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THE DISTRIBUTION OF GOLD AND OTHER ELEMENTS IN SOILS AT THE GRANNY SMITH GOLD DEPOSIT, WESTERN AUSTRALIA

M.J. Lintern and C.R.M. Butt

CRC LEME OPEN FILE REPORT 53

October 1998

(CSIRO Division of Exploration Geoscience Report 385R, 1993.
Second impression 1998)

CRC LEME is an unincorporated joint venture between The Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining, established and supported under the Australian Government's Cooperative Research Centres Program.

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RESEARCH ARISING FROM CSIRO/AMIRA REGOLITH GEOCHEMISTRY PROJECTS 1987-1993

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" (1987-1993) 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 included 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. 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.

Although the confidentiality periods of the research reports have expired, the last in December 1994, they have not been made public until now. Publishing the reports through the CRC LEME Report Series is seen as an appropriate means of doing this. By making available the results of the research and the authors' interpretations, it is hoped that the reports will provide source data for future research and be useful for teaching. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authorisation 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.

This report (CRC LEME Open File Report 53) is a Second impression (second printing) of CSIRO, Division of Exploration Geoscience Restricted Report 385R, first issued in 1993, which formed part of the CSIRO/AMIRA Project P241.

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FRONTISPIECE

Entrance to the Goanna Pit at Granny Smith showing the hardpan and underlying saprolite. Profile 1 is 6.5m in height and is located to the right hand side of the photograph.

PREFACE

Research in the earlier phase of this Project (AMIRA Project P241) established that in the southern Yilgarn Block of Western Australia, gold is preferentially concentrated in secondary carbonates in soils. This enrichment, which appears to be active under prevailing climatic conditions, gives rise to the surface expression of gold mineralization, even where the mineralization is concealed beneath leached saprolite or transported overburden. In the northern Yilgarn Block, however, pedogenic carbonates are developed only patchily and cannot be used as an effective sample medium. The landscape is characterized instead by the widespread presence of red brown hardpans, in which the gold abundances are generally, but not always, low, and the relationship between gold concentrations in hardpan and mineralization is unclear. One of the objectives of this continuation Project (AMIRA Project P241A) has been to investigate the nature of the occurrence of gold in hardpan and, if possible, to determine the mechanism of gold dispersion where there is no pedogenic carbonate. The Granny Smith mine was selected for study because it is a major gold deposit whose surface expression is obscured by the presence of hardpan. However, it had been established that over two of the deposits, the hardpan was partly developed in residuum and some horizons were enriched in gold. Granny Smith therefore provided a relatively simple situation for study. However, it cannot necessarily be concluded that the results have a wide application until further examples are considered.

C.R.M. Butt
Project Leader
April 1993.

ABSTRACT

The distribution of Au and other elements was examined at the Granny Smith Au deposit, south of Laverton. The area is extensively covered by hardpan, which is particularly common in the northern part of the Yilgarn Craton and inland Australia. Five profiles were studied, some to 10 m depth, for textural, geochemical and mineralogical characteristics pertaining to the distribution of Au and other elements. Laboratory studies were performed to examine the nature and behaviour of Au in the soil. Selected bedrock samples were analysed for trace elements in order to determine their potential as pathfinders for Au mineralization. This study was to complement work previously performed south of the Menzies Line where a strong association was found between pedogenic carbonate and Au.

The distribution of Au at Granny Smith appears to be primarily related to the contact between transported and residual components of the hardpan and is coincident with a trend towards increasingly alkaline conditions. South of the Menzies Line, such a change of pH has no significant effect on the distribution of Au. Segregations of hardpan material from contact between the transported and residual components indicates that the matrix does not necessarily contain all the Au because some is associated with lithorelic fragments cemented within the matrix. Furthermore, there does not appear to be any general mineralogical, geochemical or textural associations of Au with other components within the profiles, although these do exist within individual profiles. Laboratory experiments indicate that some Au is associated with specific extractable phases within the soil *e.g.*, manganese oxides, organic material and soluble silica but, compared with Au that can be leached using water or iodide alone, they do not represent a highly significant fraction. Gold is generally found to be at least as soluble in water and iodide as in some soils south of the Menzies Line, but mobility in the surficial environment appears to be severely restricted due to encapsulation within the hardpan cement. Re-adsorption of dissolved Au by hardpan is possible, but is weaker than that occurring with ferruginous soils in the south.

Arsenic, W, Mo and, perhaps, Sb are associated with primary mineralization, but only As is retained at detectable concentrations in the upper regolith. Barium, Cu and Zn are weakly enriched in bedrock and are retained in the upper saprolite; however, Ba may also indicate the presence of felsic rocks, such as granodiorite, rather than mineralization. The generally low abundances of Bi, Cd, In, Pb, Se and Ag in primary mineralization eliminate them as potential pathfinder elements.

The work highlights the problems associated with exploration for Au in areas dominated by hardpan. Further studies and examples are required before any recommendations on specific sampling procedures can be made.

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THE DISTRIBUTION OF GOLD AND OTHER ELEMENTS IN SOILS AT GRANNY SMITH, WESTERN AUSTRALIA

M.J. Lintern and C.R.M. Butt.

1 INTRODUCTION

A primary objective of CSIRO-AMIRA Project 241A is to investigate the nature of the surface expression of Au mineralization in areas dominated by the occurrence of red-brown hardpan. Hardpans are silicified, near-surface horizons of the regolith, present over much of the arid interior of Australia; in Western Australia they occur north of the Menzies Line (Figure 1). They include a wide range of materials set in a siliceous red earthy matrix, having a variably coarse, laminated appearance, with characteristic dark, patchy coatings of Mn oxides (mangans) on partings. Hardpans commonly consist of detrital materials of colluvial or alluvial origin but may pass gradationally downwards into residuum, including saprolite, all cemented by silica.

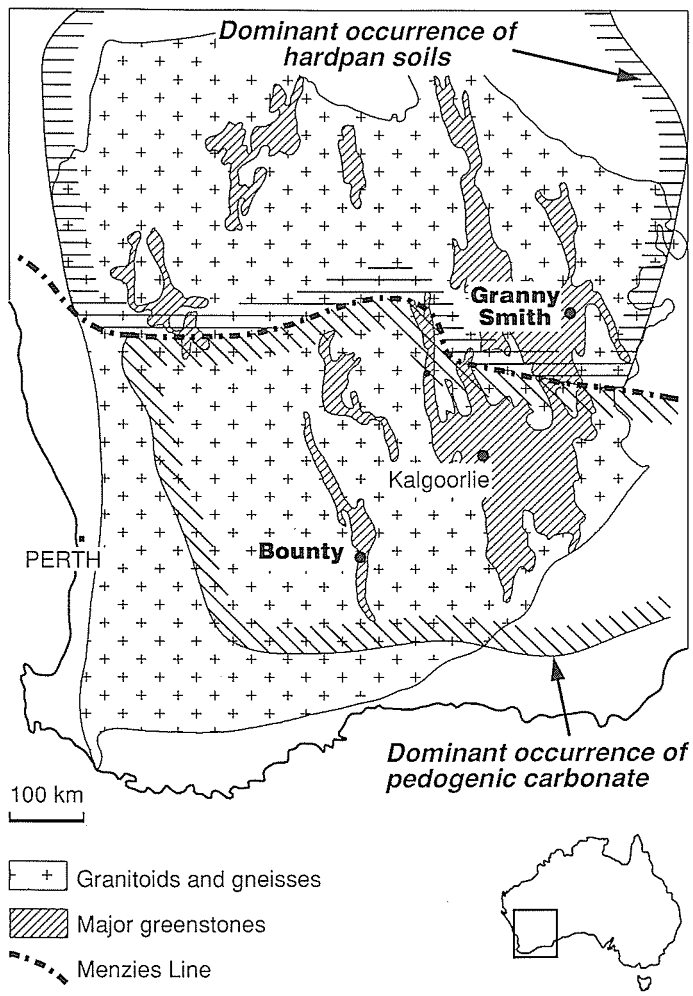

Figure 1: Map showing location of hardpan, pedogenic carbonate and Menzies Line in W.A. (Hardpan distribution after Churchward, 1983).

The formation of hardpan has been partly ascribed to climatic conditions. It is most probably formed by deposition of silica, during temporary waterlogging of the first few metres of the soil profile, following periods of heavy convectional rainfall and flooding during warm to hot months (Teakle, 1936; Litchfield and Mabbutt, 1962; Stace *et al.,* 1968; Brewer *et al.,* 1972). The widespread nature of the hardpan at shallow depths beneath actively eroding and aggrading surfaces is evidence that the hardpan is still forming under the present climate conditions.

Mobilization of both Ca and Au also occurs in the northern half of the Yilgarn Block. However, Ca is not reprecipitated in the soil as surficial pedogenic carbonate, as in the southern Yilgarn, but forms massive valley calcretes in major drainages. In contrast, the red-brown hardpans are abundant and, in effect, the silica cement substitutes for the carbonates as a soil evaporite mineral. The fate of Au is uncertain. Previous and on-going studies (CSIRO-AMIRA Projects P241 and P241A) have demonstrated the active nature of Au dispersion under present climatic conditions. This is particularly evident in the southern half of the Yilgarn Block, where Au concentrates with pedogenic carbonates (calcite and dolomite), commonly in the top metre of the regolith. Such concentrations give a superjacent Au anomaly above Au mineralization even where the soil is developed in transported overburden and/or there is a substantial leached or depleted zone. The mobility of Au and Ca is suspected to be associated with evapotranspiration, with precipitation as a response to a solubility front in the soil, and is confined to sites where the carbonates are emplaced in the soil. No other ore-related elements appear to be associated with the carbonates.

The distinction between the southern and northern halves of the Yilgarn Block is not restricted to soil type. Other differences between north and south of the Line include groundwater salinity and acidity, rainfall (volume, frequency and seasonality), air temperatures and evaporation rates (Butt *et al.*, 1977)[1]. These factors are, in part, inter-related, for example, acacias are generally more tolerant of the hotter drier climate than eucalypts.

Initial discussions with personnel from Placer (G.C. Hall and S.J. Hunt, personal communications, 1992) indicated that there was some enrichment of Au in the surface horizons. Specifically, there appeared to be (i) a patchy and unreliable geochemical signal in unconsolidated soil above the hardpan, (ii) little Au occurring in the top part of the hardpan but (iii) an *anomalous zone at the base of the hardpan*, beneath which was a saprolite zone low in Au until the main body of mineralization.

The specific aims of the research were to determine:

1. whether Au is concentrated in any, or part, of the soil profile;
2. whether Au is associated with a particular mineral phase;
3. the relationship between Au in the soil and hardpan and the underlying mineralization;
4. whether other ore-related elements are present in the soil and hardpan profiles;
5. the probable mechanism of Au mobilization;
6. optimum sampling procedures for hardpan-covered areas.

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[1] The "Line" was first recognized by Moore in 1894 (Moore, 1898) and marks a vegetation boundary between acacia and eucalypts and was termed the Mulga Line. Moore travelled by camel train from Southern Cross to Siberia and then to Goongarrie (30 degrees south) at which point the change in vegetation was noticed. Gardner (1942) confirms this location. The boundary has more recently been referred to as the "Menzies Line" although the "Goongarrie Line" is probably historically more correct.

Accordingly, the procedure adopted in the study has been to:

1. log and sample in detail the hardpan profile directly overlying mineralization, continuing into underlying saprolite and mineralization; sample intervals as close as 10 cm were necessary, allowing the opportunity of sampling individual horizons, structures and cementing phases;
2. hand pick individual samples into different phases;
3. determine distributions of Au and a range of major and trace elements;
4. investigate element distributions in terms of profile structure and mineralogy of specific materials;
5. investigate the use of partial extraction techniques as a means of determining the origin of Au in the soil and hardpan.

2 SITE DESCRIPTION

2.1 Regional and local geology

The Granny Smith Au deposit is 25 km south of Laverton and lies on a major structural corridor on which several other Au deposits are located (Figure 2). The regional and local geology have been described by Hallberg (1983) and Hall and Holyland (1990). The Granny Smith deposit comprises three ore zones (Figure 2):

(i) *Goanna*. Mineralization occurs in a shear zone trending NNW and dips 50° E with a strike length of at least 1 km and thickness that varies between 5 and 20 m. The host rocks are sediments (including BIF), which are weathered to depths of up to 80 m.

(ii) *Grannys*. Grannys is 1.5 km south of Goanna and mineralization occurs as a shallow sub-horizontal blanket along the contact between a granodiorite intrusion and overlying sediments and rocks. The contact is sheared and brecciated. The shear has a strike length of 600 m, is up to 500 m wide, 15 to 40 m thick and dips 25° E. The depth of oxidation is highly variable, ranging from 10 to 80 m. A higher grade zone exists in the upper part of mineralization. Located 1.5 km to the south of Goanna.

(iii) *Windich*. Located 0.8 km south of Grannys, Windich is buried beneath at least 5 m of colluvium/alluvium. The deposit has not yet been fully defined but is estimated to be 400 m long, 150 m wide and 30 m thick with a dip of 10° E.

The proved and probable reserve is estimated to be 12.22 million tonnes at 1.69 ppm Au (Gold Gazette, 8th Feb 1993). At the time of commencement of study, Goanna and Grannys were being mined and Windich further evaluated.

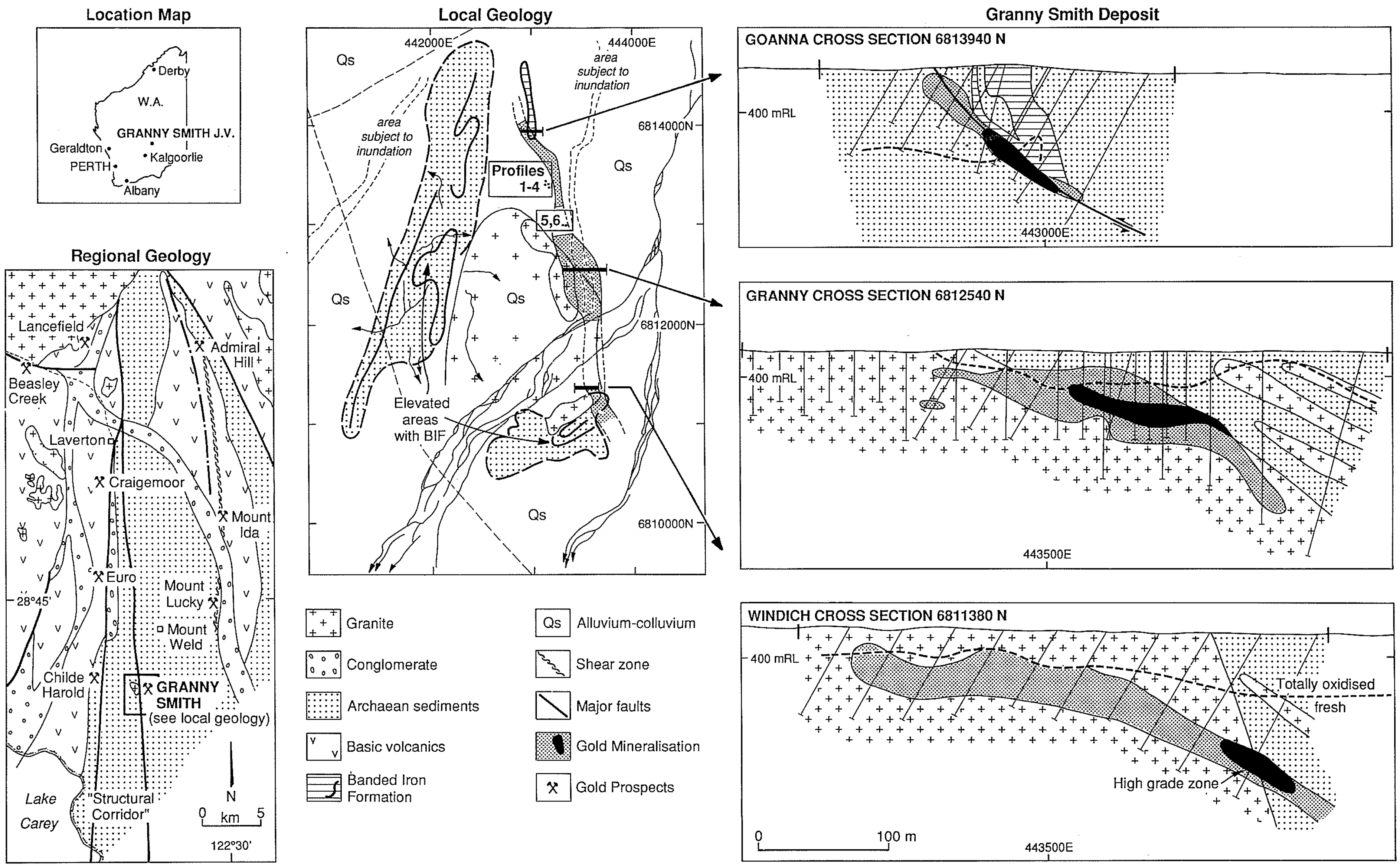

Figure 2: Regional and local geology of the study area (after Hallberg (1983); Hall and Holyland (1990). The locations of the soil profiles studied in detail are shown. Sections are through Goanna, Grannys and Windich showing the Au mineralization (redrawn from data from Placer Exploration Ltd).

2.2 Topography and vegetation

The land surface is essentially flat lying and consists of colluvium and alluvium at about 410 m AHD, with two hills of BIF rising above the surrounding plain. The higher hill (465 m) lies to the west of the Grannys zone and the smaller (430 m) to the south of the Windich zone, flanking the floodplain. Deeper gullies drain the flanks of the higher hill.

Drainage consists of a series of small tributaries with an approximate north south orientation draining into a major tributary (Windich Creek) to the south. All tributaries flow sporadically after heavy rainfall that falls principally during summer months. Windich Creek flows south and bifurcates around the lower hill and ultimately enters Lake Carey, 10 km to the south-west. Windich Creek is a floodplain consisting of anastomosing smaller creeks bordered in places by a series of regular sandy dunes running perpendicular to the drainage line (wandarrie[2] banks). The present drainage has been modified by pit construction and tailings dams. The groundwater is saline being about 50000 TDS at Grannys about 50,000 TDS increasing with depth and towards Windich Creek (about 200,000 TDS).

2.3 Vegetation

Vegetation is open scrub (dense along creek lines) consisting primarily of mulga (*Acacia aneura*) with a sparse understorey of *Cassia*, *Eremophila* and *Kochia*. The paucity of vegetation is not unusual for this area and is largely due to overgrazing by sheep (Milewski, 1992), and the presence of soils that are generally poor in essential plant nutrients (N, Ca, K, P), and which have a high ratio of Na to K and Ca.

2.4 Regolith

The upper portion of the regolith consists of three horizons, unconsolidated soil or topsoil, hardpan and brecciated saprolite:

Topsoil. Gravelly, unconsolidated shallow sandy acidic colluvium varying in thickness from a few centimetres to nearly a metre. The gravels consist of coarse polymictic clasts, including BIF, ferruginous nodules and quartz.

Hardpan. Red brown, indurated colluvium and residual clays several metres thick having a variable sub-texture consisting of laminated and blocky units with occasional friable segregations. In the upper portion, mangans, manganiferous nodules and Mn staining are common. Calcareous segregations occur towards the base of the hardpan. The hardpan commonly grades into brecciated saprolite with depth.

Saprolite. This consists of sub-angular clasts of weathered bedrock in a groundmass of red-brown clays, locally mottled ochre, red and/or orange. The upper saprolite, to a depth of at least 9m, is commonly calcareous. Carbonates (calcite) are dispersed through the clay-rich matrix as clasts and also form veins and segregations. The abundance of carbonate is surprising, since little is found within the first few metres as occurs with pedogenic carbonate south of the Menzies Line. The saprolite below 10m was expected to be poor in secondary carbonate, as reported for other saprolites in the region.

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[2] A native term to describe sand dunes on alluvial plains.

3 SAMPLING, PREPARATION and ANALYSIS

3.1 Sampling

Soil profiles (Figure 2) were sampled as close to mineralization as possible, and limited by safe access using a 10 m ladder. Five profiles sites were selected from existing vehicle ramps into the Goanna and Grannys deposits. Profiles were cleaned, photographed and described prior to sample collection. Samples were taken at 0.5 m intervals or where a textural change was noted, by collecting spoil dislodged by hammering. The unconsolidated soil at the surface was checked for contamination but none was evident. Sample weight was generally about 2 kg where possible. However, considerable difficulty was experienced in sampling the hardpan horizon, so whole blocks of material weighing several kg were frequently taken for later processing. Profiles 1 to 4 were selected from Goanna; profile 1 was taken on the eastern side of the ramp, and profiles 2, 3 and 4 from the western side. Profile 3 and 4 were taken from the first berm; profile 2 was located on the second berm directly below profile 3 and to the south of profile 4. Profiles 3 and 4 were estimated to be along strike. Profiles 5 and 6 were from the north face of Grannys, east of a mineralized unit. Profile 2 is considered to be part of Profile 3 (as 3-2) and Profile 4 (as 4-2) in sections 4 and 5 below.

