.2	0.310
SB0	1.5	2	4	8	260	7	10.33	17	6	100	<1	<0.5	1.9	2.5	0.6	9.6	<0.2	1.000
SB0	2	2.5	3	<5	450	7	7.98	19	8	110	1.7	0.5	2.1	2.3	0.4	13.4	<0.2	1.473
SB0	2.5	3	3	<5	800	8	5.19	28	14	150	<1	0.9	2.7	2.4	0.8	19.0	<0.2	0.709
SB0	3	3.5	5	<5	720	4	0.08	22	8	130	1.4	<0.5	2.7	2.6	0.9	12.5	<0.2	0.195
SB0	3.5	4	4	<5	520	5	0.03	13	6	150	1.9	<0.5	2.6	2.3	0.7	8.7	<0.2	0.140
SB0	4	4.5	4	<5	420	7	0.03	13	6	150	1.3	<0.5	2.8	2.4	0.8	8.0	<0.2	0.130
SB0	4.5	5	4	<5	350	13	0.03	14	6	200	1.9	<0.5	2.9	2.8	0.6	8.4	<0.2	0.108
SB0	5	5.5	5	<5	560	30	0.09	15	7	190	3.1	<0.5	3.5	2.7	0.5	9.9	<0.2	0.164
SB0	5.5	6	5	<5	350	23	0.01	14	7	230	2.0	<0.5	3.3	2.9	0.6	8.8	<0.2	0.162
SB0	6	6.5	5	<5	300	12	0.01	16	6	260	1.7	<0.5	3.3	3.1	0.8	9.4	<0.2	0.172
SB0	6.5	7	4	<5	410	5	0.02	16	8	270	<1	<0.5	3.1	2.2	<0.45	9.6	<0.2	0.244
SB0	7	7.5	5	<5	380	6	0.02	68	44	390	2.1	0.8	3.5	2.4	0.7	16.0	<0.2	0.393
SB0	7.5	8	7	7	190	9	0.02	32	31	350	1.8	1.2	3.4	2.7	0.7	21.2	<0.2	0.449
SB0	8	8.5	8	20	250	6	0.25	25	22	500	1.4	0.7	3.9	2.6	<0.47	16.8	<0.2	0.440
SB0	8.5	9	7	42	1700	15	2.34	18	22	610	<1	<0.5	5.6	2.1	<0.44	11.8	<0.2	2.170
SB0	9	9.5	3	12	580	15	5.98	5	4	140	<1	<0.5	4.5	2.2	<0.2	3.7	<0.2	3.936
SB0	9.5	10	5	<5	420	14	4.7	5	4	170	<1	<0.5	5.8	2.6	<0.2	2.6	<0.2	3.153
SB0	10	10.5	5	<5	730	14	4.52	6	4	160	<1	<0.5	6.2	2.6	0.5	1.5	<0.2	3.095
SB0	10.5	11	6	<5	850	15	2.6	4	3	180	<1	<0.5	7.1	2.9	<0.43	1.9	<0.2	2.067
SB1	0	0.5		<5			0.21											0.108
SB1	0.5	1		7			3.81											0.245
SB1	1	1.5		6			6.47											0.353
SB1	1.5	2		5			8.84											0.485
SB1	2	2.5		8			8.89											0.746
SB1	2.5	3		8			8.75											1.512
SB1	3	3.5		<5			2.69											0.540
SB1	3.5	4		<5			0.13											0.239
SB1	4	4.5		<5			0.09											0.179
SB1	4.5	5		<5			0.18											0.197
SB1	5	5.5		8			0.12											0.199
SB1	5.5	6		<5			0.07											0.274
SB1	6	6.5		<5			0.1											0.317
SB1	6.5	7		<5			0.05											0.439
SB1	7	7.5		8			0.04											0.589

Appendix 2-1

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB1	7.5	8		16			0.4											0.695
SB1	8	8.5		9			0.57											0.908
SB1	8.5	9		21			5.87											3.548
SB1	9	9.5		13			4.07											2.551
SB1	9.5	10		27			3.6											2.440
SB1	10	10.5		<5			1.71											1.293
SB1	10.5	11		<5			0.67											0.688
SB2	0	0.5		7			0.16											0.073
SB2	0.5	1		14			2.55											0.127
SB2	1	1.5		7			6.54											0.268
SB2	1.5	2		9			13.29											1.008
SB2	2	2.5		8			10.24											1.471
SB2	2.5	3		<5			2.65											0.519
SB2	3	3.5		<5			0.19											0.321
SB2	3.5	4		<5			0.17											0.306
SB2	4	4.5		<5			0.05											0.272
SB2	4.5	5		<5			0.05											0.245
SB2	5	5.5		<5			0.03											0.285
SB2	5.5	6		<5			0.03											0.340
SB2	6	6.5		8			0.14											0.308
SB2	6.5	7		<5			0.03											0.328
SB2	7	7.5		13			0.05											0.417
SB2	7.5	8		34			0.03											0.508
SB2	8	8.5		23			2.68											2.107
SB2	8.5	9		22			1.24											1.218
SB2	9	9.5		<5			0.07											0.440
SB2	9.5	10		<5			0.01											0.434
SB2	10	10.5		<5			0.01											0.439
SB2	10.5	11		<5			0.01											0.319
SB3	0	0.5		<5			1.27											0.127
SB3	0.5	1		13			5.3											0.228
SB3	1	1.5		11			7.84											0.330
SB3	1.5	2		11			11.54											0.746
SB3	2	2.5		9			10.2											0.959
SB3	2.5	3		10			9.44											0.807
SB3	3	3.5		7			2.45											0.349
SB3	3.5	4		8			2.15											0.609