Samples of primary mineralization were randomly selected by P. Silversmith (Placer Exploration Ltd.), from diamond drill core located in the three ore zones. Lengths of core (up to 20 cm) were quartered, representative sub-samples were retained, and the remainder jaw crushed and pulverized.

3.2 Preparation

The profile samples were mixed and split into two portions; large blocks of hardpan were cut in half using a diamond saw. One sample half was retained for reference and the other progressively riffle split and jaw-crushed, with 100 to 150 g pulverized to less than <75 µm in a Mn steel mill. The remaining quarter split was used for separation studies.

3.3 Analysis

Samples were analysed as follows:

A. Profile and rock samples were analysed by XRF on fused glass discs, prepared from 1.6g sample mixed with 6.4g 12-22 flux (12 parts Li metaborate to 22 parts Li tetraborate), fused in Pt crucibles and cast into 40mm diameter discs, using an automated fusion machine. The discs were analysed on a Philips PW1480 XRF using the standard Philips X40 software :
Al, Ca, Fe, K, Mg, Na, S, and Si.

B. Profile and rock samples were analyzed by XRF using self-supporting pressed discs and 0.5% PVA glue (reported as XRF.p) by the methods of Norrish and Chappell (1977) and Hart (1989), with Fe determined for matrix correction (CSIRO) using a Philips PW 1200C:
Ag, As, Ba, Bi, Cd, Ce, Cl, Co, Cr, Cs, Cu, Ga, Ge, In, La, Mn, Mo, Nb, Nd, Ni, P, Pb, Rb, Sb, Sc, Se, Sr, Ti, V, W, Y, Zn and Zr.

C. Profile samples (30 g) were analyzed for Au by INAA (Becquerel Laboratories Pty. Ltd.). Rock samples were analyzed for Au by fire assay (Placer Exploration Ltd.).

D. Mineralogy of selected samples was determined by X-ray diffractometry (XRD), with CuKα radiation at 40kV and a graphite crystal monochromator using a Philips PW1050 Diffractometer. Minerals were determined by comparing with in-house standard overlays and the JCPDS powder file for minerals.

3.4 Sequential extraction procedure.

The following methods were used to extract 4 phases sequentially from selected samples from profile 6.

1. Exchangeable ions: 35 mL of 1M NH_4 acetate pH 7.0 (prepared by adding NH_4 to acetic acid) was added to tubes containing 1.2 g of sample and agitated for 1 hr at room temperature. The samples were centrifuged (4000 rpm, 15 min) then decanted. The residue was washed with about 15 mL of the same reagent, centrifuged (4000 rpm, 15 min) then decanted once again. The solutions were combined, digested with *aqua regia* and made up to 50 mL for analysis. The sample was retained for the next digest.

2. Carbonate: 35 mL 1M NH_4 acetate (taken to pH 5.0) was added to the tubes and agitated for 5 hr at room temperature. The samples were centrifuged (4000 rpm, 15 min) then decanted. The residue was washed with about 15 mL of the same reagent, centrifuged (4000 rpm, 15 min) then decanted once again. The solutions were combined, digested with *aqua regia* and made up to 50 mL for analysis. The sample was retained for the next digest.

3. Tamm's acid oxalate (TAO for weakly crystalline Fe oxides): 20 mL of TAO was added and shaken for 4 hr in the dark. The sample was centrifuge (4000 rpm, 15 min) then decanted. The residue was washed with about 15 mL of 0.1 M NH_4Cl pH 7, centrifuged (4000 rpm, 15 min) then decanted once again. The solutions were combined, digested with *aqua regia* several times (to remove excess reagent) and made up to 50 mL for analysis. The sample was retained for the next digest.

4. Citrate-dithionite (for strongly crystalline Fe oxides): 35 mL 0.3 M NH_4 citrate pH 7 / 0.5 g Na dithionite was added to the centrifuge tubes and agitated at 60°C. This was repeated until all visible Fe colouration had disappeared. At completion, the sample was centrifuged (4000 rpm, 15 min) and decanted and the solutions combined. The solution was digested with *aqua regia* and made up to 50 mL for analysis; digests were repeated several times to ensure complete digestion of reagent. Elements remaining undissolved are regarded as in the resistate phase.

4 DISTRIBUTION OF GOLD

4.1 Total Gold

Gold is most abundant in the hardpan, and least abundant in the unconsolidated topsoil.

Topsoil. The Au content of the topsoil varies from 3 to 18 ppb. The greatest abundances occur in profiles 5 and 6, and may be due to the inclusion of some hardpan, since the topsoil is very shallow in both these profiles. The unusually high contents found in profile 3 (12 ppb) may be due to particulate Au from sub-cropping mineralization shed from upslope, where visible Au was found (Figure 2). The strength of the anomaly in the topsoil is very weak considering that profile 6 was located only 20 m from sub-cropping mineralization.

Hardpan. The highest Au concentrations occur in profile 6 (190 ppb at 1.25 m), which is close to sub-cropping mineralization. In profiles 3, 4 and 6, the Au maxima are close to the base of the hardpan, whereas in profiles 1 and 5 the highest Au values occur in the upper part of the hardpan, with smaller maxima lower down close to the saprolite.

Saprolite. The interface between the saprolite and the hardpan is not distinct, since the former becomes brecciated and is composed of sub-angular clasts (lithorelics) supported by a siliceous hardpan matrix; the highest Au contents of the saprolite occur closest to the contact with the hardpan and may be due to the presence of this material. The highest Au content of the saprolite occurs in profile 1 (80 ppb at 3.75 m).

There appears to be a generally weak association between Au and evaporite elements *e.g.*, Na, Cl (halite) and Ca, S (gypsum), in the topsoil and hardpan, but this does not extend into the saprolite nor does it occur in all profiles. Evaporite elements are significantly correlated (99.9%) with Au in topsoil and hardpan in profile 1 (Na and Cl, $r = 0.92$ and 0.89, respectively) and profile 2 (Na and S, $r = 0.90$ and 0.93, respectively). However, the greatest Cl concentrations occur in the saprolite with smaller maxima occurring in the hardpan, but not necessarily coincident with the maximum for Au.

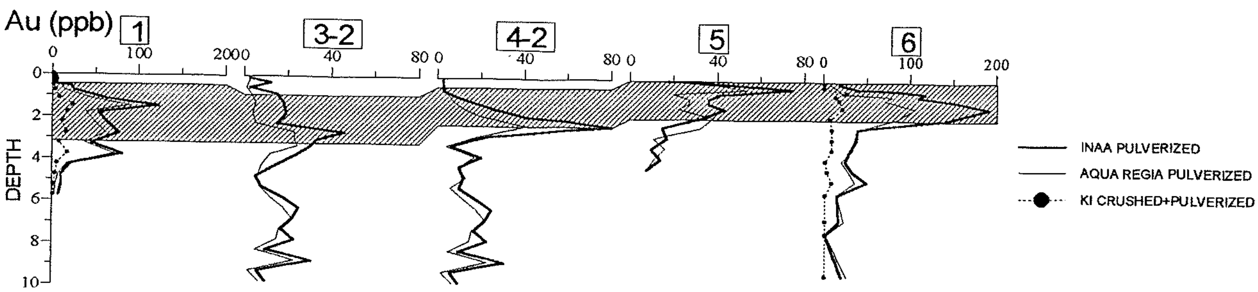

Figure 3: Gold distribution in Profiles 1-6. 0.1 M KI extractions on profile 1 and 6 only. Shading indicates approximate position of hardpan.

The strong association between Au and secondary carbonate in soils south of the Menzies Line prompted a close scrutiny of the distribution of Ca and Au at this site. Most Ca (and calcite) occurs at the top of, or within, the saprolite horizon, dispersed throughout the clay-rich matrix and as veins and concretions. However, although Au is present in some carbonate segregations (Table 3), there is no obvious relationship between the distributions of Au and Ca. *The results* *suggest that the carbonate horizon does not represent a zone of Au accumulation and is, therefore, not a good exploration sampling target (see Discussion);* some Au, however, is found in the carbonate segregations (Table 3). The accumulation of Au (except in profiles 5 and 6), appears to be related to the change of pH and the appearance of the carbonate, but it is not clear whether this relationship is one of cause and effect, or just coincidental (Figure 4).

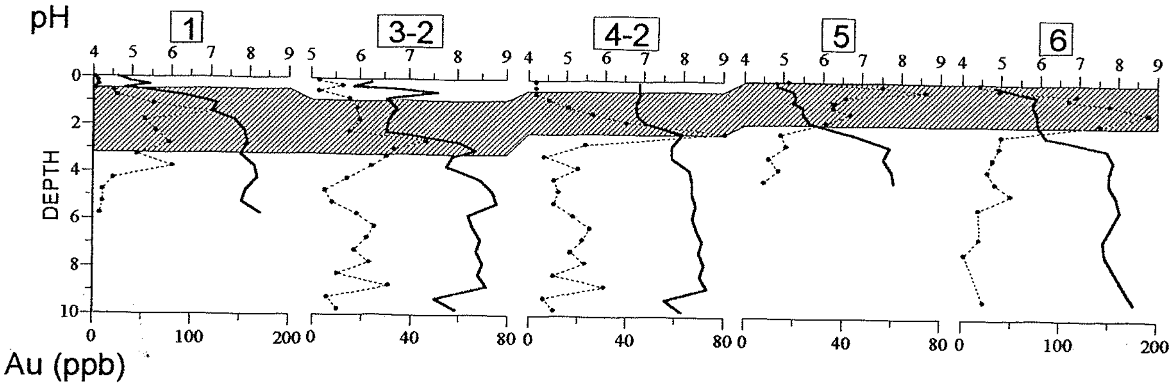

Figure 4: Gold (dashed) and pH (solid) distributions in profiles 1-6. Shading indicates approximate position of hardpan.

4.2 Selective and partial extractions.

4.2.1 Introduction

A series of partial and selective extraction experiments was performed on selected profiles to investigate the potential mobility of Au within the soil. The mobility of Au is determined by several factors, including grain size, degree of encapsulation, chemical form, and scavenging properties of the soil. The most mobile Au probably occurs as organic complexes, colloids or even as extremely fine grains. The least mobile Au is likely to be as coarse, encapsulated grains. The results of this type of experiment cannot determine the form of Au present in the soil, but may provide useful information on the processes involved in dispersion of Au away from the primary source.

A technique was developed that enabled the total amount of Au dissolved (before any Au had reprecipitated on to soil components) to be determined, and to be compared with Au that had been given the opportunity to readsorb. The two procedures are named and outlined below:

(1) gross soluble Au measures the total amount of soluble Au dissolved during the extraction phase;

(2) net soluble Au measures the total amount of Au dissolved and *remaining in solution*, after Au has had a chance to be re-adsorbed by soil particles.

Differences in the extraction by the two procedures indicate the scavenging capabilities of the soil, although this was not systematically investigated. The two techniques indicate the potential mobility and dispersion of Au in the soil. Strong reagents such as aqua regia (AR) and cyanide are powerful enough to dissolve, complex and retain Au in solution and prevent re-adsorption in most cases, whilst weaker reagents, such as water and iodide, are much less capable. Consequently, care should be taken when comparing results from different treatments.

4.2.2 Aqua regia partial extractions

All profile samples were analysed by INAA (total) and aqua regia/AAS (partial) techniques using 25-30 g of sample. Comparing analytical data for aqua regia v INAA indicates a considerable proportion (up to 47 % in profile 6) of Au present in hardpan is occluded within AR-resistant matrix (Figure 3). However, Au present in the saprolite does not show this characteristic. The Au content in the topsoil is too low for meaningful comparisons to be made. The proportion of occluded Au relative to freely available Au is approximately constant for an individual profile but is different when profiles are compared. Profile 1 appears to have the lowest proportion of occluded Au and profile 6 the highest.

4.2.3 Iodide partial extractions

Iodide extractions were performed on fine (pulverized) and coarse (jaw-crushed) profiles 1 and 6 samples. Briefly, 25 g of sample was digested in 50 mL of 0.1M KI solution saturated in $NaHCO_3$ at pH 7.5 for 24 hours; the digest was centrifuged and the supernatant liquid analysed by ICPMS. The results suggest that, for fine samples, Au has a similar distribution trend as for AR and INAA results but with an overall lower availability/solubility (Figure 5 a and b). A maximum of 25 to 30% of total Au was extracted, which is similar to the proportion from carbonate-rich material from the Bounty gold deposit soil profiles. The Au distribution shown by extractions of coarse and fine fractions are similar for profile 1, but is different in profile 6 where (i) more Au was extracted from the fine fractions of hardpan and (ii) more Au was extracted from the coarse samples of saprolite. At Mt. Hope, more Au was found in iodide extractions from coarse carbonate-rich samples than for fine. This suggests that in profile 6 there may be considerable re-adsorption onto saprolite and that pulverizing exposes more adsorption sites.

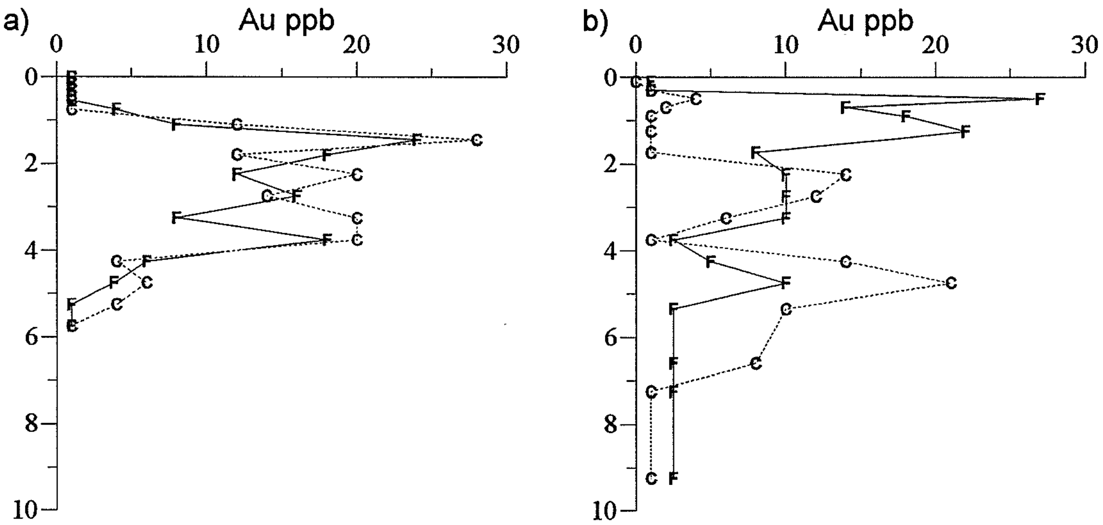

Figure 5: 0.1 M KI extractions of Au for profile 1 (a) and 6 (b) for fine (jaw crushed then pulverized), and coarse (jaw crushed only) samples.

4.2.4 Deionized water partial extractions for gross soluble Au

Profile 6 samples were reacted with deionised water (10g : 30 mL) over one week. The results indicate that a greater proportion of Au is extracted from the saprolite than hardpan (Figure 6) and that, in some saprolite samples, an astonishing near 40% of the Au is water soluble. Furthermore, there appears to be a strong association between soluble Au in the saprolite and Ca (Figure 6a). Interestingly, more Au was extracted from saprolite by deionized water (measured as gross soluble) than by iodide (measured as net soluble), even though iodide is a more powerful reagent than deionised water. This suggests Au has been re-adsorbed by constituents present in the saprolite and, under natural conditions, would not be readily chemically dispersed by soil water.

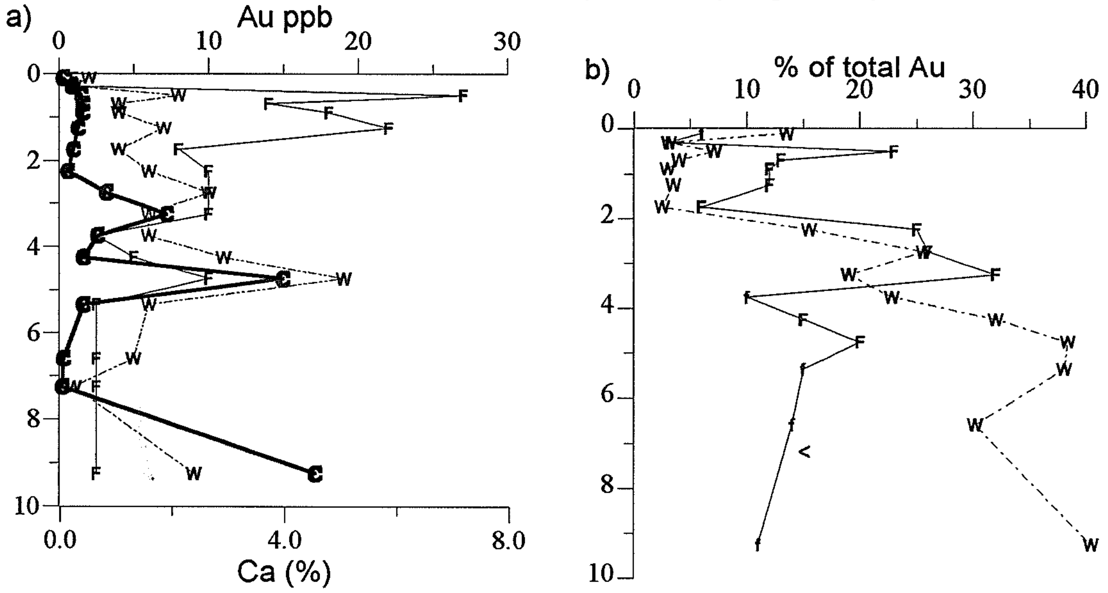

Figure 6: Comparison of gross soluble Au extractability using (i) iodide (reaction time 1 day, F), and (ii) deionised water (reaction time 1 week, W) for profile 6: (a) raw data, (b) data expressed as percentage of total Au in sample. Lower case f (in b) denotes that these values are below the detection limit. C in (a) denotes total Ca in %.

The low extractability of Au from hardpan supports the suggestion that a greater proportion of Au is immobile in the hardpan (even though pulverized) than the saprolite. The poor extractability from hardpan applies to deionised water and *aqua regia* reagents (Figure 7).

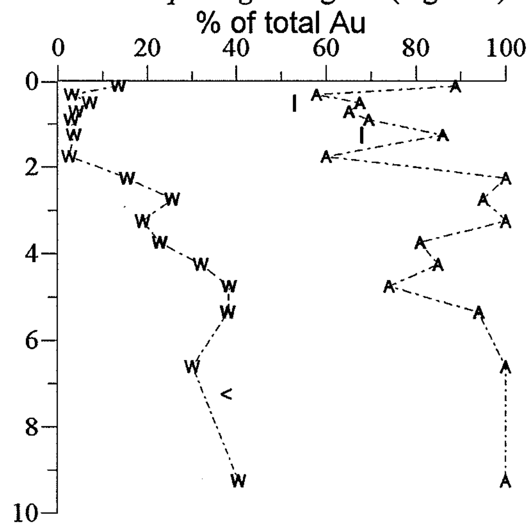

Figure 7: Percentage extraction of net soluble Au from profile 6 using deionised water (1 week, W) and normal *aqua regia* digest (A). I indicates iodide extraction of net soluble Au for two samples (1 week).

4.2.5 Selective extractions.

Several different reagents were used to investigate associations between Au and specific constituents in 6 selected soil samples (Table 1). Four samples were selected from Granny Smith and two from areas close to Au mineralization at Bounty, for comparative purposes.

Table 1: Location, description, and Mn and organic carbon concentrations of samples used in selective extractions.

Sample	*Location*	*Description*	*Mn (ppm)*	*org C (%)*
5060	Granny (profile 5, 0.4 m)	Hardpan, heavy Mn-staining	524	na
5073	Granny (profile 6, 0.5 m)	Hardpan, cemented	396	0.04
5076	Granny (profile 6, 1.25 m)	Hardpan, some Mn staining	142	0.04
5008	Goanna (profile 1, 1.45 m)	Hardpan, some saprolite, Mn.	144	0.04
1470	Bounty	Red clay, carbonate-rich	295	0.18
1251	Bounty	Laterite gravel, Fe oxide rich.	73	0.02

Samples (10 g) were boiled for two hours in 30 mL of reagent and then made up to volume and bottled rolled for one week. Gross soluble Au was measured. A duplicate set of samples had iodide (0.1M KI) added as well. The reagents used and their properties were:

(i) deionised water - to dissolve the least strongly adsorbed or most mobile Au;
(ii) hydrogen peroxide (10%) - to dissolve manganese oxides and organic material;
(iii) sodium carbonate (0.1M, pH 11) - to dissolve readily soluble silica[3]
(iv) sodium hydroxide (1M, pH 14) - to partially dissolve resistant silica and clay minerals.

In addition, a set with unboiled deionised water was included for comparative purposes. By having samples with and without iodide, supplementary information is gathered on the nature of the Au exposed by the digest. For example, a higher Au concentration with iodide would indicate that extra Au (either larger grains or different complexes) has been dissolved in addition to that dissolved by the reagent alone; no difference would indicate that no additional Au has been dissolved. The results are expressed as a percentage of total Au and summarised in Figure 8.

The results indicate that:

1. It has been shown that the gross solubility of Au is greater (sample 1251, 1470) than previously considered. This is consistent with suggestions made by Gray *et al.*, 1990 (p. 51) that Au may be re-adsorbed onto soil material.

[3] F.J. Hingston, personal communication, 1992; Litchfield and Mabbutt, 1962.

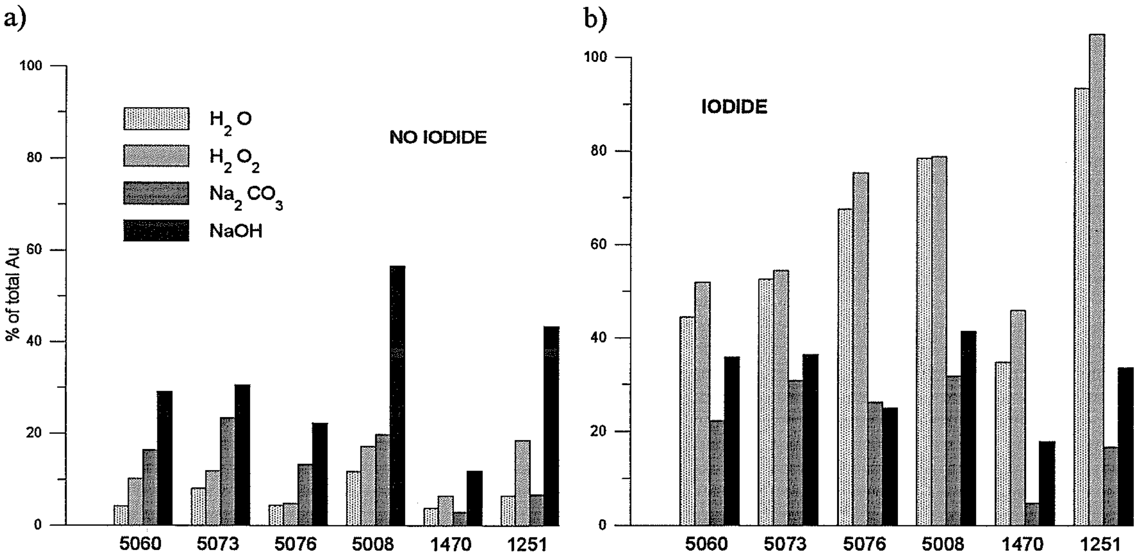

Figure 8: All digestion results using boiled extractant indicated in legend (a) without KI and (b) with KI added. All samples were bottle rolled for 1 week and gross soluble Au was measured. The location and brief sample description are given in Table 1. The unboiled water control results are summarized in Figure 9a.

2. Some Au is easily dissolved by water (Figure 9). Boiling tends to reduce the availability of Au for water alone. The reasons for this are unclear but may be due to the changed solubility of Au complexes after boiling. Iodide will dissolve more Au than water alone, hence Au remaining undissolved after iodide extraction is either even coarser, occluded or present as a relatively weakly soluble complex.

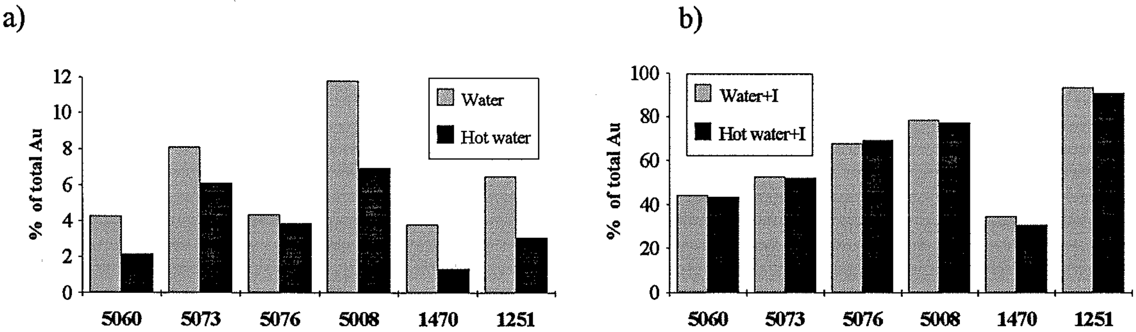

Figure 9: Hot water digestion (a) without and (b) with the addition of iodide (I). For sample description see Table 1.

The relative proportions of the different types of Au can be interpolated from the differences observed between (i) water and (ii) water-with-iodide extractions:

a) the highest proportion of highly soluble (water) Au is:
hardpan/laterite> carbonate (5008 > 5073 > 1251 > 5076 > 5060 > 1470).
b) the highest proportion of medium soluble (iodide) Au is:
laterite > hardpan > carbonate (1251 > 5008 > 5076 > 5073 > 5060 > 1470).
c) the highest proportion of weakly soluble Au is:
carbonate > hardpan > laterite (1470 > 5060> 5073> 5076 > 5008 > 1251).

3. Samples selectively dissolved with peroxide consistently released more Au than those without, indicating that some minor amounts (<10%) of Au are associated with organic matter or Mn oxides in the hardpan (Figure 10). However, the proportion of Au does not appear to be related to the concentration of Mn or organic C. The Fe-rich sample (1251) has the least Mn and organic C of all the material tested yet has the most available Au after peroxide digest (16%). Little extra Au was extracted after the addition of iodide to the peroxide digest compared with the water with iodide extraction, which suggests that most of the additional Au made available after peroxide digest is water soluble (Figure 10b). These results are similar to sequential digests (H_2O_2 then CN^-) on hardpan samples (see section 5.4).

a) b)

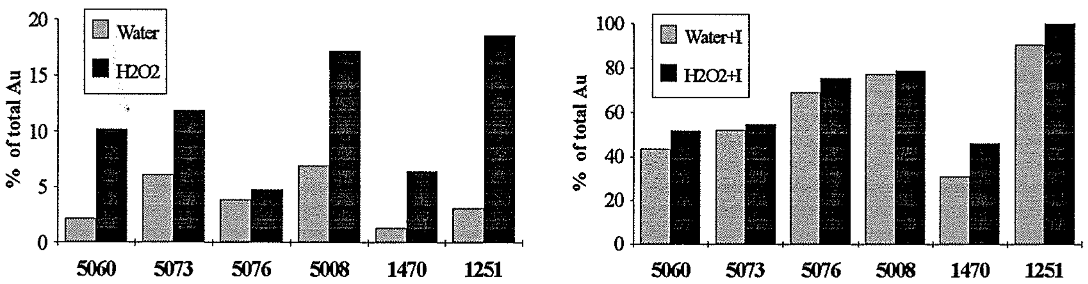

Figure 10: Peroxide digestion (a) without and (b) with the addition of iodide (I). Results expressed as a percentage of total Au.

4. Over all experiments, the highest proportion of extractable Au (approximately 100%) was for the Fe-rich sample (1251) extracted with peroxide and iodide; even without peroxide over 90% was extracted from this sample.

5. The presence of iodide has little extra effect on the solubility of Au for Na_2CO_3 and NaOH digests than with just water, which suggests that Au released by these reagents is mostly highly soluble (Figure 11). Unexpectedly, the reagents with iodide added actually extract less Au than without iodide in many cases (Figure 8). This is possibly due to:

(i) rapid adsorption of AuI_2^- onto soil under alkaline conditions, or
(ii) chemical transformation of the reagent, thereby reducing Au dissolution and/or solubility, or
(iii) the low dissolution rate of Au in alkaline iodide conditions.

The saprolite-bearing hardpan sample (5008) has the highest proportion of Au soluble in hydroxide (50 %), although some of this Au can also be leached with iodide alone. Sample 1251, Fe-rich and cemented with kaolinite, also had a significant amount of Au released by hydroxide, but contains little or no hardpan cement.

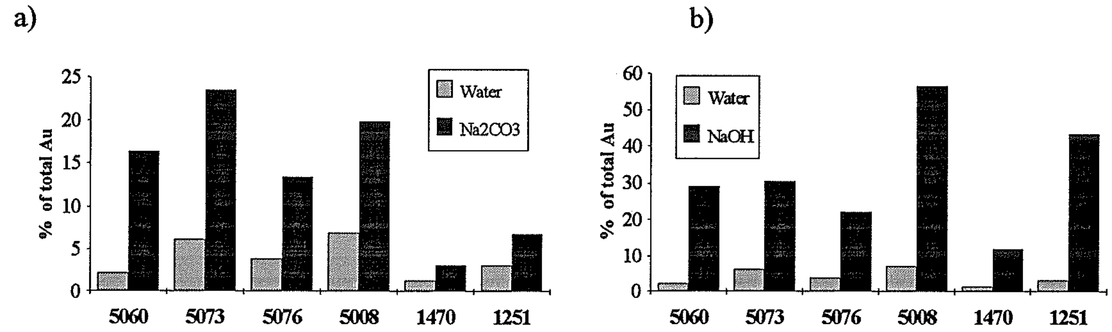

Figure 11: Sodium carbonate (a) and sodium hydroxide (b) soluble Au with no iodide present. Results expressed as a percentage of total Au.

The Na_2CO_3 extract suggests that the hardpan samples have the most Au associated with soluble silica (9 to 17%). The carbonate-rich (1470), and Fe-rich (1251) samples have little Au associated with silica.

6. The carbonate-rich sample (1470) has the lowest percentage of extractable Au by all reagents. This result is unexpected, but may due to the presence of some coarse grained Au.

4.2.6 Kinetics of gold dissolution

The kinetics of net soluble Au extraction by 0.1M KI was examined with a sequential series of batch extractions. Briefly, 25 g of three samples were digested in 50 mL of 0.1M KI solution, buffered at pH 7, over a four day period. This was repeated 5 times, with washing and drying of the sample between each series.

The results suggest that samples differ in their response to the successive additions of iodide, but it generally appears that available Au is rapidly dissolved over the first one or two extraction series for samples 5076 and 1470 but this is followed by a much slower release (Table 2). For sample 1251, the rate of Au release appears to be relatively constant. The result from a 7 day leach using iodide and measuring gross soluble Au is included for comparative purposes. The dissolution rate is particular high for the fine hardpan sample (5076) after the first treatment, and suggests that Au is readily available (although some may be initially inaccessible) and, furthermore, it is not as quickly re-adsorbed as by the Fe-oxide rich sample (1251). The low extraction for the coarse hardpan also suggests that Au is not readily accessible in this sample. The carbonate-rich soil (1470) has the highest percentage of inaccessible Au; that which is available, however, is readily dissolved and not re-adsorbed.

It appears as though an equilibrium is established between Au adsorbed onto soil material and that remaining in solution as an iodide complex:

$$AuI_2^-{}_{(aq)} \rightleftharpoons AuI_2^-{}_{(soil)}$$

OR $\rightleftharpoons Au_{(gross\ soluble)}$

Table 2: Series (1-5) of sequential 4 day iodide extractions on the same sample. After each 4 day period, the iodide solution was removed and analysed, the sample washed and dried, then a fresh iodide solution added to it. This was repeated 4 times. The last column is for a 7 day extraction and gross soluble Au is measured. Fine (f, pulverized) and coarse (c, jaw-crushed) material are compared. Results expressed as percentage of total (by INAA) Au.

Sample	*Type*	*1 (as %)*	*2 (as %)*	*3 (as %)*	*4 (as %)*	*5 (as %)*	*Gross soluble Au (as %)*
5076f	Hardpan	16	37	5	0	5	68
5076c		0	7	3	1	0	-
1251f	Fe-rich	4	4	4	4	2	93
1251c		8	5	4	4	2	-
1470f	Calcareous	16	8	6	6	5	35
1470c		22	8	2	1	1	-

4.3 Separations.

Sub-samples were hand separated from the bulk sample and sorted by type or size fraction. The two dominant sub-samples identified were "matrix" consisting largely of hardpanized (silicified) material, and "lithorelics" whose appearance had a broad similarity with the underlying saprolite. The discrimination of matrix from lithorelic is arbitrary but nominally based on texture, colour and hardness; however, microscopic investigation of the matrix reveals that lithorelics are often included within it, so that a total clean separation of the two types is rarely possible. Selected multi-element analysis was performed on the sub-samples.

For profile 1, the results indicate that Au concentrations of the matrix are *generally greater* than the lithorelics (Figure 12, Table 3), whereas, for profile 6, the Au concentration of the matrix is almost *an order of magnitude greater* than the lithorelics. However, the values are highly variable and indicate that Au is not exclusively confined to either. The <2 mm size fraction has greater Au contents than the >2 mm but is not significantly more than the bulk concentration to justify the extra effort to be useful for routine exploration sampling.

The data are interpreted to suggest that Au in the matrix for profile 1 is close to its source, probably the lithorelics with which it is intimately associated. However, for profile 6, the Au has been dispersed from the leached saprolitic material, which are thus markedly depleted in Au, or from the sub-cropping mineralization approximately 20 m to the west, before becoming cemented within the matrix. Gold present within the opaline cutans suggest mobilization and precipitation of Au (and Si) during a relatively recent modification of the matrix.

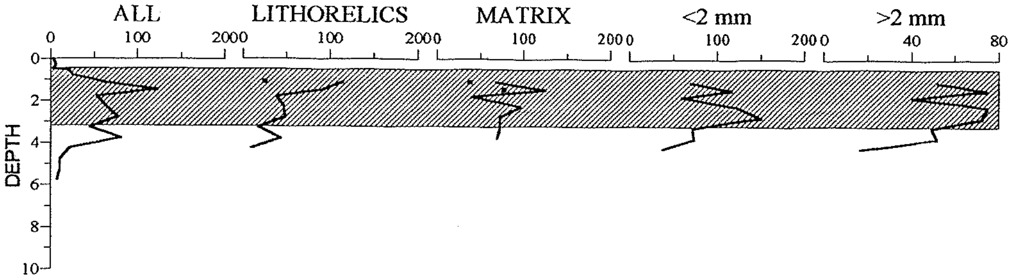

Figure 12: Gold results (ppb, INAA) for sub-samples separated from the bulk for profile 1. The black dots represent additional samples analysed. For the matrix, the black dots are from dark stained material.

Table 3: Gold contents of components separated from profiles 1 and 6. [1] opaline cutans, [2] carbonate-rich segregation. Values are in ppb.

Profile	*Depth (m)*	*Bulk (ppb)*	*Lithorelics (ppb)*	*Matrix (ppb)*	*<2 mm (ppb)*	*>2 mm (ppb)*
1	1.10	62	-	87[1]	-	-
1	1.10	62	114	68	70	52
1	1.10	62	24	38	-	-
1	1.45	123	92	76	116	74
1	1.45	-	-	124	-	-
1	1.80	53	38	39	60	40
1	2.25	64	47	96	123	75
1	2.75	78	48	72	149	72
1	3.25	45	17	72	72	49
1	3.75	81	43	69	73	52
1	4.25	21	9	-	37	16
	a.mean	*65*	*48*	*73*	*87*	*54*

Profile	*Depth (m)*	*Bulk (ppb)*	*Lithorelics (ppb)*	*Matrix (ppb)*	*<2 mm (ppb)*	*>2 mm (ppb)*
6	0.10	18	-	-	10	15
6	1.25	191	32	252	-	-
6	1.25	191	34	152	-	-
6	1.75	141	7	130	-	-
6	1.75	141	18	-	-	-
6	2.25	40	20	286	-	-
6	2.75	38	48	-	257	-
6	2.75	38	-	-	210[2]	-
	a.mean	*100*	*27*	*205*		

5 MAJOR and TRACE ELEMENTS

5.1 Aluminium

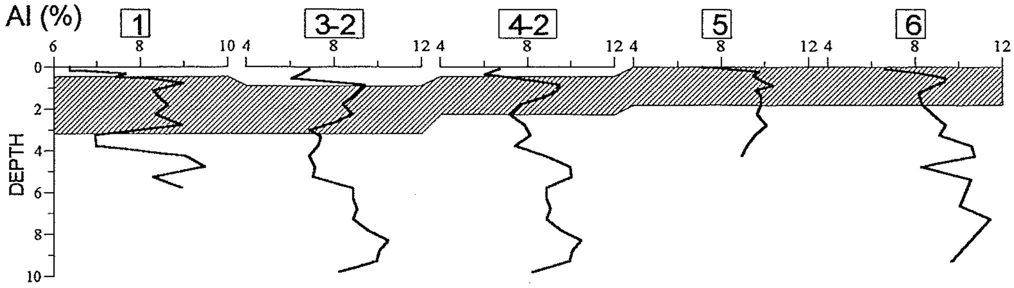

Figure 13: Aluminium distribution in profiles 1-6. Shading indicates approximate position of hardpan.

Aluminium concentrations are low in the topsoil, then increase sharply and peak in the hardpan. Directly beneath the hardpan, Al concentrations are diluted by carbonate but then increase with depth in the saprolite as the proportion of clay increases. The Al peak in the hardpan is probably an illuvial horizon that may have been formed by chemical leaching from higher in the profile and has become cemented and laminated. An alternative explanation is that clay particles have been physically translocated to form the Al-rich zone. Aluminium concentrations are similar for the matrix and lithorelic hardpan segregations.

Aluminium shows some association with Ga (Figure 14), hardpan and saprolite groups form a single trend, and the topsoil samples cluster separately. Aluminium concentrations generally increase in the saprolite with increasing K, but the generally weak agreement between the two elements indicates that most Al is probably present as kaolinite. Potassium is nearly all present in muscovite, which also increases in abundance with increasing depth.

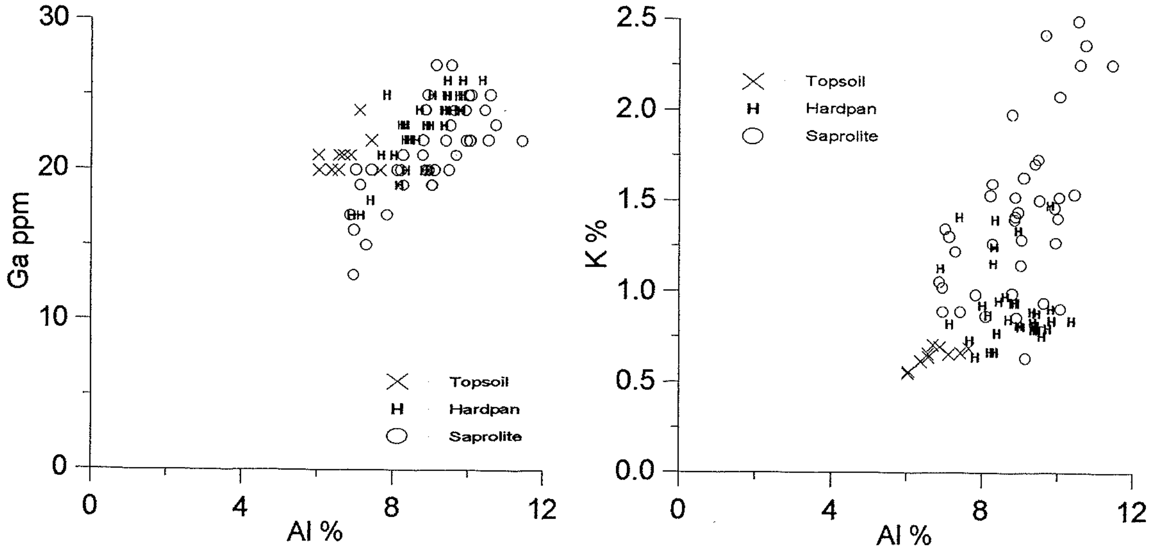

Figure 14: Binary plots of Al with Ga and K.

5.2 Silicon

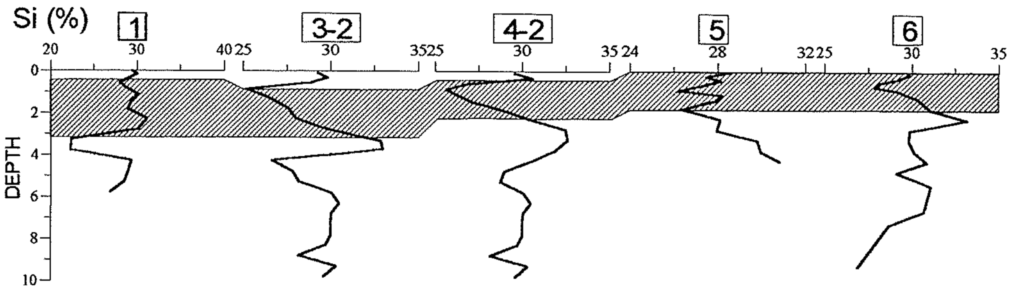

Figure 15: Silicon distribution in profiles 1-6. Shading indicates approximate position of hardpan.