Appendix 2-2

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB3	4	4.5		12			0.35											0.424
SB3	4.5	5		9			0.12											0.290
SB3	5	5.5		12			0.12											0.350
SB3	5.5	6		<5			0.13											0.372
SB3	6	6.5		<5			0.08											0.315
SB3	6.5	7		<5			0.03											0.355
SB3	7	7.5		<5			0.03											0.368
SB3	7.5	8		24			1.38											1.228
SB3	8	8.5		11			1.83											1.542
SB3	8.5	9		7			1.97											1.552
SB3	9	9.5		8			0.43											0.498
SB3	9.5	10		<5			0.03											0.163
SB3	10	10.5		<5			0.02											0.133
SB3	10.5	11		<5			0.02											0.074
SB4	0	0.5	4	6	270	5	0.17	14	5	110	1.7	<0.5	1.9	2.4	0.6	7.1	<0.2	0.069
SB4	0.5	1	4	7	250	5	2.01	13	5	110	<1	<0.5	2.0	2.5	0.8	7.7	<0.2	0.141
SB4	1	1.5	4	15	250	7	9.62	15	6	94	<1	<0.5	1.7	2.2	<0.2	8.3	<0.2	0.497
SB4	1.5	2	4	11	290	7	11.01	15	6	87	1.3	<0.5	1.6	1.9	0.5	8.6	<0.2	1.273
SB4	2	2.5	4	10	350	11	9.63	15	6	91	1.2	<0.5	1.7	1.9	0.8	9.4	<0.2	2.104
SB4	2.5	3	4	9	430	15	8.91	17	7	100	1.6	<0.5	1.9	2.1	0.5	12.8	<0.2	1.421
SB4	3	3.5	5	9	820	14	4.56	30	14	130	2.2	0.5	2.9	2.3	<0.53	18.0	<0.2	0.598
SB4	3.5	4	5	<5	420	9	1.28	29	14	140	3.0	0.6	3.2	2.7	<0.53	16.0	<0.2	0.498
SB4	4	4.5	6	9	350	7	0.16	27	13	180	2.8	<0.5	3.5	3.1	0.6	16.4	<0.2	0.239
SB4	4.5	5	6	12	360	9	0.1	43	21	180	2.6	0.9	3.7	3.2	1.0	22.0	<0.2	0.224
SB4	5	5.5	7	<5	280	15	0.14	36	15	180	4.5	0.9	3.9	2.9	0.9	27.7	<0.2	0.252
SB4	5.5	6	7	<5	140	12	0.12	35	25	180	2.6	0.7	3.7	2.6	0.8	20.4	<0.2	0.270
SB4	6	6.5	6	8	280	9	0.1	34	18	200	3.4	0.8	3.7	3.4	<0.63	19.7	<0.2	0.268
SB4	6.5	7	6	8	220	9	0.05	37	19	180	2.9	0.7	3.6	3.4	0.8	18.9	<0.2	0.258
SB4	7	7.5	12	22	310	19	0.03	20	8	170	2.2	<0.5	3.9	3.2	0.7	11.4	<0.2	0.213
SB4	7.5	8	16	58	650	24	0.04	9	8	110	1.6	<0.5	4.3	2.4	0.8	5.4	<0.2	0.229
SB4	8	8.5	20	48	930	22	0.03	9	9	94	2.2	0.5	4.5	2.6	1.0	4.4	<0.2	0.301
SB4	8.5	9	25	33	600	17	0.03	14	23	92	1.3	<0.5	5.1	2.7	<0.76	5.6	<0.2	0.272
SB5	0	0.5		<5			0.25											0.062
SB5	0.5	1		14			3.15											0.167
SB5	1	1.5		11			8											0.384
SB5	1.5	2		11			11.74											0.877
SB5	2	2.5		13			11.03											1.658

Appendix 2-3

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB5	2.5	3		<5			8.59											1.113
SB5	3	3.5		12			0.77											0.385
SB5	3.5	4		10			1.3											0.333
SB5	4	4.5		15			0.2											0.285
SB5	4.5	5		14			0.15											0.286
SB5	5	5.5		9			0.08											0.285
SB5	5.5	6		<5			0.23											0.318
SB5	6	6.5		9			0.17											0.231
SB5	6.5	7		<5			0.11											0.287
SB5	7	7.5		8			0.04											0.260
SB5	7.5	8		13			0.03											0.278
SB5	8	8.5		19			0.03											0.266
SB5	8.5	9		15			0.27											0.261
SB5	9	9.5		14			0.04											0.143
SB5	9.5	10		<5			0.01											0.085
SB6	0	0.5		9			0.74											0.083
SB6	0.5	1		12			6.39											0.214
SB6	1	1.5		18			10.48											0.401
SB6	1.5	2		14			10.61											0.538
SB6	2	2.5		13			10.7											0.739
SB6	2.5	3		<5			10.33											0.903
SB6	3	3.5		9			4.56											0.409
SB6	3.5	4		23			4.75											0.436
SB6	4	4.5		18			0.51											0.229
SB6	4.5	5		20			0.13											0.272
SB6	5	5.5		20			0.08											0.268
SB6	5.5	6		<5			0.15											0.322
SB6	6	6.5		67			5.41											2.552
SB6	6.5	7		110			6.52											3.636
SB6	7	7.5		25			2.53											1.561
SB6	7.5	8		19			3.63											2.200
SB7	0	0.5	4	11	290	4	0.49	15	6	120	1.7	<0.5	2.0	2.3	0.4	8.2	<0.2	0.082
SB7	0.5	1	4	16	160	7	6.55	17	6	100	1.2	<0.5	1.9	2.5	0.3	9.2	<0.2	0.308
SB7	1	1.5	5	16	290	6	5.3	15	6	100	1.4	<0.5	1.9	2.3	0.5	8.0	<0.2	0.272
SB7	1.5	2	5	20	280	12	11.87	15	6	88	1.6	<0.5	1.7	1.9	0.3	9.4	<0.2	0.740
SB7	2	2.5	4	12	360	13	11.35	17	6	85	1.2	<0.5	1.7	1.9	0.3	10.7	<0.2	1.630
SB7	2.5	3	3	13	460	9	4.61	21	9	110	1.7	0.7	2.2	2.5	0.7	14.8	<0.2	1.070