Silicon concentrations are generally about 30%, although significant variations can be observed (Figure 15). Mean Si concentrations are similar for the topsoil, hardpan and saprolite. Below the sand-rich topsoil, concentrations of Si commonly decrease sharply at the top of the hardpan and then increase with depth to peak at the base of, or immediately below, the hardpan. In the saprolite, Si concentrations generally decrease with depth. Two possible explanations for this are that:

(i) the Si distribution in the hardpan may be related to an illuvial horizon similar to, but displaced below, that for Al (see opaline cutans in Table 4), or, more probably,

(ii) it is due to higher concentrations of Si associated with the increasing quantities of brecciated and partially weathered saprolite at the base of the hardpan and upper part of the saprolite.

Matrix segregated from the base of the hardpan horizon has low Si contents (Table 4) due to dilution by carbonate. Silicon is not correlated with any mineral or element.

Table 4: Silicon results (%) for profiles 1 and 6. [1] designates opaline cutans.

Profile	*Depth (m)*	*Lithorelics (%)*	*Matrix (%)*		*Profile*	*Depth (m)*	*Lithorelics (%)*	*Matrix (%)*
1	1.100	-	32.51[1]		6	0.100	-	-
1	1.100	-	29.65		6	1.250	-	30.42
1	1.100	31.83	26.98		6	1.250	33.73	30.85
1	1.450	31.87	29.56		6	1.750	33.50	31.57
1	1.450		28.98		6	1.750		-
1	1.800	29.44	28.37		6	2.250	33.09	31.52
1	2.250	31.75	30.40		6	2.750	28.63	-
1	2.750	31.68	28.50		6	2.750	-	-
1	3.250	30.64	15.46					
1	3.750	30.12	19.65			*a.mean*	*32.2*	*31.1*
1	4.250	30.71	-			*st.dev*	*2.1*	*0.5*
	a.mean	*31.0*	*26.4*					
	st.dev	*0.9*	*4.9*					

5.3 Iron

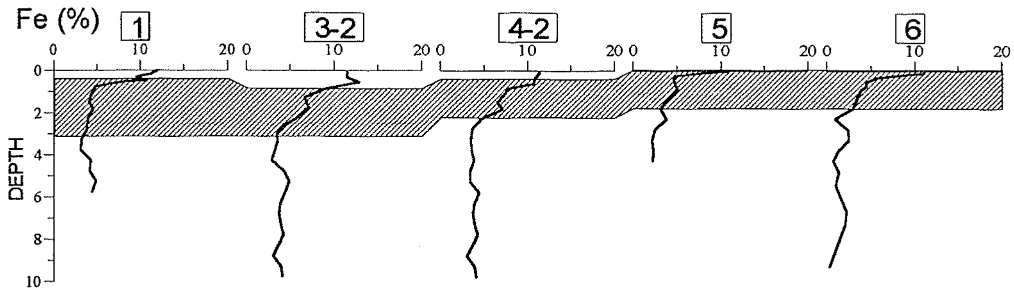

Figure 16: Iron distribution in profiles 1-6. Shading indicates approximate position of hardpan.

The distribution of Fe follows a similar pattern in all five profiles. The main feature is the high concentration in the topsoil associated with the BIF fragments. The concentration in the hardpan decreases gradually and indicates that some of the Fe has been leached (chemically or mechanically) from the unconsolidated soil into the hardpan.

Sequential extraction results (7 samples) indicate that most Fe is present as either crystalline Fe oxides (41 - 78%) or as resistate compounds (21 - 57%) (see Appendix). Amorphous Fe oxides constitute <5% of the total Fe present. The results also indicate that the crystalline and amorphous Fe and Mn oxides are important scavengers of trace elements such as Cu (up to 23%), Co (91%) and Ni (25%). It appears that Fe is also important for controlling plant growth as 42% of soil P (an essential plant nutrient), and over 50% of saprolite P is not plant-available because of its association with crystalline Fe and Mn oxides.

Several elements are statistically significantly correlated (99.9%) with Fe and include P (r= 0.80), Mn (0.70), Co (0.81), Cr (0.76), Cu (0.35), Zn (0.55) and REE. These are either adsorbed to Fe oxide minerals (at specific adsorption sites) or are even more strongly bound (ion substitution) within the crystal lattice. The associations are illustrated on binary plots (Figure 17) and indicate the correlations are generally independent of sample type for P, Zn, V, and, in part, Cu and V. There is no apparent association between As and Fe, although these elements are strongly correlated elsewhere in the Yilgarn.

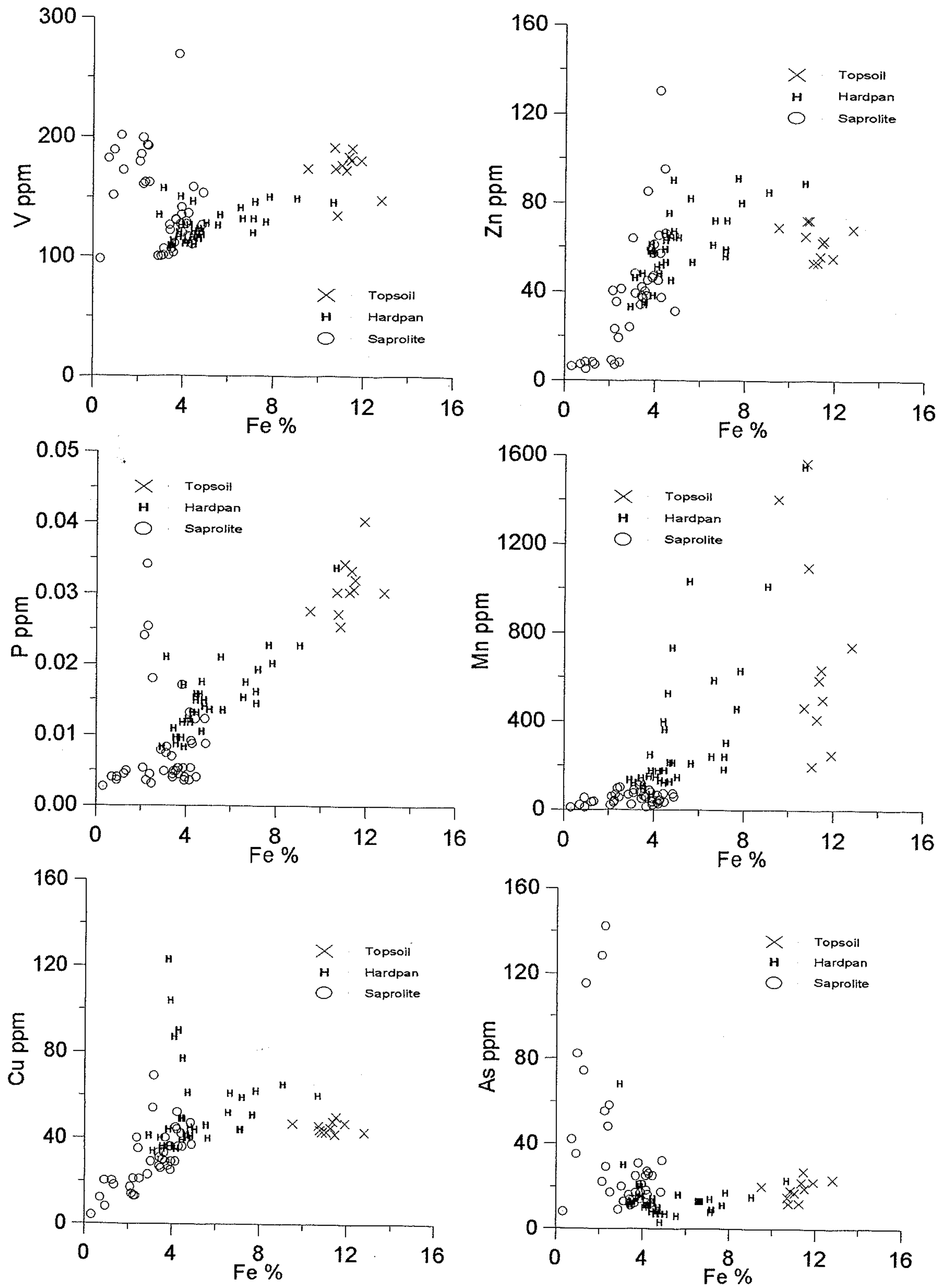

Figure 17: Binary plots of Fe with V, Zn, P, Mn, Cu and As.

5.4 Manganese

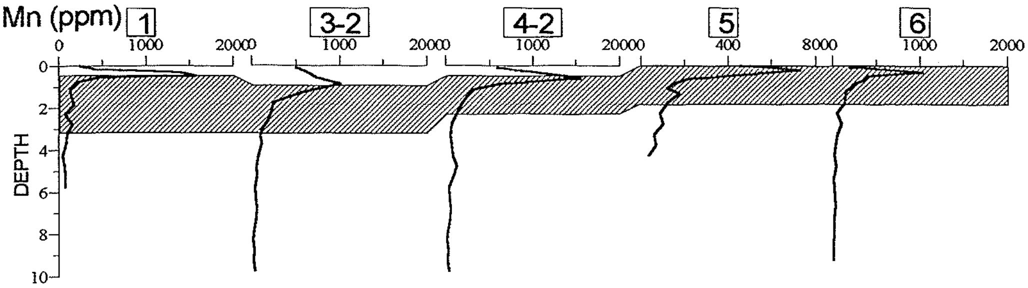

Figure 18: Manganese distribution in profiles 1-6. Shading indicates approximate position of hardpan.

Black Mn staining is a characteristic of hardpan soils. Peak Mn concentration, more than any other chemical data, best indicate the top of the hardpan for all profiles. The distribution is similar to Fe, but the maxima are displaced lower by a few tens of centimetres. Manganese is present in soils as oxides and oxyhydroxides (McKenzie, 1989), but XRD of mangans separated from the hardpan at this site has indicated the presence of poorly crystalline Mn oxides (wad). The mangans are thin, only a few microns thick in places, but highly conspicuous; analyses indicate that very little Mn is required to impart the black colouration on a sample. The formation of Mn-rich cutans and nodules in soil is not fully understood (see references in McKenzie, 1989, p452-453). However, it has been suggested that:

(i) Mn^{2+} is formed and mobilized during periods of soil waterlogging;
(ii) reduced Mn is thermodynamically unstable with respect to oxidation at pH >4, but this does not proceed quickly;
(iii) reduced Mn becomes adsorbed on existing Mn oxide surfaces by autocatalysis or on fine soil particles; alternatively, it may be oxidized (to Mn^{4+}) by $Fe(OH)_3$ with Fe^{2+} mobilization.

The distribution of Mn oxides are important since many trace elements are known to accumulate in, on or within them (see section 5.3 Iron); these include anions of weak acids (*e.g.*, molybdate, phosphate, selenite, *etc.*), weakly hydrolyzed cations (*e.g.*, Co, Cr, Cu, Ni, Pb, V, Zn; McKenzie, 1989), and actinides (Cerling and Turner, 1982). The association between Mn and Co, and Mn and Ce is partly dependant on sample type (Figure 19). It is thought that the scavenging characteristics of Mn oxides are related to their crystallinity, structure stability, large surface area to volume ratio, and the low pH of the zero-point charge (Healy *et al.*, 1966).

Manganese staining was investigated in selected samples by SEM, selective extraction, sequential extraction and by direct analysis of Mn-rich segregations. The initial experiments used hydrogen peroxide as the extractant on jaw crushed material only (Table 5); this did not dissolve a significant proportion of the total Mn from the sample, but did remove the black staining. This indicated that the "visible" Mn only constitutes about 1.5% of the total Mn. Significant amounts (relative to the amount of Mn extracted) of Au and Co were removed with peroxide suggesting some association with the coatings. Further Au was extracted by cyanide but 66 - 68% remained in the residue, indicating that the remaining Au was encapsulated. In the selective extractions reported in section 4.3.5, about 50% of Au remained undissolved after peroxide then iodide digestion on pulverized material (Figure 10b). Comparisons of XRF analyses of dark stained material (samples 5088, 5089) with adjacent material did not reveal any significant differences either with the amount of Mn or other components, except that concentrations of Mn, S, Ba and REE were slightly higher in sample 5089 compared with the bulk sample. SEM studies revealed marginally more Mn in the dark stained areas when compared with adjacent unstained areas.

Sequential extractions indicate that Mn is associated with at least five phases, with most remaining undissolved in the residue. The most significant phases containing Mn are (i) in the unconsolidated soil, the resistate phase (65%), (ii) in the hardpan, amorphous (54%) and crystalline (32%) Fe oxides, and (iii) in the saprolite, exchangeable (13%) and carbonate (29%). This trend is largely as expected and reflects the generally mobile nature of Mn in the hardpan and saprolite. The results indicate important associations of Mn with trace elements (see section 4.5.3 Iron).

Many of the trace elements are correlated more strongly with Fe and/or P, with which Mn shares a similar distribution. The binary plots (Figures 17, 25 and 29) reveal that there are at least three phases of Mn, associated with the three textural classes, although there may be overlap between the hardpan and the unconsolidated soil. The association of Mn with Fe and P may be real or coincidental. The strongest correlations occur in the hardpan.

Table 5: Sequential extractions of Mn and selected elements from jaw crushed hardpan samples 5060 and 5073 using H_2O_2 and CN^-. Results expressed as percentages of total. N.B. Little Mn is extracted even though dark staining was removed. "n.a." - sample not analysed.

Sample	*Trial*	*Treatment*	*Au (µg)*	*Au (as %)*	*Fe (as %)*	*Ni (as %)*	*Co (as %)*	*Mn (as %)*	*Ba (as %)*
5060	1	H_2O_2	0.4	5.8	0.0	0.2	1.5	1.5	0.2
		cyanide	1.8	25.9	na	na	na	na	na
		residue	4.74	68.3	*100*	*99.8*	*98.5*	*98.5*	*99.8*
	2	H_2O_2	0.34	5.9	0.0	0.2	0.8	1.3	0.2
		cyanide	1.6	27.9	na	na	na	na	na
		residue	3.805	66.2	*100*	*99.8*	*99.2*	*98.7*	*99.8*
5073	1	H_2O_2	0.54	2.0	0.0	0.7	0.8	1.7	0.2
		cyanide	8.4	30.6	na	na	na	na	na
		residue	18.5	67.4	*100*	*99.3*	*99.2*	*98.3*	*99.8*
	2	H_2O_2	0.46	2.6	0.0	0.7	0.8	1.7	0.2
		cyanide	5.4	30.5	na	na	na	na	na
		residue	11.87	66.9	*100*	*99.3*	*99.2*	*98.3*	*99.8*

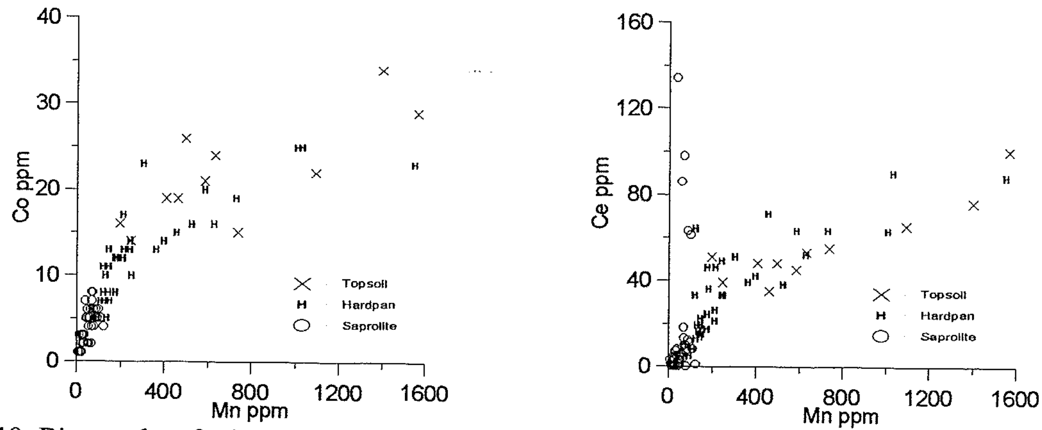

Figure 19: Binary plots for Mn with Co and Ce.

5.5 Calcium

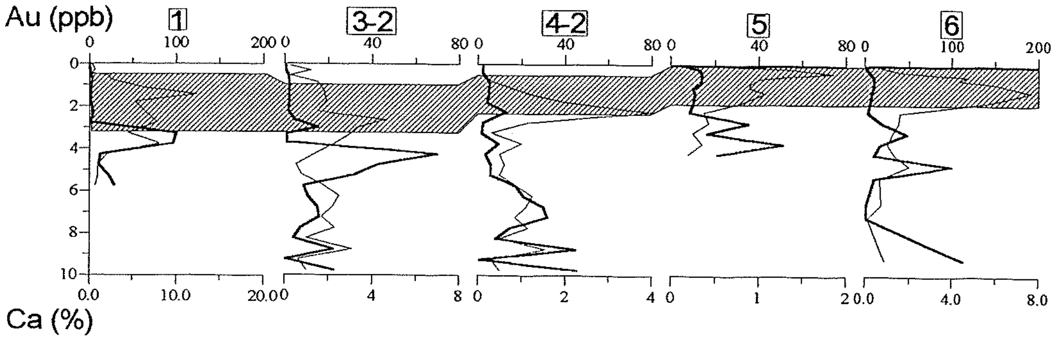

Figure 20: Calcium (thick line) and Au (thin line) distributions in profiles 1-6. Shading indicates approximate position of hardpan.

The distribution of Ca is controlled by calcite; no dolomite was detected. Concentrations are low in the unconsolidated soil and hardpan but increase markedly in the saprolite. The highest Ca concentrations are present in profiles 1 and 3, at the base of the hardpan. Field observations suggest that the carbonate in the upper part of the profile is secondary. Separations of matrix and lithorelics from the hardpan indicate that most Ca is associated with the matrix (see Appendix). There is little association between Ca and Au, except possibly in profile 5 (Figure 20, Figure 21). The poor association between these elements differs markedly with findings for south of the Menzies Line and is discussed in more detail in section 6.

Sequential extractions indicate that most Ca in unconsolidated soil and hardpan is present in exchangeable form (84%) whereas in the saprolite, most Ca is present in carbonate (17 to 68 %) or as exchangeable ions (up to 76%). Calcium and Mg show some association in the unconsolidated soil and saprolite (Figure 21), whereas in the hardpan, the amount of Mg is independent of the Ca concentration and is not associated with carbonate.

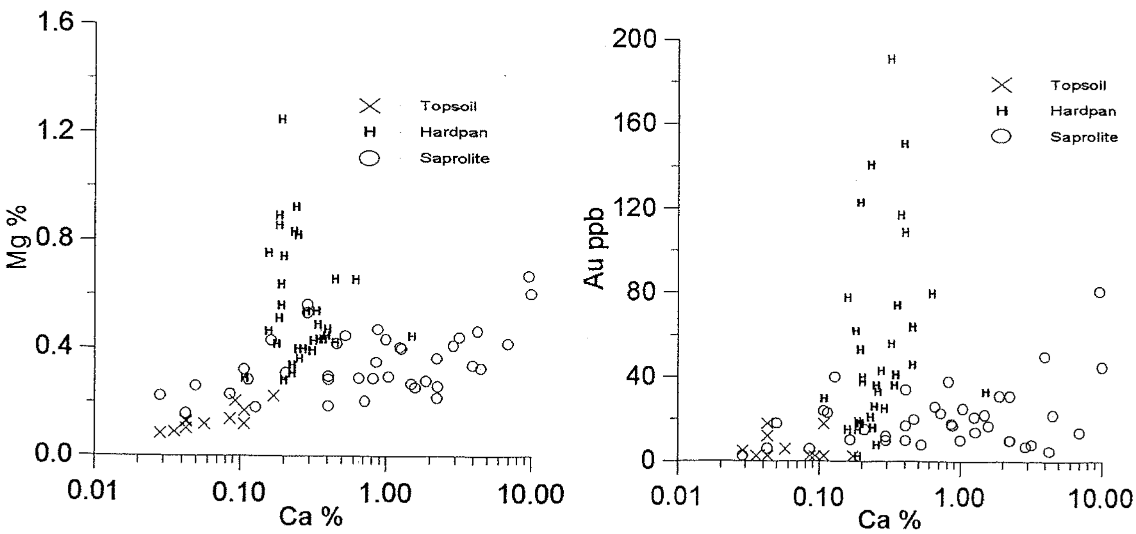

Figure 21: Selected binary plots for Ca with Mg and Au.

5.6 Magnesium

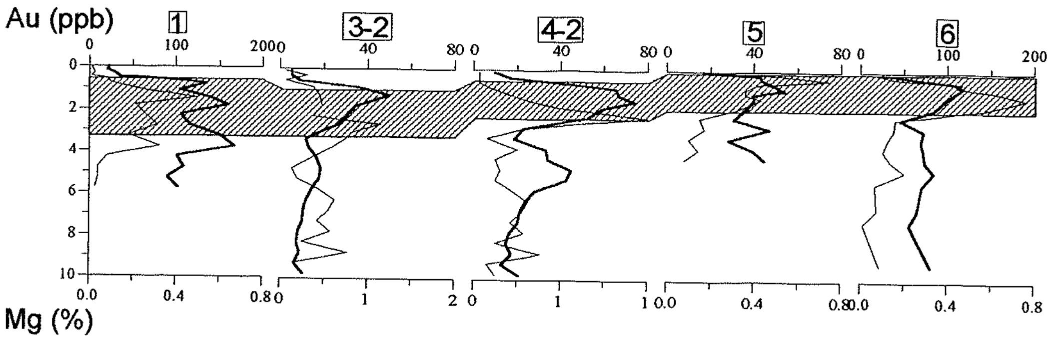

Figure 22: Magnesium (thick line) and Au (thin line) distributions in profiles 1-6. Shading indicates approximate position of hardpan.

Magnesium concentrations are very low (<1.3 %), being most abundant in the hardpan, dominantly in the matrix (Figure 22). No dolomite was detected and there is poor agreement between the distributions of Ca and Mg, a significant difference compared to the pedogenic carbonates of the southern Yilgarn. Nevertheless, sequential extractions indicate a strong relationship between Mg and Ca, although the proportion of Mg associated with resistates is much higher. There is a weak association between Mg and Ni in saprolite and hardpan (Figure 23), possibly indicating the presence of remnant ferromagnesian minerals. In Profile 6, high concentrations of Mg are associated with the highest Au concentrations (Figures 22 and 23); the significance of this is unclear and does not occur in other profiles.

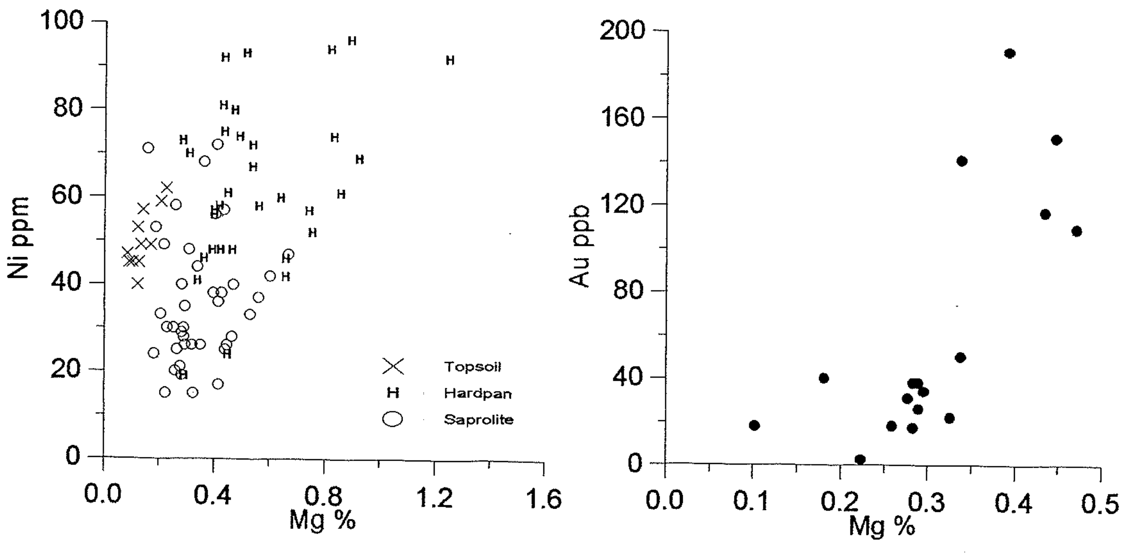

Figure 23: Binary plot for Mg with Ni, and with Au (profile 6).

5.7 Potassium

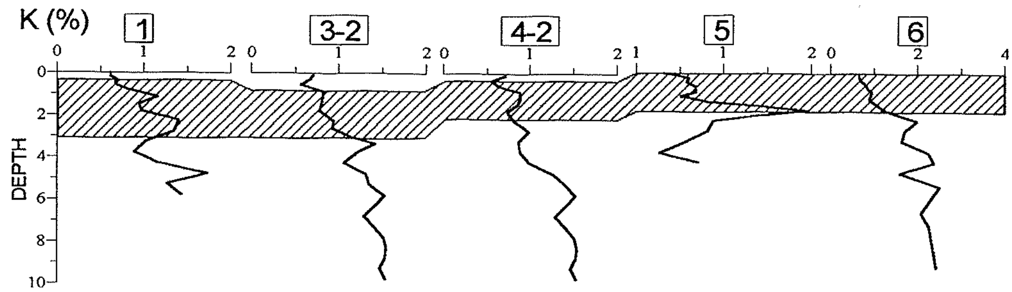

Figure 24: Potassium distribution in profiles 1-6. Shading indicates approximate position of hardpan.

The distribution of K is strongly associated with the distribution of muscovite, especially in the saprolite (Figure 25). Potassium abundance generally increases with depth in accordance with the degree of weathering. Separations from hardpan indicate that more K is associated with the lithorelics than the matrix. The "spike" of K in profile 5 is probably due to alunite. Potassium is significantly correlated (99.9%) with Rb ($r = 0.74$), although there are different populations in each horizon (Figure 25). This suggests either greater leaching of K in the saprolite, or different sources of muscovite in the hardpan and soil.

In all samples but one, little K (<5%) was dissolved during sequential extractions, indicating that most is present as chemically resistant minerals (muscovite). The exception to this was for the upper hardpan sample, which had significant K associated with all extractable phases.

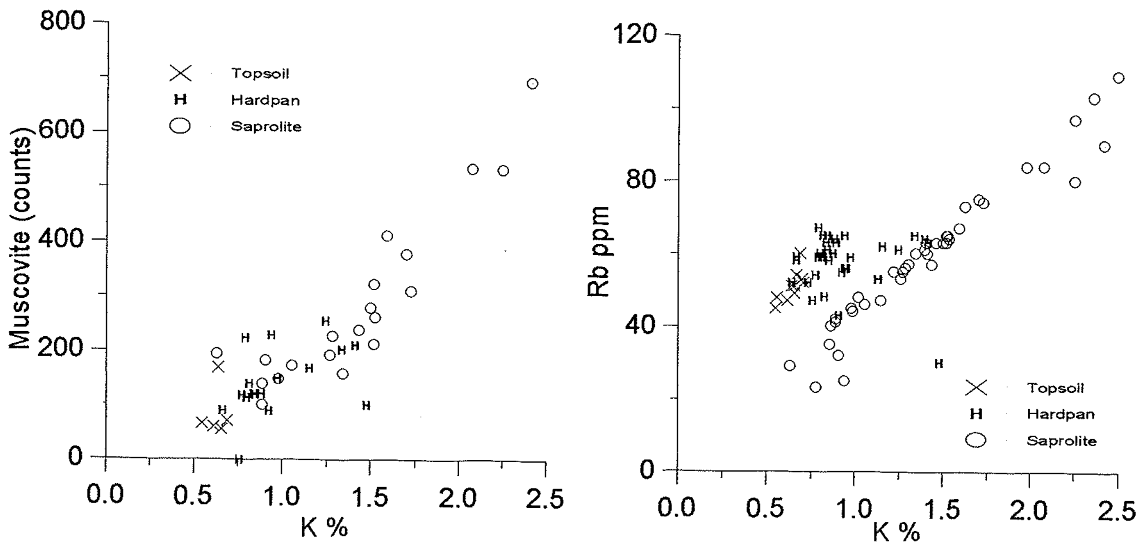

Figure 25: Binary plots showing strong relationship of K with muscovite and Rb. Muscovite "concentrations" determined from XRD peak heights at 8.72 (degrees 2θ).

5.8 Sodium

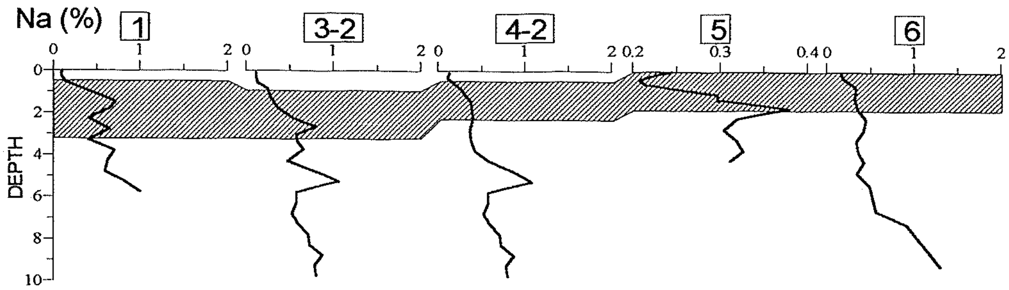

Figure 26: Sodium distribution in profiles 1-6. Shading indicates approximate position of hardpan.

Sodium concentrations increase with depth and are significantly correlated (99.9%, r = 0.63) with halite (Figure 27). Maxima in the profile curves indicates small zones of salt accumulation, which may represent conduits for percolating meteoric waters similar to, but deeper than, those for Ca. There appears to be an association between Na and S which suggest that there is an accumulation of sulphate with the halite (Figure 27). Barite has been identified in hardpan from Youanmi (Gedeon and Butt, 1989) and would not be unexpected here. Sodium is significantly correlated with pH (r = 0.7), Cl (0.87) and K (0.6).

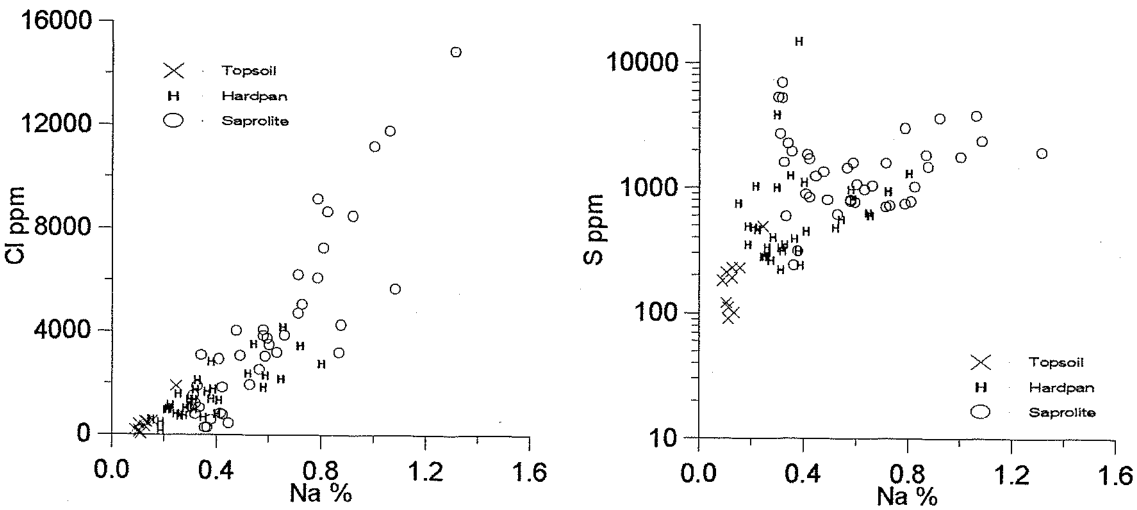

Figure 27: Binary plots for Na with Cl (indicating halite) and S (possibly indicating barite).

5.9 Phosphorus

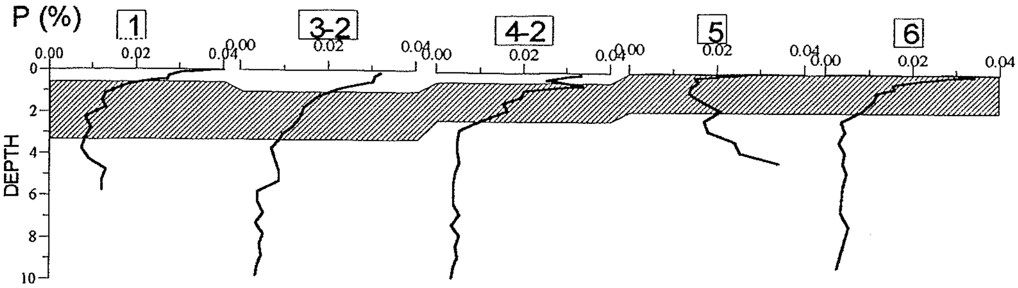

Figure 28: Phosphorus distribution in profiles 1-6. Shading indicates approximate position of hardpan.

The distribution of P follows closely that of Fe (section 5.3, Figure 17). Concentration of P is greatest in the topsoil, where it is probably associated with organic matter and Fe oxides (Figure 28). In the hardpan and saprolite, P is more closely associated with REE, probably as phosphates. Concentrations decrease sharply with depth, except in profile 5 where REE concentrations are also significantly greater. Phosphorus is significantly correlated (99.9%) with Fe (r = 0.8, see Figure 17), Mn (0.63, Figure 29) and Ce (0.82, Figure 29).

Sequential extractions indicate that P is mainly hosted by three main phases. The unconsolidated soil has the greatest (43%) proportion of exchangeable P, probably with organic matter, with the remainder associated with crystalline Fe oxides. In the hardpan and saprolite, P is associated with Fe oxides and resistate minerals.

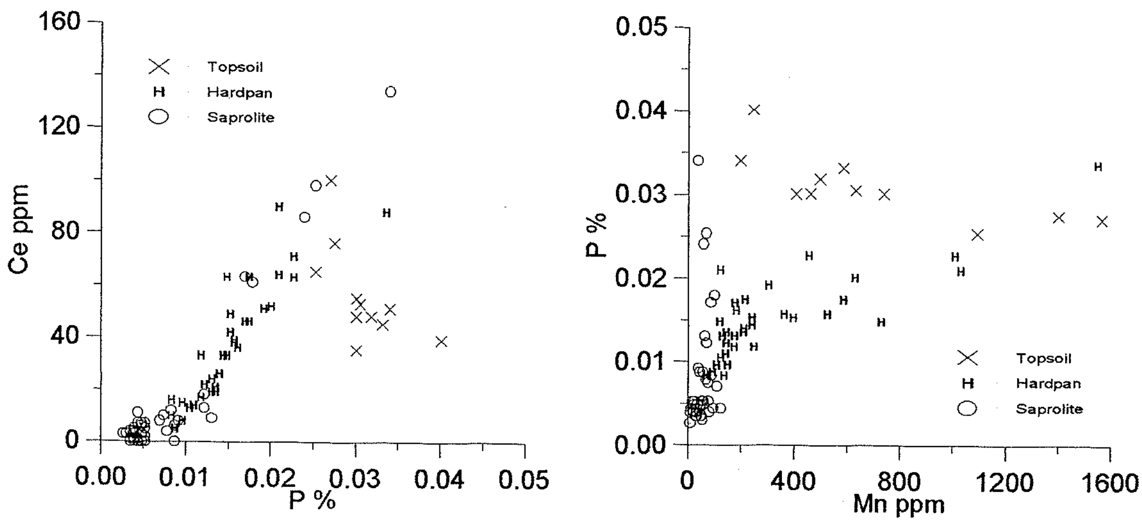

Figure 29: Binary plots for P with Ce and Mn.

5.10 Titanium

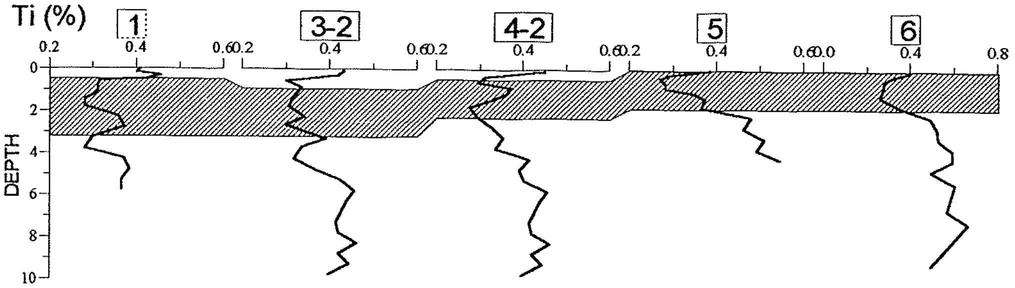

Figure 30: Titanium distribution in profiles 1-6. Shading indicates approximate position of hardpan.

In highly weathered soils, Ti and Zr concentrate through residual accumulation, as more soluble constituents are leached. However, at Granny Smith, Ti and Zr concentrations are commonly lower in the hardpan than in the unconsolidated soil or saprolite (Figure 31) and supports the contention that hardpan has been formed by introduction of constituents into the profile *e.g.*, Al and Si, thereby diluting pre-existing concentrations of these elements. High Ti concentrations in the topsoil are probably associated with resistant minerals such as rutile or anatase. Some topsoil samples are unusually low in Zr. The ratio of Ti to Zr indicates the samples have been derived from a parent having an andesitic composition (see Hallberg, 1984); bed-rock samples (including BIF, diorite and granodiorite) plot in the same broad field. There is a strong relationship between Ti and V in the lithorelic and matrix separations from hardpan (Figure 31). Vanadium commonly replaces Ti in rutile (Smithells, 1967) which is present in the samples.

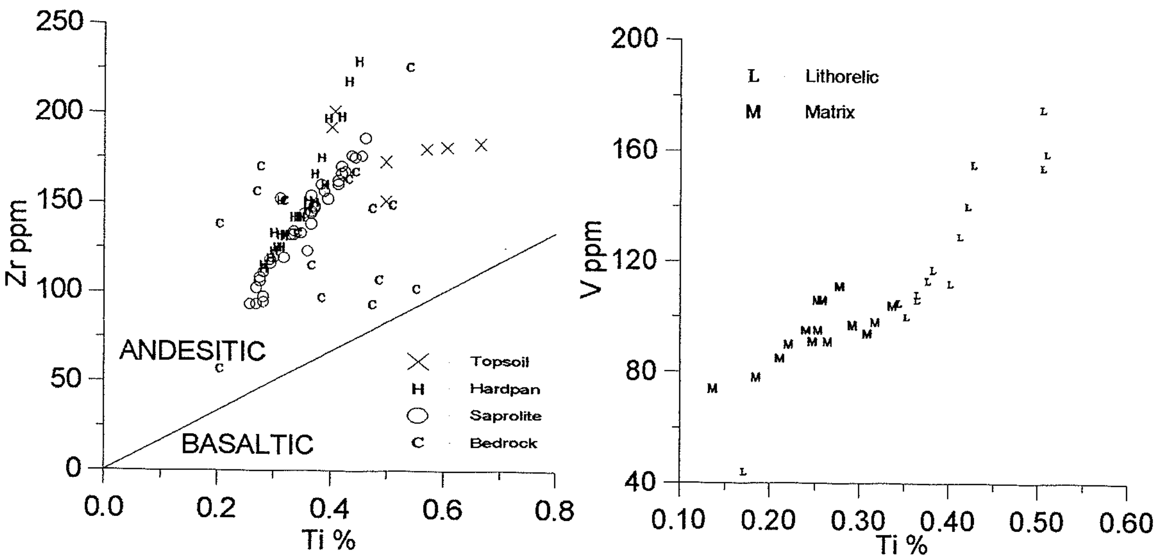

Figure 31: Binary plots for Ti with Zr and V (separations).

5.11 Trace elements associated with mineralization

Trace elements other than Au may provide either a spatially larger or a more coherent distribution pattern to indicate mineralization. A limited number of samples of primary mineralization were analysed to determine which elements, if any, were present in sufficiently high concentrations to have potential use as a pathfinder for Au. The distribution of these elements in the profiles was also determined. Bed-rock and profile results are summarized in Table 6 and Figure 32, respectively. No background samples were collected.

5.11.1 Primary mineralization

The trace element composition of the primary mineralization is summarized in Table 6. In addition to Au, the most significant enriched elements are W, Mo and, possibly, Sb. The concentration of base metals (Cu, Pb and Zn) and As are moderate to low and unlikely to be diagnostic. Copper and Zn have been detected in sulphides, whereas As appears to be strongly related to the Fe content. The Ba content is highly variable and although it may be associated with mineralization, high concentrations in felsic rocks such as granodiorite reduce its potential as a pathfinder. The concentrations of Bi, Cd, In, Se and Ag are at or below detection limits.

Table 6: Summary statistics of selected trace elements for 16 bed-rock samples. Values in ppm. Values quoted below 10 ppm (except Au) are unreliable.