Appendix 2-4

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB7	3	3.5	5	16	900	22	1.03	39	20	130	2.5	0.6	3.1	2.7	<0.42	20.8	<0.2	0.450
SB7	3.5	4	7	6	440	18	0.15	16	7	160	2.6	<0.5	3.1	2.9	0.7	10.4	<0.2	0.190
SB7	4	4.5	7	<5	250	20	0.1	18	7	160	3.9	<0.5	3.4	3.0	0.4	10.7	<0.2	0.160
SB7	4.5	5	11	<5	290	20	0.08	20	8	160	2.3	<0.5	3.6	2.6	<0.2	11.2	<0.2	0.160
SB7	5	5.5	18	16	450	25	0.04	14	8	160	3.1	<0.5	3.9	2.8	0.6	10.9	<0.2	0.170
SB7	5.5	6	15	60	280	18	0.09	46	34	150	2.4	0.7	3.6	2.0	0.5	15.0	0.23	0.400
SB7	6	6.5	20	83	480	17	4.66	23	10	120	<1	1.2	3.0	2.6	<0.53	38.8	0.22	2.560
SB7	6.5	7	35	37	600	13	2.94	19	7	110	1.2	0.6	3.7	3.0	0.5	10.0	0.22	1.980
SB7	7	7.5	38	18	540	12	1.79	21	8	140	2.5	0.7	3.8	3.5	0.9	9.5	0.23	1.230
SB7	7.5	8	56	19	450	10	2.73	19	7	130	1.5	0.8	4.7	3.5	0.7	8.0	0.22	1.820
SB8	0	0.5		13			0.15											0.100
SB8	0.5	1		21			3.13											0.280
SB8	1	1.5		29			9.09											0.510
SB8	1.5	2		30			11.74											0.790
SB8	2	2.5		18			10.33											1.560
SB8	2.5	3		15			6.74											1.880
SB8	3	3.5		<5			0.32											0.280
SB8	3.5	4		7			0.09											0.150
SB8	4	4.5		29			0.06											0.140
SB8	4.5	5		<5			0.06											0.140
SB8	5	5.5		14			0.05											0.160
SB8	5.5	6		87			0.05											0.420
SB8	6	6.5		151			3.36											2.810
SB8	6.5	7		41			1.19											1.420
SB8	7	7.5		22			1.98											1.770
SB8	7.5	8		18			2.37											1.740
SB9	0	0.5	4	29	230	5	0.56	16	6	130	1.7	<0.5	2.1	2.6	0.5	8.1	<0.2	0.130
SB9	0.5	1	5	41	160	8	8.01	16	6	97	1.8	<0.5	1.8	2.2	0.5	8.8	<0.2	0.450
SB9	1	1.5	5	43	280	8	11.33	14	6	87	<1	<0.5	1.7	2.0	0.4	9.1	<0.2	0.700
SB9	1.5	2	4	42	370	8	10.97	16	7	88	1.3	<0.5	1.7	1.9	<0.44	11.3	<0.2	1.280
SB9	2	2.5	6	39	450	9	8.87	21	8	100	1.6	0.6	2.1	2.2	0.8	15.8	<0.2	1.800
SB9	2.5	3	6	31	500	9	3.11	41	20	130	2.3	1.0	2.7	2.8	<0.56	25.6	0.2	0.690
SB9	3	3.5	7	10	590	15	0.23	19	8	150	2.6	<0.5	3.1	3.4	1.0	12.3	<0.2	0.210
SB9	3.5	4	10	13	290	36	0.12	18	7	160	3.3	<0.5	3.9	2.7	0.6	11.8	<0.2	0.180
SB9	4	4.5	9	9	560	23	0.14	21	9	150	3.2	<0.5	3.7	2.5	0.5	11.8	<0.2	0.160
SB9	4.5	5	10	33	350	29	0.11	18	7	140	2.9	<0.5	3.6	2.2	<0.52	11.1	<0.2	0.170
SB9	5	5.5	98	1200	1200	34	0.11	25	8	140	1.9	<0.5	4.4	2.7	<0.52	13.0	<0.2	0.170

Appendix 2-5

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB9	5.5	6	221	750	1100	16	0.33	42	21	130	1.0	1.0	4.8	2.5	1.1	19.1	<0.2	0.620
SB9	6	6.5	232	550	1200	15	0.87	52	8	130	3.1	0.8	3.9	4.0	1.7	25.9	0.26	0.850
SB9	6.5	7	141	290	900	8	2.71	90	4	97	<1	1.0	2.0	4.7	1.0	47.8	0.28	1.540
SB9	7	7.5	81	580	1000	10	1.94	53	4	85	1.4	0.7	1.5	3.9	1.5	27.0	0.24	1.200
SB10	0	0.5		13			0.17											0.120
SB10	0.5	1		21			5.46											0.380
SB10	1	1.5		20			7.1											0.390
SB10	1.5	2		24			11.44											0.750
SB10	2	2.5		20			11.49											1.690
SB10	2.5	3		14			11.56											0.750
SB10	3	3.5		9			4.26											0.220
SB10	3.5	4		<5			0.39											0.170
SB10	4	4.5		29			0.15											0.530
SB10	4.5	5		27			3.72											0.750
SB10	5	5.5		19			2.47											1.590
SB10	5.5	6		72			2.99											1.320
SB11	0	0.5		9			1.96											0.090
SB11	0.5	1		15			0.19											0.260
SB11	1	1.5		16			2.5											0.440
SB11	1.5	2		18			8.29											0.620
SB11	2	2.5		15			12.07											0.860
SB11	2.5	3		8			9.54											0.570
SB11	3	3.5		12			3.47											0.370
SB11	3.5	4		14			0.19											0.360
SB11	4	4.5		56			0.33											0.650
SB11	4.5	5		38			6.85											0.730
SB11	5	5.5		13			1.5											0.820
SB11	5.5	6		23			4.89											2.780
SB12	0	0.5		9			0.1											0.100
SB12	0.5	1		11			3.52											0.350
SB12	1	1.5		17			5.46											0.410
SB12	1.5	2		17			11.68											0.660
SB12	2	2.5		11			8.74											0.900
SB12	2.5	3		<5			1.92											0.580
SB12	3	3.5		<5			0.21											0.250
SB12	3.5	4		41			6.24											0.750
SB12	4	4.5		57			9.3											0.870