Element	Mean	Std.dev	Minimum	Maximum
Antimony	3	3.4	0.5	14
Arsenic	49	77	0.5	244
Barium	490	322	68	1188
Bismuth	1	1.15	0.5	5
Cadmium	1	0.63	0.5	3
Copper	49	32	0.5	116
Gold	7.2	3.9	2.8	16.4
Indium	1	0.52	0.5	2
Lead	14	51	3	76
Molybdenum	13	17	0.5	69
Selenium	1	0.24	0.5	1
Silver	1	1.24	0.5	5
Tungsten	64	33	12	129
Zinc	156	135	23	541

5.11.2 Regolith

Arsenic. In the topsoil, As concentrations are variable and are likely to be contained within Fe segregations. Hardpan tends to be generally poor in As, although small maxima are occasionally located near the base (profiles 1, 5 and 6). Concentrations tend to increase with depth and values are greatest (142 ppm) close to mineralization (profile 6). Arsenic tends to be associated with the lithorelics in the segregations.

Tungsten. Tungsten contents are nearly always below the detection limit (5 ppm), despite the high concentrations in the primary mineralization.

Barium. Barium in the unconsolidated soil and top of the hardpan is possibly associated with the sparingly soluble mineral, barite which accumulates, like pedogenic carbonate, in semi-arid or arid regions. Particularly strong maxima are found at the top of the hardpan.

Copper. Copper is most abundant in the hardpan with concentrations decreasing with depth. Separations of matrix and lithorelic material from the hardpan indicate, however, that generally more Cu is found within the saprolite fraction. Some lithorelic samples are relatively rich in Cu (*e.g.*, 355 ppm, Profile 1, 3.75 m). Sequential extractions indicate that Cu is present in relatively labile forms. In the unconsolidated soil and top of the hardpan, Cu is mostly present in the exchangeable phase, whereas in the saprolite, it is present in the exchangeable and carbonate phases.

Zinc. Zinc distribution in the topsoil and hardpan is strongly related to the distribution of Mn. However, in the saprolite where mean Mn concentrations are relatively low (55 ppm), Zn concentrations may be greater than in the hardpan. The lithorelic sample containing high Cu also has the highest Zn for any other sample (415 ppm). These data suggest that fragments of unweathered or only slightly weathered material persist in the near-surface saprolite.

The concentrations of Bi, Cd, In, Mo, Sb and Se are at or below detection limits.

5.11.3 Summary

In summary, only W, Mo and, possibly, Sb, are sufficiently enriched in the primary mineralization to offer potential as pathfinder elements for Au. Consequently, the low W contents of the hardpan and saprolite are surprising and suggest that either W has been leached or that it is neither chemically or physically dispersed in the saprolite, hardpan or soil. Additional studies need to determine background concentrations of these elements, and to increase the number of samples both from near the surface and the bedrock.

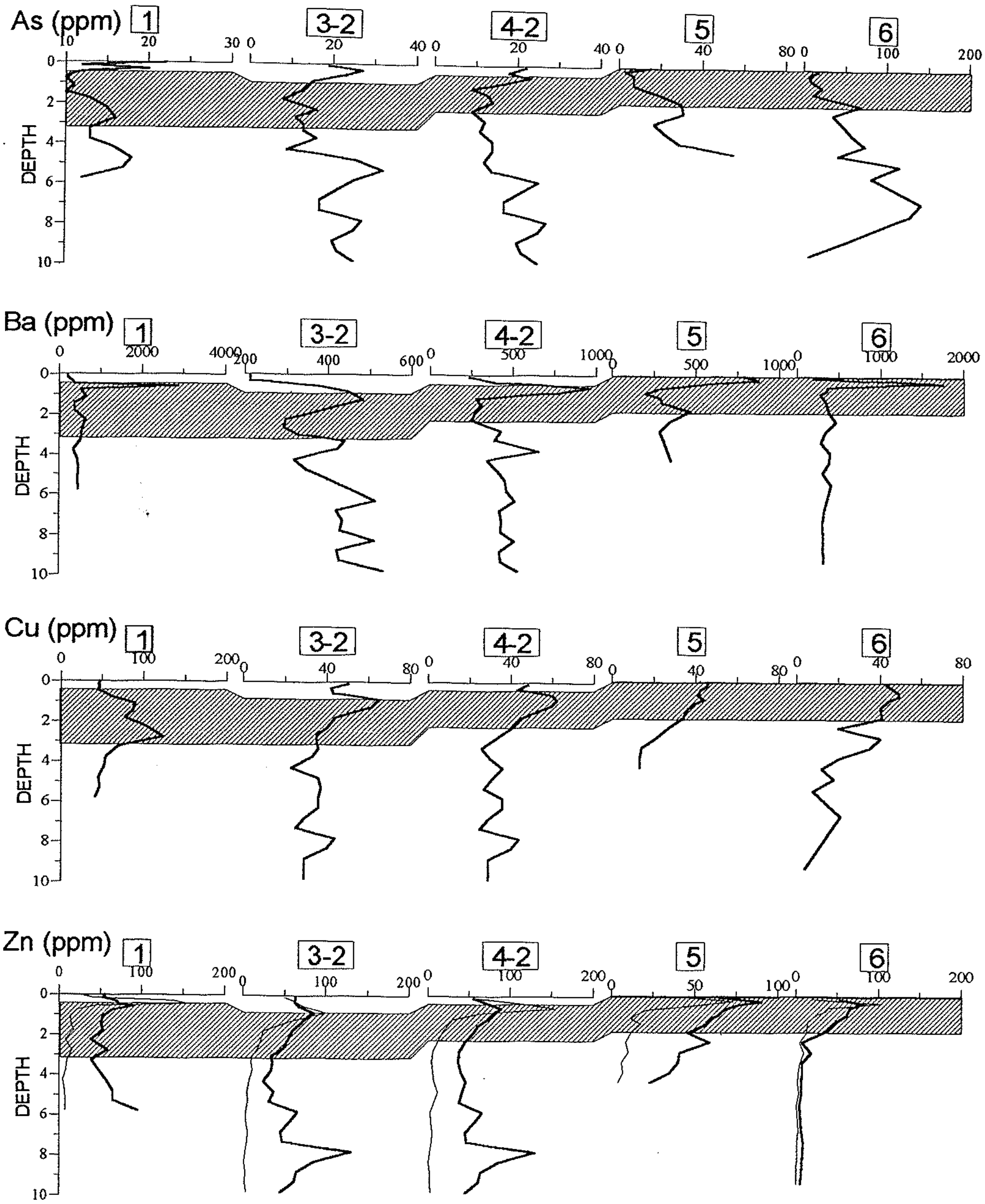

Figure 32. Arsenic, Ba, Cu and Zn distributions for profiles 1-6. Shading indicates approximate position of hardpan. Fainter line on Zn plot is Mn (divided by 10) distribution. Bismuth, Cd, In, Mo, Sb, Se and W are at or below detection limits.

6 DISCUSSION AND CONCLUSIONS

The distribution of Au in the upper horizons of the regolith at Granny Smith appears to be primarily related to the contact between transported and residual components of the soil profile; this usually occurs towards the base of the hardpan and is coincident with a trend towards increasing alkaline conditions. Soils have become acid as a result of leaching of base cations from the upper part to the lower part of the profile. The topsoil and hardpan is acid, with pH below 7 (minimum 4.6), whereas the upper saprolite is alkaline due to the precipitation of carbonate and other cations. Segregations of hardpan from contact zone indicates that Au is present in lithorelics and the matrix of the hardpan, although most is found in the latter. Furthermore, there does not appear to be any general relationship between Au and mineralogical, geochemical or textural features of the profiles, although there are some apparent associations within individual profiles. For example, Au appears to be strongly correlated with salt in profile 1, and weakly related to Ca in profile 4.

Laboratory experiments indicate that some Au is associated with specific phases within the soil *e.g.*, manganese oxides, organic material and soluble silica but, compared with Au that can be leached using water and iodide alone, they do not represent a highly significant fraction. Gold is generally found to be as least as soluble in water and iodide as some soil material south of the Menzies Line but, unlike Au found in these carbonate-rich soils, its mobility in the surficial environment may be restricted due to encapsulation within the hardpan material. There is some indication (profile 6) that water soluble Au is related to the Ca concentration as found in earlier studies. Re-adsorption of dissolved Au by hardpan material does occur, but not as strongly as with Fe oxide-rich material.

The results indicate that the Au-Ca association, highly significant at several sites south of the Menzies Line, is only weakly present, if at all, at Granny Smith, even though evidence for the association was specifically and critically investigated. Generally, Au and Ca do not follow the same pattern of mobilization and precipitation as noted in the south and, therefore, the carbonates should not specifically be sought as an exploration sample medium. Pedogenic carbonates are, in general, uncommon north of the Menzies Line and it is uncertain whether those at Granny Smith are either typical for the region or not equivalent in their origin as those to the south.

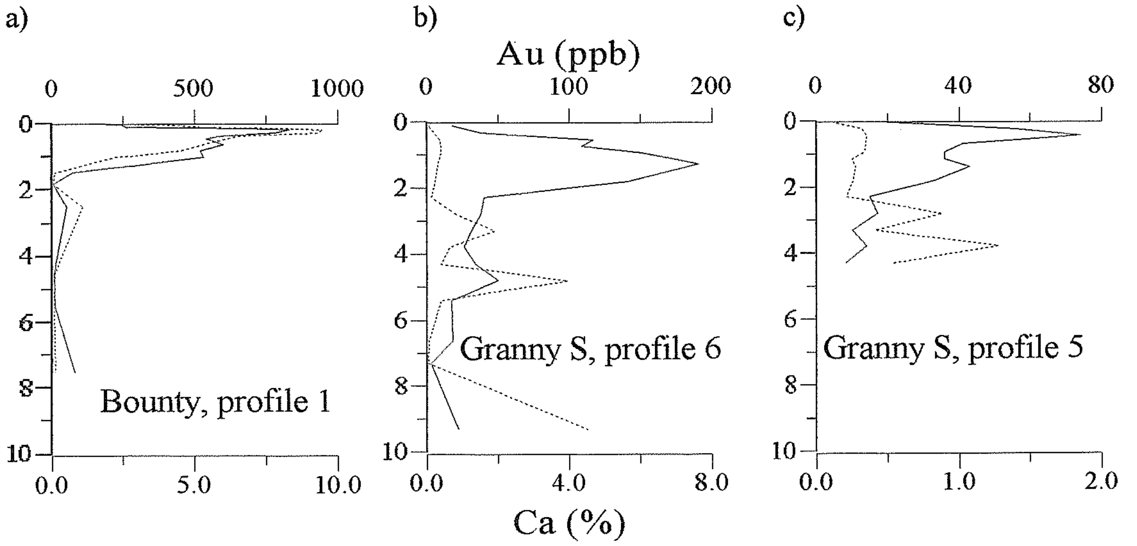

Figure 33: Examples of Au and Ca (dotted line) distribution north and south of Menzies Line: a) profile 1, Bounty Au deposit; b) profile 6, Granny Smith; c) profile 5, Granny Smith.

The reasons for the differing behaviour of Au and Ca north and south of the Menzies Line may be due to the soil hydrology. Previous descriptions and interpretations (Lintern, 1989; Lintern *et al.*, 1990) of sites south of the Menzies Line indicated that the mechanism by which the Au-Ca association is generated may be purely coincidental: that is to say, Ca and Au are precipitated from soil solutions when water is removed by evapotranspiration, so that water movement in the soil determines that Ca and Au will precipitate in the same position in the soil profile. Furthermore, soil incubation studies indicate that Au associated with the carbonate is relatively mobile. However, at Granny Smith, it is clear that this simple model requires some modification. The distribution of Au in the soil profiles at Granny Smith is comparable to that south of the Menzies Line (Figure 33): the Au distribution appears to follow a normal Gaussian depth function, albeit noisier, which suggests that at some stage during the development of the hardpan, mobilization and precipitation of Au may have took place in a manner similar to that which has occurred in the clay-rich profiles south of the Menzies Line. However, Ca distribution is markedly different even though Ca is probably derived from local rock sources, and has precipitated deeper in the profile.

The depth at which the carbonate appears to be accumulating does not appear to be wholly related to, or predictable from, the annual rainfall as suggested by Jenny (1941) or Yaalon (1983): the rainfall at Laverton (222 mm) is slightly less than at Kalgoorlie (256 mm) yet the zone of carbonate accumulation is variable occurring below 3 m and at least to 9 m; at Kalgoorlie, the carbonate usually occurs within the top 1-2. Clearly, other factors are important for the depth at which carbonate (but not Au) accumulates, and may include the following inter-related characteristics of the region:

(i) Type (frequency and duration) of rainfall; rainfall is sporadic and often occurs in large quantities over a short period during summer months. The high evaporation rates imply that effective rainfall is less and soils dry more rapidly than in the winter-rainfall areas. This, in turn, results in a shorter growing season.
(ii) Hydrology; most rainfall does not percolate down through the soil profile but probably either flows over the surface, or channels preferentially through macropores that occur in the hardpan; the clay-rich calcareous soils that occur south of the Menzies Line, on the other hand, allow more general permeation of water through micropores.
(iii) Type of vegetation; *Acacia* dominate the landscape rather than *Eucalyptus* which predominantly occur south of the Menzies Line.
(iv) Low organic content and, presumably, biological activity in soils north of the Menzies Line.
(v) Soils are acid becoming alkaline with depth whereas in the southern Yilgarn, many soil types are alkaline becoming acid with depth.

The role of vegetation in the dispersion of Au in areas dominated by hardpan has not been examined, but two factors suggest that it may not be significant. Firstly, roots have difficulty penetrating the hardpan and thus accessing sources of Au in the regolith. Secondly, there is a paucity of trees, particularly those supported by extensive root systems. Plants growing in arid areas are adapted to collect a significant proportion of rainfall and channel it via their stems (stem-flow) into the ground at their base for adsorption by the roots. Furthermore, it has been observed that hardpan is often broken around the base of larger plants such as acacias which will further assist penetration of water, and leaching of ions, through the hardpan by stem flow and from run-off. Plant roots that manage to grow through the hardpan will be advantaged by it since any water reaching the deeper regolith is protected from rapid evaporation. Those plants able to survive could be an effective biogeochemical sample medium since they are able to sample through the hardpan carapace to underlying Au-bearing material. Partial extraction experiments indicate that Au immediately beneath the hardpan is easily dissolved and, presumably, is readily available to plant roots.

This study indicates that prescriptions for geochemical exploration for Au in areas dominated by hardpan will be more difficult than for areas south of the Menzies Line. No interpretation of the behaviour of Au in soils at Granny Smith should be extrapolated to all sites that have hardpan, since only five profiles were sampled. Nevertheless, sampling of hardpan at the contact between transported and residual components may have some general application. However, confident identification of this material in drill cuttings is difficult. Furthermore, different characteristics may be exhibited where the hardpan is developed entirely within transported overburden, which itself may be 5 - 10m thick and overlie leached saprolite. An alternative strategy is to sample the entire hardpan material but this will be less cost effective particularly if the hardpan is thick, and dilute, possibly, already weak enrichments associated with specific horizons. Partial extraction procedures may be useful to determine more recently deposited Au; they indicate that the Au is potentially mobile within the hardpan but re-sorption, and the massive texture of hardpan, restricts the mobility of Au in the natural environment.

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APPENDICES

Page

PROFILE DESCRIPTIONS

9.1.1 Profile 1 (443151E, 6813387N)

0-0.4	Red sandy silty colluvium; possibly contaminated. BIF, Fe oxide fragments; friable matrix. Becoming weakly laminated with depth. Tree roots.
0.4-0.9	Top of hardpan. Strongly indurated by pale coloured cement.
0.9-3.0	Hardpan. Small (<1 mm) white crystals (gypsum, silica) in hand specimens. Manganese coatings. Appearance of saprolite blocks (some with striated appearance) whose frequency and size increases with depth. Carbonate (trace).
3.0-3.5	Well cemented; saprolite blocks in calcareous matrix. Carbonate (abundant).
3.5-5.0	Poorly consolidated. Saprolite blocks in earthy calcareous matrix. Carbonate (abundant).
5.0-5.5	Larger saprolite blocks; reduced amount of matrix. Salty efflorescence appearing on profile face. Less calcareous with segregations of carbonate up to 8cm.
5.5-6.5	Similar to above; large red blocks of saprolite; minor, and more earthy matrix. Carbonate (abundant).

Profile 1, located near the vehicle ramp to Goanna Pit, is characterized by three major horizons; these are (i) unconsolidated soil of 1 to 2 m, (ii) an indurated hardpan of 2 to 3 m metres and (iii) a friable saprolite zone containing clasts of partially weathered rock in a slight to highly calcareous clay-rich matrix. Quartz is abundant in the friable colluvium, decreases within the hardpan and gradually increases in concentration with depth thereafter. Kaolinite increases with depth. Hematite is abundant near the surface, where it is associated with BIF fragments and Fe oxide segregations, and in the hardpan horizon. Goethite is more abundant in the hardpan. Calcite occurs in the saprolite, particularly directly beneath the hardpan. Muscovite gradually increases with depth. The pH increases markedly with the base of the hardpan horizon and the occurrence of the carbonate.

Iron is strongly concentrated in the topsoil, presumably in hematite. Minor elements associated with this horizon include As, Ce, Co, Cr, Mn, Nb, P, Pb, Ti, V, Zn and Zr. Aluminium and silicon distributions are associated with kaolinite, quartz and muscovite; further Al and Si are associated with amorphous phases in the hardpan horizon. Sodium, Cl, Ba, Cu, La, Nd, Ni, S and Y have maxima associated with the hardpan horizon. Elements more concentrated in the saprolite include K (in muscovite), Na and Cl (in halite?), Ni, Pb, S and Zn. There is a notable dilution of most elements (except Mg, Ca, and Sr) with the occurrence of the calcite segregations.

The gold distribution is not associated with any soil horizon, mineralogy or major element distribution. It is most concentrated within the hardpan, although values are still high in the saprolite. There is little Au in the soil compared with the hardpan.

Highly significant correlations (99.9%) between major elements and other components are:

Ca: calcite	Na: pH, Cl, S, Sr.
Fe: P, Ce, Co, Cr, Pb, V, Zr.	P: Fe, Cr, Sr.
K: muscovite	S: Cl, Na, Sr.
Mn: Ce, Co.	Ti: rutile

Aluminium, Mg and Si are not correlated with other elements/minerals at this level of significance.

9.2.2 Profile 2 (443130E, 6813429N)

5.5-7.5 Pale moderately soft saprolite. Red mottling of saprolite, and veins of reddish calcareous earth increasing with depth. Fine grained carbonate as veins and on partings.

7.5-8.0 Red and grey saprolite with a possible change in lithology (colour). Carbonate occurring in veins.

8.0-8.5 Pale grey saprolite becoming increasingly speckled (red/purple) with depth. Cross-cutting carbonate veinlets.

8.5-9.0 Purple/red speckled grey saprolite; a few carbonate veins; possible harder textured with depth.

9.0-9.5 Purple red saprolite; harder not brittle; carbonate (some).

9.5-10.0 Purple-red saprolite; cross cutting of brittle band (10 cm) has carbonate veinlets along contact.

N.B. Carbonate veinlets occur throughout profile and reddish calcareous earths at 5m become paler with depth especially between 6 to 8m. Carbonate restricted to the earthy matrix rather than the saprolite. All samples damp and slightly salt incrusted.

Profile 2 consists entirely of saprolite. The main features of the profile are the wide variety of colours of the clay minerals presumably caused by Fe oxide staining, and veinlets and segregations of carbonate. Kaolinite, calcite, muscovite, quartz and halite increase in abundance with depth, but goethite slightly decreases.

There are no major variations in the major element concentrations in this profile. Aluminium, K and Rb, Na and Cl, and Ni increase with depth and are associated with clay minerals, muscovite and halite, respectively. Arsenic, Cu, and Zn increase markedly at about 8m and are related to the apparent change in lithology noted in the field. All elements except Au, La, Mg, S and Sr are diluted by the occurrence of Ca (calcite) at about 9 m.

Gold concentrations are below 40 ppb and do not appear to be related to any major element or mineral element concentration, except that the maxima for Ca and Au are coincident.

Highly significant correlation (99.9%) between major elements and other components are:
K: Rb.
Mn: La.
Ti: Zr.
Aluminium, Ca, Fe Mg, Na, P, S and Si are not correlated with other elements/minerals at this level of significance.