Appendix 2-6

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB12	4.5	5		51			4.06											0.430
SB12	5	5.5		53			3.55											1.670
SB13	0	0.5		9			0.17											0.090
SB13	0.5	1		15			4.28											0.300
SB13	1	1.5		13			5.57											0.350
SB13	1.5	2		22			13.08											0.750
SB13	2	2.5		15			12.52											1.280
SB13	2.5	3		<5			4.55											1.020
SB13	3	3.5		7			1.03											0.310
SB13	3.5	4		<5			0.22											0.230
SB13	4	4.5		17			0.26											0.340
SB13	4.5	5		19			4.05											0.760
SB13	5	5.5		<5			2.69											1.420
SB13	5.5	6		<5			0.98											0.940
SB14	0	0.5	4	8	350	4	0.12	15	6	120	1.3	<0.5	2.2	2.7	0.6	8.5	<0.2	0.100
SB14	0.5	1	5	14	230	15	5.29	18	7	110	1.3	<0.5	2.1	2.4	0.4	10.1	<0.2	0.520
SB14	1	1.5	4	10	240	12	3.93	17	7	110	1.8	<0.5	2.2	2.3	0.4	9.8	<0.2	0.370
SB14	1.5	2	4	10	210	15	4.99	20	7	110	1.6	<0.5	2.1	2.5	0.6	10.7	<0.2	0.420
SB14	2	2.5	6	11	360	14	5.54	20	6	110	2.1	0.6	2.2	2.5	0.4	11.6	<0.2	0.410
SB14	2.5	3	5	10	330	14	7.43	22	7	110	1.5	0.6	2.1	1.9	0.5	14.9	<0.2	1.360
SB14	3	3.5	5	6	600	13	3.83	26	9	120	2.7	0.7	2.4	2.6	0.4	18.9	<0.2	0.830
SB14	3.5	4	8	31	470	13	1.2	46	10	120	2.2	1.2	2.7	2.9	0.8	30.7	<0.2	0.590
SB14	4	4.5	5	28	650	17	1.49	33	13	98	2.7	0.8	2.5	2.4	0.6	15.4	<0.2	0.770
SB14	4.5	5	5	38	670	15	8.34	23	5	45	2.7	0.5	1.9	2.4	0.6	15.0	<0.2	1.310
SB14	5	5.5	4	10	610	6	2.54	37	5	13	3.7	0.9	2.0	3.1	<0.75	28.8	<0.2	0.660
SB14	5.5	6	7	<5	860	12	0.62	57	6	19	3.1	1.1	2.0	3.3	<0.71	48.0	0.23	0.320
SB15	0	0.5		11			0.14											0.150
SB15	0.5	1		14			4.76											0.400
SB15	1	1.5		14			10.36											0.620
SB15	1.5	2		18			9.86											1.280
SB15	2	2.5		13			8.69											1.500
SB15	2.5	3		9			5.74											1.100
SB15	3	3.5		8			0.35											0.310
SB15	3.5	4		7			0.28											0.230
SB15	4	4.5		<5			0.24											0.170
SB15	4.5	5		32			1.22											1.050
SB15	5	5.5		23			1.33											1.010

Appendix 2-7

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB15	5.5	6		8			0.63											0.420
SB16	0	0.5		9			0.16											0.080
SB16	0.5	1		16			2.47											0.290
SB16	1	1.5		16			5.62											0.510
SB16	1.5	2		16			11.17											0.840
SB16	2	2.5		11			9.89											1.200
SB16	2.5	3		9			5.76											1.220
SB16	3	3.5		16			0.35											0.400
SB16	3.5	4		12			0.1											0.220
SB16	4	4.5		20			0.07											0.270
SB16	4.5	5		15			0.09											0.280
SB16	5	5.5		<5			0.06											0.400
SB16	5.5	6		<5			0.02											0.510
SB16	6	6.5		<5			0.02											0.750
SB16	6.5	7		<5			0.02											0.530
SB17	0	0.5	3	15	270	3	0.1	15	6	120	1.2	<0.5	2.1	2.3	0.5	8.1	<0.2	0.080
SB17	0.5	1	5	28	190	11	3.77	18	7	110	1.4	<0.5	2.2	2.5	0.5	10.0	<0.2	0.350
SB17	1	1.5	6	33	260	21	8.22	19	7	110	1.4	<0.5	2.1	2.4	0.4	10.8	<0.2	0.500
SB17	1.5	2	5	49	260	17	11.61	16	6	96	1.4	<0.5	1.8	2.1	0.5	10.4	<0.2	0.700
SB17	2	2.5	5	47	320	17	11.36	16	6	92	1.5	<0.5	1.7	1.8	0.4	10.9	<0.2	1.550
SB17	2.5	3	5	37	430	14	9.94	18	7	90	1.6	<0.5	1.9	2.0	0.6	14.7	<0.2	1.710
SB17	3	3.5	7	33	440	14	1.53	32	11	150	2.4	0.8	2.9	2.8	0.7	23.1	<0.2	0.630
SB17	3.5	4	8	21	340	13	0.16	33	16	160	2.5	<0.5	3.5	2.6	0.4	14.6	<0.2	0.270
SB17	4	4.5	34	82	750	14	4.06	43	13	350	1.4	0.8	3.8	2.7	0.7	26.0	<0.2	0.840
SB17	4.5	5	46	65	440	10	4.62	48	12	410	<1	0.7	3.7	2.5	1.1	32.7	<0.2	2.220
SB17	5	5.5	39	130	370	11	5.19	34	16	370	<1	0.9	3.8	2.3	0.4	23.9	<0.2	2.990
SB17	5.5	6	48	50	470	12	0.41	43	17	520	<1	0.9	4.6	3.0	1.1	23.5	<0.2	0.210
SB18	0	0.5		11			0.09											0.080
SB18	0.5	1		15			2.19											0.300
SB18	1	1.5		22			6.99											0.480
SB18	1.5	2		21			11.26											0.690
SB18	2	2.5		17			10.92											1.590
SB18	2.5	3		11			5.31											0.930
SB18	3	3.5		<5			0.51											0.380
SB18	3.5	4		16			3.65											0.550
SB18	4	4.5		21			6.99											1.120
SB18	4.5	5		15			1.74											0.840

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB18	5	5.5		10			0.45											0.360
SB18	5.5	6		<5			0.06											0.080
SB19	0	0.5		22			0.11											0.090
SB19	0.5	1		34			2.45											0.370
SB19	1	1.5		35			5.35											0.470
SB19	1.5	2		47			10.65											0.770
SB19	2	2.5		35			9.16											1.350
SB19	2.5	3		50			8.05											1.210
SB19	3	3.5		30			0.51											0.320
SB19	3.5	4		24			0.12											0.150
SB19	4	4.5		33			0.11											0.100
SB19	4.5	5		38			0.11											0.080
SB19	5	5.5		120			0.12											0.070
SB19	5.5	6		170			0.13											0.060
SB20	0	0.5		12			0.14											0.100
SB20	0.5	1		12			1.91											0.270
SB20	1	1.5		13			8.07											0.540
SB20	1.5	2		14			10.11											0.730
SB20	2	2.5		7			7.61											1.290
SB20	2.5	3		<5			0.69											0.540
SB20	3	3.5		7			0.15											0.440
SB20	3.5	4		14			1.25											1.480
SB20	4	4.5		8			5.57											4.050
SB20	4.5	5		11			6.92											4.920
SB20	5	5.5		9			4.39											4.700
SB20	5.5	6		8			2.72											5.470
SB21	0	0.5		<5			0.13											0.090
SB21	0.5	1		15			1.37											0.180
SB21	1	1.5		9			9.73											0.460
SB21	1.5	2		13			11.4											0.730
SB21	2	2.5		8			12.31											1.890
SB21	2.5	3		<5			0.6											0.340
SB21	3	3.5		<5			0.11											0.220
SB21	3.5	4		23			0.18											0.460
SB21	4	4.5		39			8.48											3.000
SB21	4.5	5		26			3.11											2.400
SB21	5	5.5		55			3.69											3.070

Appendix 2-9

Hole # Unit	From m	To m	As ppm	Au ppb	Ba ppm	Br ppm	Ca %	Ce ppm	Co ppm	Cr ppm	Cs ppm	Eu ppm	Fe %	Hf ppm	K %	La ppm	Lu ppm	Mg %
SB22	0	0.5	4	<5	200	2	0.11	12	6	120	1.1	<0.5	2.1	2.4	0.5	7.0	<0.2	0.070
SB22	0.5	1	4	9	170	5	2.91	17	6	120	1.8	<0.5	2.3	2.6	0.5	9.4	<0.2	0.260
SB22	1	1.5	3	10	280	9	10.91	18	6	100	1.7	<0.5	2.0	2.1	<0.2	10.8	<0.2	0.550
SB22	1.5	2	3	6	370	12	15.24	17	6	87	1.0	0.6	1.7	2.0	0.4	13.4	<0.2	0.710
SB22	2	2.5	4	<5	510	10	8.05	24	9	110	1.9	0.6	2.2	2.1	0.8	14.9	<0.2	0.980
SB22	2.5	3	5	<5	870	9	4.89	30	12	140	2.3	0.6	2.7	2.7	<0.43	18.5	<0.2	0.920
SB22	3	3.5	4	<5	1400	9	0.81	33	12	170	2.6	<0.5	3.1	3.0	<0.48	14.4	<0.2	0.440
SB22	3.5	4	5	<5	630	13	0.11	16	7	150	2.0	<0.5	2.9	2.7	0.9	9.7	<0.2	0.230
SB22	4	4.5	4	<5	960	15	0.11	28	11	250	3.2	<0.5	3.6	2.6	1.0	15.1	<0.2	0.360
SB22	4.5	5	6	<5	1500	24	0.15	38	19	340	2.6	0.9	3.8	3.2	1.9	19.1	<0.2	0.640
SB22	5	5.5	5	<5	1200	13	0.1	42	19	380	1.7	0.8	3.5	3.1	2.3	22.1	<0.2	0.630
SB22	5.5	6	3	<5	1000	9	0.07	60	29	450	2.3	1.2	4.8	3.1	1.9	32.2	<0.2	1.060
SB23	0	0.5		6			0.34											0.170
SB23	0.5	1		7			3.67											0.420
SB23	1	1.5		8			11.17											0.530
SB23	1.5	2		6			14.9											0.750
SB23	2	2.5		7			11.77											1.030
SB23	2.5	3		16			7.92											0.780
SB23	3	3.5		13			6.81											0.790
SB23	3.5	4		8			8.83											1.250
SB23	4	4.5		21			9.98											2.420
SB23	4.5	5		15			0.9											1.750
SB23	5	5.5		<5			0.11											1.110
SB23	5.5	6		<5			0.11											1.120
SB24	0	0.5		<5			0.13											0.110
SB24	0.5	1		<5			4.56											0.480
SB24	1	1.5		5			9.99											0.460
SB24	1.5	2		<5			15.28											0.780
SB24	2	2.5		6			13.02											1.130
SB24	2.5	3		<5			2.26											0.540
SB24	3	3.5		<5			0.57											0.330
SB24	3.5	4		<5			0.41											0.350
SB24	4	4.5		<5			1.47											0.670
SB24	4.5	5		<5			0.47											0.540
SB24	5	5.5		8			0.22											0.450
SB24	5.5	6		9			11.08											1.070
SB24	6	6.5		13			9.13											1.760