9.2.3 Profile 3 (443121E, 6813444N)

- 0.0-0.4 Friable red soil containing BIF gravels and cobbles; base of soil marked by stone-line of BIF; roots and rootlets.
- 0.4-0.7 Slightly cemented (laminated) and marks the beginning of the hardpan; contains BIF gravels and Fe oxide nodules.
- 0.7-2.8 Weakly cemented hardpan becoming stronger and more laminated with depth; strong Mn staining on partings (mangans). BIF fragments and gravels diminish in abundance with depth; the base of the horizon is composed of silty/sandy colluvium with few BIF gravels; carbonate (as veinlets).
- 2.8-3.4 Hardpan with brecciated saprolite containing saprolite blocks to 5-10 cm. Becoming softer with depth; carbonate (some)
- 3.4-4.0 Weakly cemented saprolite breccia with friable matrix.
- 4.0-4.5 Moderately hard, speckled and mottled saprolite.
- 4.5-5.0 Moderately hard, purple saprolite.
- 5.0-5.5 Softer yellow and red saprolite.

Profile 3, located in Goanna Pit, consists of three major horizons; these are (i) soil, <1 m, (ii) indurated hardpan, about 2 m thick containing transported BIF material in the upper portion and residual lithorelics in the lower portion, (iii) a friable brecciated saprolite consisting of partially weathered blocks (>10 cm) and carbonate segregations. A narrow quartz vein passes up through the saprolite to the base of the hardpan, terminating in a weak stone line. Quartz, kaolinite, muscovite and halite abundances are lowest in the hardpan, and increase with depth. Iron oxide abundances are greatest in the soil and hardpan, where they are associated with the BIF segregations. Goethite abundances decrease with depth and hematite has an irregular distribution. Calcite occurs beneath the hardpan, locally forming discrete carbonate segregations.

The soil and hardpan contain high concentrations of Fe, As, Ce, Co, Cr, Cu, La, Mn, Ni, P, Pb, Sc, Ti, V, Y, Zn and Zr that gradually decrease with depth, and suggest an association with hematite. Certain of these elements (Cu, La, Mn, Nd, Ni, Y and Zn) are particularly concentrated in the hardpan and may be associated with goethite or, since Al and Mg have maxima here, amorphous clay minerals. Silicon content is high in the soil, abruptly decreases at the top of the hardpan, then increases with depth. Potassium and Ca have maxima in the saprolite and are strongly associated with muscovite and calcite, respectively.

Gold is most abundant at the boundary between the hardpan and the saprolite. There is an abrupt increase in the concentration of the Au (from 19 to 46 ppb) and soil alkalinity (from 6.6 to 8.0) at this point. However, Au does not appear to be specifically associated with the hardpan or saprolite. Gold decreases with depth in the saprolite horizon.

Highly significant correlation (99.9%) between major elements and other components are:

Al: Mg,	Mn: Fe, P, Ce, Co, Cu, La, Nd, Ni, Pb, Y and Zn.
Ca: calcite.	S: pH, Cl, Na, Ce, Co, Cr, Pb and V.
Fe: Mn, P, Ce, Co, Cr, Pb V and Zn.	Ti: Zr.
K: Na.	P: Fe, Mn, Ce, Co, Cr, Pb and V.
Mg: Al.	Na: pH, Cl, K and S.

Silicon is not correlated with other components at this level of significance.

9.2.4 Profile 4 (443123E, 6813430N)

0.0-0.5 Friable, loamy red soil containing abundant BIF gravels and cobbles with some Fe oxide segregations and rounded quartz gravels. Rootlets. Stone line at base.

0.5-1.6 Friable hardpan becoming cemented and paler with depth. BIF gravels and Fe segregations. Mangans.

1.6-2.5 Blocky, less well cemented and paler hardpan with finer BIF gravels. Mn staining common. Friable carbonate vein 2 cm thick, sub-horizontal.

2.5-3.0 Saprolite breccia (5-10 cm) in friable "hardpan" matrix.

3.0-3.5 Purple saprolite breccia in soft red/orange earthy matrix.

3.5-4.0 Purple saprolite breccia in soft, carbonate-rich matrix..

4.0-4.5 Indurated saprolite (red and purple) in a slightly harder "hardpan" matrix. Mangans.

4.5-5.5 Similar to above but becoming softer, increasing saprolite proportion to "hardpan" matrix with depth.

Profile 4, in the Goanna Pit, has similar textural, mineralogical and geochemical characteristics to profile 3, located 14 m north. It consists of three horizons, namely (i) soil containing abundant BIF gravels, Fe oxide segregations and rounded quartz float, (ii) hardpan containing BIF fragments, Fe oxide segregations and Mn staining and (iii) saprolite, consisting of breccia (angular blocks of saprolite in hardpan matrix) in the upper portion, and variably friable (often calcareous) and hardened, matrix-supported saprolite blocks in the lower portion. Quartz is abundant in the friable colluvium, scarce in the hardpan and increasingly abundant with depth in the saprolite. Kaolinite and muscovite steadily increase down the profile. Iron oxides, particularly hematite, decrease with depth. Calcite is associated with the calcareous matrix in the saprolite.

The soil has high concentrations of (i) Fe, As, Co, Cr, Pb, V and Zr associated with Fe oxides (especially hematite), (ii) Si associated with quartz, (iii) P with organic material and/or Fe oxides and (iv) Ti. The hardpan has high concentrations of Al, Mg, Mn, REE, Ba, Cl, Co, Cu, Ga, Ni, Rb and Zn. The saprolite is poor in trace elements and rich in Si, Na, Cl and S. Potassium is strongly correlated with muscovite. There is a notable increase in soil pH at the top of the saprolite.

Gold is below the detection limit (5 ppb) in the soil but gradually increases with depth to reach a maximum (80 ppb) at the base of the hardpan, above the saprolite breccia, and then decreases sharply. The maximum is coincident with Ca.

Highly significant correlation (99.9%) between major elements and other components are:

Al: K
Fe: Mn, P, Ce, Co, Cr, La, Pb, V and Zn.
K: Al, Na, S, Cl, muscovite.
Mn: Fe, P, As, Ce, Co, La, Nd and Zn.
Na: K, S and Cl.
P: Fe, Mn, Ce, Co, Cr, Cu, La, Nd, Pb, V and Zn.
S: pH, K, Na and Cl.
Ti: Zr.

Calcium, Mg and Si are not correlated with other components at this level of significance.

9.2.5 Profile 5 (443325E, 6813028N)

0.0-0.1	Friable red soil containing BIF gravels/cobbles.
0.1-0.3	Moderately indurated laminated hardpan, dark red brown in appearance; mangans; some pale clays.
0.3-0.5	Moderately indurated hardpan, blocky and red brown in appearance containing some widely spaced (10-15 cm) fragments of saprolite. Rootlets present.
0.5-0.8	Increasingly friable hardpan containing some roots.
0.8-1.5	Friable horizon containing large blocks of indurated hardpan (20 - 40 cm) which itself contains pale blocks (up to 5 cm) of saprolite.
1.5-2.0	Hardpan with increasing frequency of saprolite blocks which are more ferruginous.
2.0-4.0	Saprolite breccia hardpan. Pale saprolite blocks increasing with less hardpan matrix. Carbonate present.
4.0-8.0	Bleached saprolite (no hardpan) with some orange and red mottles.

This profile consists of (i) a shallow soil (0.1 m), (ii) a hardpan, containing blocks of saprolite that increase in size and frequency with depth, which diffusely grades into (iii) saprolite that consists entirely of highly coloured soft clays. Mangans are a prominent feature of the upper part of the hardpan. Quartz, kaolinite, goethite, calcite and muscovite increase in abundance with the increasing proportion of saprolite. Hematite is more abundant when the sample is dominated by hardpan. Alunite is present in the saprolite.

Iron, P, Cl, Co and Cr contents are greatest in the soil and sharply decrease with the appearance of the hardpan; As, Mn, Rb, Ti, V, and Zr concentrations are also relatively high relative to the hardpan. In the hardpan, Al, Fe, Mg, Mn, Ba, Co, Cu, Ni, Rb, Y, Zn concentrations are high; some of these elements (Fe, Mn, Co, Ni, Rb and Zn) decrease in concentration with depth and appear to be related to oxides of Fe and Mn. Barium, Ce, La, Nd and Y contents in the upper part of the hardpan appear to be associated with Mn oxides. Silicon and Al concentrations do not vary substantially down the profile. The K maximum at 2 m is coincident with maxima for alunite, Cl, Na, P, S, Sr and Pb.

Gold is most abundant in the hardpan, particularly the upper part (74 ppb, 0.4 m), and decreases with depth; there is a smaller maximum (43 ppb, 1.35 m) lower in the hardpan. Gold distribution is not strongly related to any component, although there are some associations with Ca, Fe and Mn. The distribution of Ni is significantly correlated (99.9 %) with Au.

Highly significant correlation (99.9%) between major elements and other components are:

Al: Mg
Ca: quartz, calcite.
K: S.
Mg: Al.
Mn: Ba, Cr, Zn.
Na: Sr.
P: Cr.
S: K.
Ti: pH, As, Ce, La, Pb, Zr.

Iron and Si are not correlated with other components at this level of significance.

9.2.6 Profile 6 (443306E, 6813019N)

0.0-0.2 Friable red soil containing BIF fragments.
0.2-0.6 Top of hardpan. Laminated and red brown in appearance; mangans are prominent. Moderately indurated horizon.
0.6-0.8 Massive hardpan containing occasional saprolite blocks (up to 2 cm).
0.8-2.0 Laminated hardpan with abundant mangans.
2.0-5.0 Paler massive hardpan with blocks of saprolite.
5.0-5.7 Saprolite, less brecciated. Purple red in appearance. Spotty to pervasive colours. Carbonate present.
6.5-6.7 Orange and purple mottled clay- rich saprolite. No carbonate.
7.5-8.0 Purple, mottled clay-rich saprolite. No carbonate.
9.0-9.5 Pale green grey clay-rich saprolite. Carbonate present.

The profile is located at the north end of Grannys and about 20m east of the contact between BIF and sediments. It is similar in appearance to profile 5 and consists of (i) shallow soil (0.2 m) consisting of colluvium with abundant BIF fragments, (ii) hardpan, laminated towards the surface and blocky with depth, which grades into (iii) saprolite, brecciated in the upper portion. Mangans are a feature of the upper part of the hardpan. Quartz is abundant at the surface (transported sands), poor in the hardpan and decreases further with increasing depth. Kaolinite, muscovite, halite, albite and alunite increase with depth with the appearance of the saprolite. Hematite and goethite, more abundant than in profile 5, decrease with depth. Calcite is patchy in distribution and is strongly related to the occurrence of calcareous matrix in the lower part of the hardpan and in the saprolite.

The distribution of the major elements and their concentration ranges are very similar to profile 5 located 19 m to the east. Iron, P, Cr, Pb Ti, V and Zr share maxima in the soil and are associated with the BIF. In the subsoil and the upper part of the hardpan, the mangans (sample 5089) are richer in Mn, Ba, S and REE. Aluminium and Si concentrations do not vary appreciably; the distribution of Al is related to the presence of albite. Sodium and Cl increase down the profile and are associated with halite. Calcium concentrations are strongly related to calcite and have maxima at 3.3, 4.8 and 9.3 m. Magnesium is most abundant in the hardpan. Potassium and Rb distributions are very similar and follow the distributions of muscovite and alunite. Arsenic and Cu are related to the distribution of Fe.

The soil contains very little Au. Gold is most abundant in the hardpan (maxima at 1.25 m of 190 ppb), and decreases markedly in abundance in the saprolite. Its distribution is associated with that of Mg (Figure 23).

Highly significant correlation (99.9%) between major elements and other components are:

Al: K, Rb, albite.
Ca: calcite.
Fe: P, Ce, Co, Cr, La, Nd.
K: pH, Al, Ti, Rb, muscovite, alunite, siderite.
Mg: Au.
Mn: Ba, Ce, Co, La, Nd, Ni, Y, Zn.
Na: Cl, halite.
Ti: pH, K, S, Rb, V, Zr, quartz, kaolinite.
S: Ti.
P: Fe, Ce, Co, Cr, La, Nd, Y.

Silicon is not correlated with other components at this level of significance.

PROFILE DATA

SAMPLE	E	N	PROFILE	DEPTH metres	orgC uv-vis %	pH units	cond (uS1:5)	Al xrf %	Ca xrf %	Cl xrf ppm	Fe xrf %	Fe xrf(p) %	K xrf %	Mg xrf %
04-5001	443151	6813387	1	0.005	0.241	4.64	368	6.37	0.04	410	11.91	10.5	0.61	0.09
04-5002	443151	6813387	1	0.150	0.179	4.95	170	6.38	0.03	200	11.25	9.9	0.61	0.08
04-5003	443151	6813387	1	0.300	0.118	5.43	164	7.66	0.06	90	9.52	8.8	0.69	0.12
04-5004	443151	6813387	1	0.450	0.009	4.81	355	7.43	0.09	480	10.77	9.8	0.66	0.14
04-5005	443151	6813387	1	0.550	<0.001	5.38	351	8.21	0.23	570	7.68	7.1	0.66	0.31
04-5006	443151	6813387	1	0.750	<0.001	6.32	919	8.98	0.29	1020	4.71	5.2	0.81	0.54
04-5007	443151	6813387	1	1.100	<0.001	7.16	1801	8.30	0.18	2370	4.28	4.7	1.15	0.42
04-5008	443151	6813387	1	1.450	<0.001	7.02	3110	8.44	0.19	3450	4.09	4.6	0.95	0.56
04-5009	443151	6813387	1	1.800	<0.001	7.60	1924	8.62	0.19	2170	4.48	4.8	0.97	0.64
04-5010	443151	6813387	1	2.250	<0.001	7.86	1214	8.34	0.45	1320	3.91	4.4	1.39	0.42
04-5011	443151	6813387	1	2.750	<0.001	7.93	2660	8.95	0.16	4160	3.80	4.3	1.34	0.46
04-5012	443151	6813387	1	3.250	<0.001	7.76	1833	6.96	10.01	2920	3.16	3.6	1.02	0.60
04-5013	443151	6813387	1	3.750	<0.001	8.13	4020	6.97	9.62	6190	3.13	3.6	0.89	0.67
04-5014	443151	6813387	1	4.250	<0.001	8.19	3520	9.03	1.26	3170	4.25	4.6	1.15	0.40
04-5015	443151	6813387	1	4.750	<0.001	7.89	2650	9.49	1.00	3480	4.18	4.6	1.73	0.43
04-5016	443151	6813387	1	5.250	<0.001	7.79	5460	8.28	2.24	8630	4.86	5.1	1.26	0.36
04-5017	443151	6813387	1	5.750	<0.001	8.28	6750	8.95	2.91	11180	4.43	4.7	1.44	0.41
04-5019	443130	6813429	2	5.750	<0.001	8.23	-	8.87	0.86	3810	4.48	5.0	1.52	0.35
04-5020	443130	6813429	2	6.250	-	8.32	-	8.87	1.04	4040	3.96	4.5	1.41	0.30
04-5021	443130	6813429	2	6.750	-	8.47	-	9.04	1.49	1930	3.69	4.3	1.29	0.27
04-5022	443130	6813429	2	7.250	-	8.39	-	8.86	1.59	3710	3.94	4.6	1.39	0.25
04-5023	443130	6813429	2	7.750	-	8.53	-	9.53	0.72	4700	4.23	4.4	1.50	0.20
04-5024	443130	6813429	2	8.250	-	8.43	-	10.45	0.41	5060	3.69	4.1	1.54	0.19
04-5025	443130	6813429	2	8.750	-	8.60	-	10.05	2.24	4250	3.04	3.5	1.52	0.22
04-5026	443130	6813429	2	9.250	-	7.53	-	9.93	0.04	6070	3.97	4.5	1.46	0.16
04-5027	443130	6813429	2	9.750	-	7.97	-	8.22	2.27	7220	4.17	4.7	1.53	0.26
04-5028	443121	6813444	3	0.100	-	6.23	-	6.88	0.04	50	11.52	9.9	0.70	0.13
04-5029	443121	6813444	3	0.300	-	5.87	-	6.56	0.04	40	11.46	10.3	0.66	0.13
04-5030	443121	6813444	3	0.550	-	7.58	-	6.05	0.17	520	12.81	11.2	0.56	0.22
04-5031	443121	6813444	3	0.850	-	6.55	-	9.41	0.19	800	9.05	7.7	0.81	0.89
04-5032	443121	6813444	3	1.250	-	6.74	-	9.03	0.19	730	6.65	6.7	0.81	1.25
04-5033	443121	6813444	3	1.750	-	6.57	-	8.39	0.19	1660	7.13	6.4	0.77	0.86
04-5034	443121	6813444	3	2.250	-	6.53	-	8.83	0.16	3500	5.64	5.8	0.94	0.75
04-5035	443121	6813444	3	2.650	-	8.04	-	8.01	0.45	2760	4.18	4.6	0.92	0.66
04-5036	443121	6813444	3	3.000	-	8.37	-	6.90	1.51	1830	3.53	4.0	1.13	0.45
04-5037	443121	6813444	3	3.300	-	7.89	-	7.39	0.11	2290	3.55	4.1	1.41	0.29
04-5038	443121	6813444	3	3.700	-	7.78	-	7.29	0.11	3840	3.38	3.9	1.22	0.32
04-5039	443121	6813444	3	4.250	-	8.48	-	6.87	6.95	4020	2.90	3.4	1.05	0.42
04-5040	443121	6813444	3	4.750	-	8.73	-	7.13	4.28	9130	4.30	4.9	1.30	0.46
04-5041	443121	6813444	3	5.250	-	8.80	-	7.02	3.22	11780	4.91	5.4	1.34	0.44
04-5042	443123	6813430	4	0.100	-	6.87	-	6.70	0.11	320	11.37	10.1	0.71	0.12
04-5043	443123	6813430	4	0.350	-	6.88	-	6.03	0.09	160	10.86	9.3	0.55	0.20
04-5044	443123	6813430	4	0.600	-	6.89	-	7.83	0.19	490	10.67	9.5	0.64	0.51
04-5045	443123	6813430	4	0.850	-	6.80	-	9.44	0.25	700	7.83	7.9	0.88	0.82
04-5046	443123	6813430	4	1.150	-	6.77	-	9.33	0.24	960	7.20	7.0	0.89	0.83
04-5047	443123	6813430	4	1.450	-	6.82	-	8.69	0.24	2830	6.56	6.6	0.85	0.92
04-5048	443123	6813430	4	1.800	-	7.04	-	7.67	0.20	1760	7.11	6.5	0.73	0.74
04-5049	443123	6813430	4	2.200	-	-	-	6.06	6.68	770	4.85	-	0.95	0.56
04-5050	443123	6813430	4	2.250	-	7.97	-	7.14	0.62	790	4.71	4.8	0.82	0.66
04-5051	443123	6813430	4	2.750	-	7.69	-	7.84	0.11	270	3.64	4.1	0.98	0.28
04-5052	443123	6813430	4	3.250	-	7.69	-	8.11	0.09	570	3.48	3.9	0.86	0.23
04-5053	443123	6813430	4	3.750	-	8.15	-	7.43	0.46	760	3.57	4.0	0.89	0.42
04-5054	443123	6813430	4	4.250	-	8.22	-	8.81	0.16	3030	3.90	4.5	0.99	0.43
04-5055	443123	6813430	4	4.750	-	8.21	-	9.96	0.29	3180	3.43	4.0	1.27	0.56
04-5056	443123	6813430	4	5.250	-	8.31	-	10.02	0.29	5660	3.43	4.0	1.40	0.53
04-5057	443123	6813423	grab	4.000	-	7.31	-	7.51	0.11	200	4.12	4.8	1.56	0.31
04-5058	443325	6813028	5	0.005	-	4.83	-	7.12	0.11	1900	10.71	9.2	0.66	0.17
04-5059	443325	6813028	5	0.200	-	4.84	-	9.74	0.32	1150	4.80	5.3	0.80	0.43
04-5060	443325	6813028	5	0.400	-	5.25	-	9.45	0.35	960	4.62	5.2	0.79	0.43
04-5088	443325	6813028	grab(dk stain)	0.401	-	-	-	9.75	0.31	300	5.43	-	0.81	0.47
04-5061	443325	6813028	5	0.650	-	5.31	-	9.85	0.34	990	4.83	5.4	0.84	0.49
04-5062	443325	6813028	5	0.900	-	5.24	-	10.37	0.34	780	5.04	5.7	0.84	0.54
04-5063	443325	6813028	5	1.100	-	5.48	-	9.58	0.25	1260	4.44	5.0	0.76	0.40
04-5064	443325	6813028	5	1.350	-	5.49	-	9.82	0.27	1360	3.89	4.5	0.90	0.40
04-5065	443325	6813028	5	1.750	-	5.67	-	9.80	0.26	1380	3.11	3.7	1.48	0.36
04-5066	443325	6813028	5	2.250	-	6.79	-	9.64	0.21	790	3.82	4.3	0.94	0.31
04-5067	443325	6813028	5	2.750	-	7.68	-	10.08	0.88	1060	2.51	2.9	0.90	0.47
04-5068	443325	6813028	5	3.250	-	7.53	-	9.56	0.41	1190	2.15	2.5	0.78	0.28
04-5069	443325	6813028	5	3.750	-	7.74	-	9.15	1.28	1880	2.32	2.7	0.63	0.40
04-5070	443325	6813028	5	4.250	-	7.80	-	8.92	0.53	1510	2.25	2.6	0.86	0.45
04-5071	443306	6813019	6	0.100	0.121	4.83	535	6.58	0.04	530	11.06	8.3	0.64	0.10
04-5072	443306	6813019	6	0.300	0.055	5.32	233	8.32	0.20	150	5.55	6.1	0.66	0.28
04-5073	443306	6813019	6	0.500	<0.001	5.89	1318	9.37	0.37	1570	4.42	5.1	0.79	0.43
04-5074	443306	6813019	6	0.700	<0.001	5.80	1604	9.35	0.40	1750	4.48	5.2	0.83	0.47
04-5075	443306	6813019	6	0.900	<0.001	5.80	1660	8.88	0.39	2100	3.83	4.4	0.94	0.45
04-5089	443306	6813019	grab	0.901	-	-	-	8.75	0.29	640	3.83	4.5	0.77	0.37
04-5076	443306	6813019	6	1.250	<0.001	5.90	1183	8.16	0.31	1350	3.45	4.0	0.87	0.39
04-5077	443306	6813019	6	1.750	<0.001	5.93	755	8.32	0.23	660	2.93	3.4	1.25	0.34
04-5078	443306	6813019	6	2.250	<0.001	6.14	724	8.80	0.13	440	0.92	1.1	1.98	0.18
04-5079	443306	6813019	6	2.750	<0.001	7.70	1093	9.40	0.82	800	2.41	2.8	1.70	0.29
04-5080	443306	6813019	6	3.250	<0.001	7.87	1132	9.10	1.89	1040	2.46	2.8	1.63	0.28
04-5081	443306	6813019	6	3.750	0.004	7.77	1340	10.59	0.66	270	1.27	1.4	2.25	0.29
04-5082	443306	6813019	6	4.250	<0.001	7.76	2040	10.74	0.41	1830	0.72	0.8	2.36	0.30
04-5083	443306	6813019	6	4.750	<0.001	7.95	1980	8.27	3.96	3070	1.36	1.6	1.59	0.34
04-5084	443306	6813019	6	5.350	<0.001	8.05	2380	10.54	0.41	3060	0.97	1.1	2.49	0.28
04-5085	443306	6813019	6	6.600	<0.001	7.62	3060	10.06	0.05	2520	2.24	2.3	2.08	0.26
04-5086	443306	6813019	6	7.250	<0.001	7.66	6030	11.44	0.03	8470	2.10	1.8	2.25	0.22
04-5087	443306	6813019	6	9.250	<0.001	8.41	8750	9.68	4.53	14850	0.33	0.3	2.42	0.33