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Appendix 2-10

Hole #Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB0	0	0.5	0.14	31	0.3	6	1.3	<1	5.2	<2	<2	0.7	<100
SB0	0.5	1	0.15	26	0.3	7	1.6	<1	6.0	<2	<2	0.8	<100
SB0	1	1.5	0.15	31	0.4	6	1.5	1.0	4.9	<2	<2	0.7	<100
SB0	1.5	2	0.17	32	0.4	6	1.6	<1	4.9	2.3	<2	0.8	<100
SB0	2	2.5	0.25	23	0.2	6	2.2	<1	5.3	2.8	<2	1.0	<100
SB0	2.5	3	0.59	27	0.4	7	3.2	<1	5.2	3.0	<2	1.1	<100
SB0	3	3.5	1.11	50	0.4	7	1.9	<1	6.1	3.1	<2	0.7	<100
SB0	3.5	4	1.00	49	0.4	7	1.2	<1	5.2	<2	<2	0.5	<100
SB0	4	4.5	0.83	38	0.5	8	1.1	1.1	5.8	2.0	<2	<0.5	<100
SB0	4.5	5	0.71	31	0.5	9	1.0	<1	6.9	3.3	<2	0.7	<100
SB0	5	5.5	0.64	53	0.4	12	1.0	<1	8.0	5.5	<2	0.7	<100
SB0	5.5	6	0.79	45	0.3	11	1.0	<1	7.4	4.8	<2	0.7	<100
SB0	6	6.5	0.77	45	0.3	11	1.2	<1	7.9	2.9	<2	0.7	<100
SB0	6.5	7	0.99	39	0.3	10	1.2	<1	6.3	3.0	<2	0.6	<100
SB0	7	7.5	0.88	48	0.4	12	3.6	1.4	6.7	4.9	<2	1.4	<100
SB0	7.5	8	0.68	31	0.6	12	3.4	<1	7.5	6.8	<2	1.3	<100
SB0	8	8.5	0.68	<20	0.6	12	2.5	1.2	5.8	3.1	<2	1.1	<100
SB0	8.5	9	0.54	21	0.7	14	1.9	<1	4.2	3.5	<2	1.0	<100
SB0	9	9.5	0.32	<20	0.3	16	0.7	<1	1.8	5.3	<2	0.8	100
SB0	9.5	10	0.30	<20	0.7	22	0.7	1.0	1.8	3.2	<2	1.0	140
SB0	10	10.5	0.29	<20	0.9	22	0.7	<1	1.7	<2	<2	1.0	130
SB0	10.5	11	0.29	<20	0.6	25	0.5	<1	1.9	6.4	<2	1.0	150
SB1	0	0.5											
SB1	0.5	1											
SB1	1	1.5											
SB1	1.5	2											
SB1	2	2.5											
SB1	2.5	3											
SB1	3	3.5											
SB1	3.5	4											
SB1	4	4.5											
SB1	4.5	5											
SB1	5	5.5											
SB1	5.5	6											
SB1	6	6.5											
SB1	6.5	7											
SB1	7	7.5											

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Appendix 2-11

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB1	7.5	8											
SB1	8	8.5											
SB1	8.5	9											
SB1	9	9.5											
SB1	9.5	10											
SB1	10	10.5											
SB1	10.5	11											
SB2	0	0.5											
SB2	0.5	1											
SB2	1	1.5											
SB2	1.5	2											
SB2	2	2.5											
SB2	2.5	3											
SB2	3	3.5											
SB2	3.5	4											
SB2	4	4.5											
SB2	4.5	5											
SB2	5	5.5											
SB2	5.5	6											
SB2	6	6.5											
SB2	6.5	7											
SB2	7	7.5											
SB2	7.5	8											
SB2	8	8.5											
SB2	8.5	9											
SB2	9	9.5											
SB2	9.5	10											
SB2	10	10.5											
SB2	10.5	11											
SB3	0	0.5											
SB3	0.5	1											
SB3	1	1.5											
SB3	1.5	2											
SB3	2	2.5											
SB3	2.5	3											
SB3	3	3.5											
SB3	3.5	4											

Appendix 2-12

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB3	4	4.5											
SB3	4.5	5											
SB3	5	5.5											
SB3	5.5	6											
SB3	6	6.5											
SB3	6.5	7											
SB3	7	7.5											
SB3	7.5	8											
SB3	8	8.5											
SB3	8.5	9											
SB3	9	9.5											
SB3	9.5	10											
SB3	10	10.5											
SB3	10.5	11											
SB4	0	0.5	0.15	27	0.5	5	1.2	<1	4.4	<2	<2	<0.5	<100
SB4	0.5	1	0.17	30	0.3	5	1.2	<1	4.8	2.1	<2	0.7	<100
SB4	1	1.5	0.17	<20	0.3	5	1.4	<1	4.2	<2	<2	0.7	<100
SB4	1.5	2	0.19	28	0.4	5	1.5	<1	4.1	<2	<2	0.7	<100
SB4	2	2.5	0.29	26	0.3	5	1.5	<1	4.1	3.6	<2	0.6	<100
SB4	2.5	3	0.39	<20	0.4	6	2.1	<1	4.8	4.1	<2	0.9	<100
SB4	3	3.5	0.54	46	0.5	11	2.7	<1	7.5	4.0	<2	1.0	100
SB4	3.5	4	0.61	39	0.4	12	2.3	<1	8.4	5.1	<2	0.9	100
SB4	4	4.5	0.58	46	0.6	13	2.4	1.3	9.2	4.4	<2	1.4	100
SB4	4.5	5	0.59	51	0.5	15	3.5	1.2	10.1	13.5	<2	1.4	<100
SB4	5	5.5	0.66	54	0.5	16	4.2	1.6	9.9	19.7	<2	1.6	110
SB4	5.5	6	0.64	43	0.6	15	3.1	<1	9.6	15.5	<2	1.2	110
SB4	6	6.5	0.78	41	0.5	13	2.8	1.0	9.6	10.5	<2	1.2	<100
SB4	6.5	7	0.78	41	0.6	14	2.8	1.2	10.2	15.1	<2	1.3	100
SB4	7	7.5	0.92	43	1.0	13	1.7	<1	7.4	8.7	<2	1.1	<100
SB4	7.5	8	0.94	27	2.0	16	1.2	<1	4.6	10.1	8	1.2	<100
SB4	8	8.5	1.01	38	2.2	17	1.1	<1	3.9	13.1	11	1.4	<100
SB4	8.5	9	0.95	32	2.6	18	1.4	<1	3.4	10.8	12	1.5	<100
SB5	0	0.5											
SB5	0.5	1											
SB5	1	1.5											
SB5	1.5	2											
SB5	2	2.5											

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB5	2.5	3											
SB5	3	3.5											
SB5	3.5	4											
SB5	4	4.5											
SB5	4.5	5											
SB5	5	5.5											
SB5	5.5	6											
SB5	6	6.5											
SB5	6.5	7											
SB5	7	7.5											
SB5	7.5	8											
SB5	8	8.5											
SB5	8.5	9											
SB5	9	9.5											
SB5	9.5	10											
SB6	0	0.5											
SB6	0.5	1											
SB6	1	1.5											
SB6	1.5	2											
SB6	2	2.5											
SB6	2.5	3											
SB6	3	3.5											
SB6	3.5	4											
SB6	4	4.5											
SB6	4.5	5											
SB6	5	5.5											
SB6	5.5	6											
SB6	6	6.5											
SB6	6.5	7											
SB6	7	7.5											
SB6	7.5	8											
SB7	0	0.5	0.16	33	0.3	6	1.4	<1	5.1	<2	<2	0.7	<100
SB7	0.5	1	0.18	25	0.3	6	1.5	<1	4.9	2.7	<2	0.8	<100
SB7	1	1.5	0.17	29	0.4	5	1.4	<1	4.3	2.2	<2	0.6	<100
SB7	1.5	2	0.26	24	0.3	5	1.5	<1	4.1	5.0	<2	0.6	<100
SB7	2	2.5	0.36	32	0.4	5	1.7	<1	4.2	3.5	<2	0.7	<100
SB7	2.5	3	0.58	33	0.4	7	2.4	1.2	5.1	4.0	<2	0.9	<100

Appendix 2-14

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB7	3	3.5	0.62	48	0.4	12	3.3	<1	7.5	6.8	<2	1.3	110
SB7	3.5	4	0.55	43	0.7	11	1.1	<1	7.9	4.6	<2	0.6	<100
SB7	4	4.5	0.51	39	0.5	13	1.1	<1	8.0	3.9	4	0.7	<100
SB7	4.5	5	0.53	37	0.6	14	1.1	<1	9.0	4.9	<2	0.7	100
SB7	5	5.5	0.60	34	0.5	13	1.0	<1	8.5	8.9	<2	0.6	100
SB7	5.5	6	0.63	59	0.6	14	3.3	<1	7.9	17.5	<2	1.7	100
SB7	6	6.5	0.49	49	1.3	13	5.7	<1	5.7	6.3	<2	1.6	100
SB7	6.5	7	0.36	44	1.8	15	2.3	1.3	4.1	4.7	<2	1.5	<100
SB7	7	7.5	0.34	47	1.9	19	2.3	<1	5.1	4.1	6	1.9	<100
SB7	7.5	8	0.29	32	2.1	18	2.1	<1	4.9	5.1	<2	1.8	<100
SB8	0	0.5											
SB8	0.5	1											
SB8	1	1.5											
SB8	1.5	2											
SB8	2	2.5											
SB8	2.5	3											
SB8	3	3.5											
SB8	3.5	4											
SB8	4	4.5											
SB8	4.5	5											
SB8	5	5.5											
SB8	5.5	6											
SB8	6	6.5											
SB8	6.5	7											
SB8	7	7.5											
SB8	7.5	8											
SB9	0	0.5	0.18	31	0.5	6	1.3	<1	5.2	<2	<2	0.7	<100
SB9	0.5	1	0.15	28	0.3	5	1.4	<1	4.9	2.1	<2	0.8	<100
SB9	1	1.5	0.14	<20	0.3	5	1.5	<1	4.2	2.5	<2	0.6	<100
SB9	1.5	2	0.19	24	0.2	5	1.8	<1	4.7	3.0	<2	0.8	<100
SB9	2	2.5	0.39	38	0.3	7	2.5	<1	5.1	3.6	<2	1.0	<100
SB9	2.5	3	0.57	39	0.4	9	3.8	1.2	7.3	6.9	<2	1.4	<100
SB9	3	3.5	0.55	44	0.5	11	1.5	1.1	8.1	8.4	<2	1.0	<100
SB9	3.5	4	0.54	47	0.8	14	1.2	<1	7.9	2.5	<2	0.9	100
SB9	4	4.5	0.53	53	0.4	15	1.1	1.0	8.0	3.4	<2	0.6	100
SB9	4.5	5	0.57	40	0.4	14	1.0	<1	7.7	5.6	<2	0.5	110
SB9	5	5.5	0.51	43	1.5	14	1.5	1.4	7.5	5.9	<2	0.9	100

Appendix 2-15

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB9	5.5	6	0.50	51	2.6	13	3.1	<1	6.1	5.3	10	1.6	120
SB9	6	6.5	0.44	79	2.2	16	3.3	1.1	6.2	4.9	6	2.0	110
SB9	6.5	7	0.33	59	1.7	18	3.3	1.1	6.1	5.3	13	2.1	<100
SB9	7	7.5	0.25	47	1.4	14	2.8	<1	5.3	2.1	26	1.9	<100
SB10	0	0.5											
SB10	0.5	1											
SB10	1	1.5											
SB10	1.5	2											
SB10	2	2.5											
SB10	2.5	3											
SB10	3	3.5											
SB10	3.5	4											
SB10	4	4.5											
SB10	4.5	5											
SB10	5	5.5											
SB10	5.5	6											
SB11	0	0.5											
SB11	0.5	1											
SB11	1	1.5											
SB11	1.5	2											
SB11	2	2.5											
SB11	2.5	3											
SB11	3	3.5											
SB11	3.5	4											
SB11	4	4.5											
SB11	4.5	5											
SB11	5	5.5											
SB11	5.5	6											
SB12	0	0.5											
SB12	0.5	1											
SB12	1	1.5											
SB12	1.5	2											
SB12	2	2.5											
SB12	2.5	3											
SB12	3	3.5											
SB12	3.5	4											
SB12	4	4.5											

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Appendix 2-16

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB12	4.5	5											
SB12	5	5.5											
SB13	0	0.5											
SB13	0.5	1											
SB13	1	1.5											
SB13	1.5	2											
SB13	2	2.5											
SB13	2.5	3											
SB13	3	3.5											
SB13	3.5	4											
SB13	4	4.5											
SB13	4.5	5											
SB13	5	5.5											
SB13	5.5	6											
SB14	0	0.5	0.19	29	0.5	6	1.4	<1	5.3	<2	<2	0.7	<100
SB14	0.5	1	0.24	31	0.4	7	1.6	<1	5.2	<2	<2	0.7	<100
SB14	1	1.5	0.23	34	0.3	6	1.6	<1	5.4	<2	<2	0.8	<100
SB14	1.5	2	0.28	33	<0.2	7	1.7	<1	5.1	2.7	<2	0.7	<100
SB14	2	2.5	0.31	37	0.4	7	2.0	<1	5.4	3.3	3	0.8	<100
SB14	2.5	3	0.47	29	0.5	7	2.5	<1	5.2	3.5	<2	1.0	<100
SB14	3	3.5	0.57	36	0.4	8	3.0	<1	6.3	4.1	<2	1.1	<100
SB14	3.5	4	0.90	41	0.7	8	4.6	<1	7.0	4.9	<2	1.3	<100
SB14	4	4.5	0.78	28	0.4	9	2.5	1.1	6.4	7.0	<2	0.9	<100
SB14	4.5	5	1.90	58	0.4	5	2.2	<1	5.3	4.5	<2	0.9	110
SB14	5	5.5	3.48	41	0.4	4	2.8	2.1	6.5	3.7	<2	1.2	140
SB14	5.5	6	2.65	64	0.4	4	4.0	<1	5.7	3.0	<2	1.4	130
SB15	0	0.5											
SB15	0.5	1											
SB15	1	1.5											
SB15	1.5	2											
SB15	2	2.5											
SB15	2.5	3											
SB15	3	3.5											
SB15	3.5	4											
SB15	4	4.5											
SB15	4.5	5											
SB15	5	5.5											

Appendix 2-17

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB15	5.5	6											
SB16	0	0.5											
SB16	0.5	1											
SB16	1	1.5											
SB16	1.5	2											
SB16	2	2.5											
SB16	2.5	3											
SB16	3	3.5											
SB16	3.5	4											
SB16	4	4.5											
SB16	4.5	5											
SB16	5	5.5											
SB16	5.5	6											
SB16	6	6.5											
SB16	6.5	7											
SB17	0	0.5	0.16	26	0.4	6	1.3	<1	5.0	<2	<2	0.6	<100
SB17	0.5	1	0.21	28	0.3	7	1.6	<1	5.7	<2	<2	0.7	<100
SB17	1	1.5	0.32	27	0.3	7	1.6	<1	5.2	2.8	<2	0.7	<100
SB17	1.5	2	0.28	22	0.3	6	1.7	<1	4.9	<2	3	0.8	<100
SB17	2	2.5	0.36	28	0.3	6	1.7	<1	4.6	<2	<2	0.8	<100
SB17	2.5	3	0.47	39	0.3	6	2.3	<1	4.3	2.8	2	0.8	<100
SB17	3	3.5	0.62	50	0.3	10	3.4	<1	7.6	2.6	<2	1.2	<100
SB17	3.5	4	0.56	35	0.6	11	2.0	<1	7.6	4.8	<2	1.1	<100
SB17	4	4.5	0.46	43	0.7	14	2.9	<1	6.0	5.2	5	1.2	<100
SB17	4.5	5	0.60	52	0.9	14	3.2	<1	5.6	5.9	12	1.0	<100
SB17	5	5.5	0.68	52	0.7	11	2.7	<1	5.0	7.2	3	1.0	<100
SB17	5.5	6	0.83	64	1.3	15	3.7	<1	7.0	4.5	4	1.3	110
SB18	0	0.5											
SB18	0.5	1											
SB18	1	1.5											
SB18	1.5	2											
SB18	2	2.5											
SB18	2.5	3											
SB18	3	3.5											
SB18	3.5	4											
SB18	4	4.5											
SB18	4.5	5											

Appendix 2-18

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB18	5	5.5											
SB18	5.5	6											
SB19	0	0.5											
SB19	0.5	1											
SB19	1	1.5											
SB19	1.5	2											
SB19	2	2.5											
SB19	2.5	3											
SB19	3	3.5											
SB19	3.5	4											
SB19	4	4.5											
SB19	4.5	5											
SB19	5	5.5											
SB19	5.5	6											
SB20	0	0.5											
SB20	0.5	1											
SB20	1	1.5											
SB20	1.5	2											
SB20	2	2.5											
SB20	2.5	3											
SB20	3	3.5											
SB20	3.5	4											
SB20	4	4.5											
SB20	4.5	5											
SB20	5	5.5											
SB20	5.5	6											
SB21	0	0.5											
SB21	0.5	1											
SB21	1	1.5											
SB21	1.5	2											
SB21	2	2.5											
SB21	2.5	3											
SB21	3	3.5											
SB21	3.5	4											
SB21	4	4.5											
SB21	4.5	5											
SB21	5	5.5											

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Appendix 2-19

Hole # Unit	From m	To m	Na %	Rb ppm	Sb ppm	Sc ppm	Sm ppm	Ta ppm	Th ppm	U ppm	W ppm	Yb ppm	Zn ppm
SB22	0	0.5	0.13	30	0.5	5	1.1	<1	4.8	2.9	<2	0.5	<100
SB22	0.5	1	0.15	28	0.3	7	1.5	<1	5.4	<2	<2	0.7	<100
SB22	1	1.5	0.16	<20	0.3	6	1.7	<1	5.0	<2	<2	0.8	<100
SB22	1.5	2	0.27	<20	0.4	5	2.1	<1	4.1	2.1	<2	0.8	<100
SB22	2	2.5	0.41	25	0.4	7	2.5	1.2	5.5	<2	<2	1.1	<100
SB22	2.5	3	0.49	27	0.4	9	2.8	<1	6.7	3.0	<2	1.2	<100
SB22	3	3.5	0.74	47	0.5	11	2.3	<1	7.6	3.2	<2	1.0	<100
SB22	3.5	4	0.64	35	<0.2	10	1.2	<1	7.5	3.4	<2	0.7	<100
SB22	4	4.5	0.55	83	0.5	14	1.8	<1	8.2	4.7	<2	0.7	<100
SB22	4.5	5	0.78	117	0.5	15	2.9	<1	8.8	7.2	<2	1.1	<100
SB22	5	5.5	0.46	152	0.5	16	3.2	1.7	8.5	4.0	<2	1.0	<100
SB22	5.5	6	1.41	150	0.6	18	4.3	<1	9.4	6.9	<2	1.4	110
SB23	0	0.5											
SB23	0.5	1											
SB23	1	1.5											
SB23	1.5	2											
SB23	2	2.5											
SB23	2.5	3											
SB23	3	3.5											
SB23	3.5	4											
SB23	4	4.5											
SB23	4.5	5											
SB23	5	5.5											
SB23	5.5	6											
SB24	0	0.5											
SB24	0.5	1											
SB24	1	1.5											
SB24	1.5	2											
SB24	2	2.5											
SB24	2.5	3											
SB24	3	3.5											
SB24	3.5	4											
SB24	4	4.5											
SB24	4.5	5											
SB24	5	5.5											
SB24	5.5	6											
SB24	6	6.5											