SAMPLE	Mn xrf %	Mn xrf(p) ppm	Na xrf %	P xrf %	S xrf ppm	S xrf(p) %	Si xrf %	Ti xrf %	Ti xrf(p) %	Ag xrf(p) ppm	As xrf(p) ppm	Au ppb gf/ar	Au ppb inaa	Ba xrf ppm	Ba xrf(p) ppm	Bi xrf(p) ppm
04-5001	0.023	247	0.10	0.0402	210	0.039	29.48	0.41	0.48	3	22	3	2.5	176	203	1
04-5002	0.035	407	0.09	0.0301	180	0.034	30.04	0.40	0.47	<1	12	3	5	185	198	<1
04-5003	0.123	1402	0.10	0.0275	120	0.024	29.20	0.46	0.55	3	20	4	6	263	317	1
04-5004	0.142	1566	0.13	0.0271	100	0.018	28.54	0.43	0.49	1	12	3	2.5	315	359	2
04-5005	0.045	454	0.15	0.0227	750	0.096	27.99	0.32	0.33	1	11	11	21	2822	2864	<1
04-5006	0.019	214	0.28	0.0175	400	0.154	28.57	0.31	0.32	1	10	14	25	519	504	<1
04-5007	0.012	129	0.52	0.0131	480	0.150	30.16	0.31	0.31	3	11	44	62	679	638	2
04-5008	0.013	144	0.72	0.0122	940	0.390	29.35	0.28	0.28	<1	10	90	123	361	356	<1
04-5009	0.016	175	0.65	0.0131	630	0.265	28.88	0.28	0.28	1	13	39	53	382	360	<1
04-5010	0,007	68	0.41	0.0083	450	0.203	31.12	0.36	0.34	<1	15	49	64	636	623	<1
04-5011	0.014	149	0.65	0.0096	600	0.894	30.10	0.37	0.35	1	16	62	78	507	536	<1
04-5012	0.009	89	0.41	0.0083	890	1.239	22.37	0.30	0.30	4	13	38	45	471	510	2
04-5013	0.008	76	0.71	0.0074	1580	0.712	22.32	0.28	0.28	3	13	72	81	313	331	<1
04-5014	0.005	40	0.63	0.0092	970	0.596	29.33	0.37	0.34	2	16	18	21	496	437	<1
04-5015	0.006	63	0.60	0.0131	1060	0.781	28.97	0.38	0.36	3	18	7	10	428	457	<1
04-5016	0.007	71	0.82	0.0122	1030	0.224	28.54	0.37	0.32	<1	17	4	10	450	431	<1
04-5017	0.008	70	1.00	0.0122	1780	0.430	26.91	0.37	0.32	3	12	3	7	461	456	<1
04-5019	0.004	33	0.58	0.0039	780	0.767	30.09	0.46	0.44	1	25	12	18	405	460	1
04-5020	0.004	36	0.58	0.0039	800	0.465	30.50	0.44	0.43	<1	21	18	25	492	512	2
04-5021	0.005	53	0.53	0.0052	610	0.429	30.06	0.43	0.42	<1	17	22	22	366	418	1
04-5022	0.005	49	0.59	0.0035	770	0.772	30.01	0.41	0.40	3	17	16	17	396	433	<1
04-5023	0.003	25	0.71	0.0052	710	0.255	30.00	0.42	0.40	<1	27	15	23	418	428	1
04-5024	0.002	13	0.73	0.0044	720	0.398	29.69	0.46	0.43	2	25	5	10	464	509	<1
04-5025	0.003	23	0.88	0.0048	1480	0.498	28.16	0.42	0.40	1	20	23	31	420	420	<1
04-5026	0.003	22	0.79	0.0039	750	0.166	30.30	0.44	0.41	1	21	2	6	407	426	2
04-5027	0.005	33	0.81	0.0035	780	0.246	29.59	0.40	0.39	1	25	7	10	489	532	1
04-5028	0.044	496	0.11	0.0319	110	0.020	29.28	0.43	0.53	2	19	3	2.5	190	212	1
04-5029	0.058	632	0.11	0.0305	90	0.016	29.81	0.42	0.49	<1	27	2	12	186	212	1
04-5030	0.065	738	0.13	0.0301	190	0.089	28.91	0.30	0.36	1	23	1	2.5	352	377	1
04-5031	0.087	1008	0.24	0.0227	280	0.044	25.12	0.34	0.37	2	15	3	15	541	448	1
04-5032	0.053	585	0.27	0.0175	260	0.036	26.42	0.32	0.34	<1	13	5	18	516	483	2
04-5033	0.022	242	0.36	0.0144	390	0.103	27.57	0.31	0.32	1	8	4	19	425	387	1
04-5034	0.020	209	0.54	0.0135	560	0.140	28.03	0.34	0.35	1	16	5	15	294	296	2
04-5035	0.015	174	0.80	0.0118	1310	0.298	29.39	0.30	0.30	<1	11	23	46	291	292	3
04-5036	0.010	108	0.58	0.0096	970	0.333	31.26	0.35	0.34	1	13	23	33	305	328	<1
04-5037	0.009	93	0.59	0.0087	810	0.194	32.87	0.39	0.37	<1	13	24	30	410	438	<1
04-5038	0.009	110	0.66	0.0070	1040	0.350	32.95	0.34	0.31	2	16	12	24	399	421	2
04-5039	0.006	68	0.47	0.0079	1340	0.435	26.63	0.32	0.32	2	9	8	14	294	317	1
04-5040	0.005	45	0.79	0.0087	3010	0.571	27.81	0.37	0.37	2	26	6	5	316	347	2
04-5041	0.006	57	1.06	0.0087	3820	0.709	28.19	0.43	0.43	1	32	7	8	339	401	<1
04-5042	0.056	585	0.13	0.0332	230	0.129	29.56	0.45	0.49	<1	22	2	2.5	215	235	1
04-5043	0.095	1093	0.10	0.0253	210	0.104	30.58	0.31	0.36	1	18	3	2.5	413	391	5
04-5044	0.135	1551	0.19	0.0336	350	0.193	26.81	0.29	0.33	3	23	3	2.5	986	964	2
04-5045	0.057	628	0.26	0.0201	330	0.067	25.60	0.37	0.38	<1	17	5	8	880	780	1
04-5046	0.029	303	0.31	0.0192	220	0.060	26.36	0.36	0.37	<1	9	8	16	328	275	<1
04-5047	0.022	242	0.38	0.0153	310	0.065	27.11	0.32	0.34	2	13	12	26	363	310	1
04-5048	0.017	182	0.39	0.0161	240	0.102	28.65	0.28	0.28	<1	14	19	40	313	271	<1
04-5049	<0.001	-	0.31	0.0004	18020	-	24.78	0.26	-	-	-	22	46	343	-	-
04-5050	0.011	123	0.40	0.0105	1110	0.234	30.38	0.29	0.28	<1	9	41	80	295	249	<1
04-5051	0.006	58	0.36	0.0052	240	0.087	32.48	0.33	0.31	1	12	19	23	416	427	1
04-5052	0.005	49	0.38	0.0048	310	0.099	32.59	0.35	0.33	2	11	4	6	412	392	1
04-5053	0.005	60	0.42	0.0048	840	0.695	31.90	0.34	0.32	2	14	17	20	719	654	1
04-5054	0.007	77	0.59	0.0052	1580	0.388	30.55	0.41	0.38	<1	14	10	10	320	347	<1
04-5055	0.012	124	0.87	0.0044	1820	0.438	28.97	0.39	0.35	4	12	13	12	384	406	1
04-5056	0.008	80	1.08	0.0039	2380	0.405	28.74	0.40	0.37	<1	14	6	10	426	455	<1
04-5057	0.007	75	0.37	0.0057	1090	0.366	31.12	0.35	0.34	1	8	3	7	2447	2440	<1
04-5058	0.039	461	0.24	0.0301	490	0.324	28.50	0.38	0.41	<1	15	13	18	880	791	1
04-5059	0.070	729	0.22	0.0148	460	0.257	27.48	0.29	0.30	2	3	43	56	883	871	1
04-5060	0.052	524	0.21	0.0157	480	0.058	28.11	0.27	0.28	<1	7	53	74	521	540	<1
04-5088	0.058	-	0.19	0.0140	570	-	27.03	0.29	-	-	-	20	29	430	-	-
04-5061	0.021	211	0.22	0.0140	1030	0.261	27.26	0.28	0.29	1	7	27	41	270	273	1
04-5062	0.013	144	0.26	0.0135	300	0.302	26.17	0.28	0.29	<1	7	27	36	154	202	<1
04-5063	0.011	119	0.30	0.0148	1000	0.299	28.17	0.35	0.34	1	12	22	36	270	286	<1
04-5064	0.016	176	0.30	0.0170	3850	0.566	27.93	0.37	0.37	<1	20	38	43	261	298	1
04-5065	0.009	121	0.38	0.0209	14820	1.314	26.36	0.37	0.37	<1	30	32	33	546	469	1
04-5066	0.009	87	0.32	0.0170	6920	1.206	28.10	0.48	0.46	4	31	11	15	311	346	<1
04-5067	0.010	101	0.30	0.0179	5290	0.599	27.95	0.46	0.47	1	17	16	17	259	283	2
04-5068	0.005	59	0.32	0.0240	5240	0.619	29.82	0.51	0.52	<1	22	11	10	260	307	1
04-5069	0.007	69	0.33	0.0253	1610	1.071	29.97	0.49	0.47	1	29	8	14	274	331	1
04-5070	0.003	37	0.31	0.0340	2730	0.765	30.81	0.55	0.53	1	55	7	8	326	353	<1
04-5071	0.019	197	0.16	0.0340	230	0.551	29.86	0.40	0.48	<1	17	16	18	177	195	1
04-5072	0.094	1030	0.19	0.0209	490	0.060	29.20	0.31	0.33	<1	6	22	38	1760	1753	<1
04-5073	0.034	396	0.25	0.0153	280	0.056	28.05	0.28	0.29	1	8	79	117	355	367	2
04-5074	0.032	362	0.32	0.0157	310	0.041	27.83	0.28	0.29	1	14	71	109		351	<1
04-5075	0.022	249	0.33	0.0118	350	0.043	29.16	0.27	0.27	<1	21	105	151	233	279	1
04-5089	0.041	463	0.25	0.0153	2190	0.253	29.21	0.29	0.30	2	11	65	122	414	382	1
04-5076	0.012	142	0.31	0.0109	330	0.045	30.34	0.26	0.26	3	11	165	191	256	341	2
04-5077	0.012	135	0.35	0.0083	1250	0.166	31.04	0.36	0.35	<1	68	85	141	337	379	3
04-5078	0.005	51	0.45	0.0035	1240	0.148	33.13	0.49	0.49	<1	35	41	40	442	458	1
04-5079	0.009	96	0.42	0.0044	1840	0.208	29.84	0.52	0.51	<1	48	36	38	251	339	3
04-5080	0.005	54	0.33	0.0031	590	0.091	29.80	0.53	0.50	3	58	34	31	199	285	1
04-5081	0.003	33	0.36	0.0044	1950	0.325	30.12	0.59	0.57	<1	74	21	26	324	392	2
04-5082	0.002	21	0.42	0.0039	1710	0.314	30.85	0.59	0.57	<1	42	29	34	334	386	1
04-5083	0.003	36	0.34	0.0048	2290	0.368	29.11	0.50	0.51	<1	115	37	50	254	311	1
04-5084	0.002	10	0.49	0.0039	800	0.226	31.06	0.61	0.54	2	82	16	17	378	413	3
04-5085	0.003	30	0.56	0.0035	1440	0.639	30.68	0.57	0.47	1	142	24	18	264	333	1
04-5086	0.002	18	0.92	0.0052	3600	0.448	28.64	0.67	0.37	3	128	4	<5	315	311	<1
04-5087	0.002	9	1.31	0.0026	1930	0.280	26.86	0.50	0.34	2	8	28	22	277	322	2

SAMPLE	Cd xrf(p) ppm	Ce xrf ppm	Ce xrf(p) ppm	Co xrf ppm	Co xrf(p) ppm	Cr xrf ppm	Cr xrf(p) ppm	Cs xrf(p) ppm	Cu xrf ppm	Cu xrf(p) ppm	Ga xrf ppm	Ga xrf(p) ppm	Ge xrf(p) ppm	In xrf(p) ppm	La xrf ppm	La xrf(p) ppm	Mo xrf(p) ppm
04-5001	<1	43	39	11	14	368	382	2	138	47	16	20	2	2	9	25	2
04-5002	1	39	48	12	19	318	354	3	33	45	17	20	1	5	8	26	1
04-5003	<1	87	76	27	34	312	301	5	147	47	20	20	2	0	15	30	<1
04-5004	<1	105	100	17	29	283	291	4	38	44	18	22	1	0	10	26	1
04-5005	2	74	71	9	15	180	179	1	25	51	20	23	1	1	24	35	2
04-5006	<1	58	46	10	13	136	144	4	43	61	22	23	1	0	29	36	2
04-5007	<1	36	19	12	10	124	129	2	58	90	18	23	<1	1	15	16	1
04-5008	2	39	22	10	13	107	119	4	76	87	19	22	2	2	13	20	<1
04-5009	4	27	24	6	12	117	126	1	50	77	20	22	1	0	9	17	1
04-5010	1	24	10	6	6	106	112	1	78	104	17	20	2	4	6	10	2
04-5011	<1	20	15	8	7	98	108	1	80	123	19	20	<1	0	7	12	<1
04-5012	<1	33	12	5	6	88	93	<1	39	69	15	13	1	0	<1	12	2
04-5013	4	17	10	8	8	77	87	<1	40	54	15	16	2	<1	19	16	<1
04-5014	<1	27	8	7	7	112	108	<1	45	52	17	19	2	1	4	11	2
04-5015	1	25	9	6	6	82	87	2	33	45	20	20	1	<1	8	12	<1
04-5016	<1	30	13	6	7	112	108	1	25	47	18	19	2	<1	2	17	2
04-5017	<1	44	18	9	8	81	86	1	27	42	20	20	1	<1	9	17	2
04-5019	1	25	1	<1	2	156	171	1	25	36	24	24	1	1	4	8	3
04-5020	<1	5	5	<1	3	92	103	2	15	36	20	20	<1	<1	4	12	2
04-5021	<1	8	5	<1	2	124	79	1	12	29	19	19	1	2	3	13	1
04-5022	1	24	1	2	5	83	89	1	38	25	20	24	1	2	5	13	2
04-5023	<1	4	0	2	1	101	108	1	29	44	19	23	2	<1	<1	5	1
04-5024	<1	12	0	<1	3	130	133	2	33	40	21	24	1	<1	<1	3	2
04-5025	1	9	<1	2	3	108	102	2	26	29	21	22	2	1	5	9	2
04-5026	<1	11	3	<1	2	159	137	2	28	29	20	24	1	<1	<1	6	2
04-5027	2	15	<1	<1	3	152	138	2	19	29	21	20	1	2	<1	10	1
04-5028	<1	38	48	8	26	377	372	4	38	50	17	21	2	5	9	24	1
04-5029	1	56	53	12	24	348	364	3	27	42	16	20	2	3	12	22	<1
04-5030	<1	58	55	9	15	235	243	4	42	43	15	20	3	<1	15	35	<1
04-5031	<1	63	63	15	25	175	171	5	43	65	20	25	2	<1	37	46	5
04-5032	<1	68	63	13	20	157	165	4	50	61	22	25	2	<1	31	42	<1
04-5033	1	43	33	7	13	148	152	3	22	44	19	22	1	2	12	25	<1
04-5034	2	32	21	12	12	149	156	4	17	40	19	20	1	<1	9	21	1
04-5035	<1	32	17	12	8	143	122	4	36	35	17	21	2	2	10	19	1
04-5036	1	22	8	5	7	86	85	1	20	35	16	17	<1	2	5	8	<1
04-5037	<1	28	5	3	5	78	85	3	11	36	17	18	1	<1	2	9	1
04-5038	6	17	8	3	5	80	88	3	17	33	15	15	2	3	4	11	1
04-5039	3	12	4	1	2	76	92	<1	7	23	15	17	1	<1	1	9	2
04-5040	<1	15	<1	<1	5	108	119	1	13	36	19	19	1	<1	<1	2	2
04-5041	<1	27	6	5	2	184	198	<1	33	37	21	20	1	<1	<1	8	<1
04-5042	<1	52	45	13	21	373	381	1	34	48	16	21	1	<1	8	25	1
04-5043	<1	71	65	8	22	251	240	2	45	43	16	21	2	<1	23	31	<1
04-5044	1	71	88	15	23	166	175	5	35	60	20	25	1	<1	59	70	1
04-5045	<1	41	52	8	16	187	191	5	34	62	23	26	1	4	30	45	1
04-5046	2	59	51	15	23	171	167	5	35	59	22	24	1	1	23	34	2
04-5047	<1	54	49	9	14	154	159	1	28	52	18	24	1	<1	22	27	<1
04-5048	<1	55	36	6	12	134	143	3	25	44	18	21	1	<1	18	22	1
04-5049	-	90	-	<1	-	183	-	-	<1	-	5	-	-	-	<1	-	-
04-5050	<1	28	13	5	7	124	126	1	22	40	16	17	1	<1	13	14	<1
04-5051	<1	17	5	6	5	118	93	3	11	33	17	17	1	2	<1	7	<1
04-5052	3	15	3	2	6	80	84	3	11	26	16	20	2	<1	<1	8	1
04-5053	<1	27	6	4	5	97	104	2	8	30	18	20	2	3	4	6	3
04-5054	2	28	7	2	6	116	125	3	13	36	20	22	1	3	1	9	2
04-5055	<1	20	1	5	4	122	105	2	30	31	20	22	1	<1	<1	4	<1
04-5056	1	11	<1	4	4	117	126	3	18	27	20	25	2	1	1	8	1
04-5057	1	20	16	5	4	145	124	2	8	28	18	20	1	<1	5	14	<1
04-5058	1	37	35	12	19	336	308	1	23	46	19	24	2	5	10	29	2
04-5059	<1	73	63	13	19	135	148	4	30	45	23	25	3	<1	32	43	<1
04-5060	<1	56	38	16	16	125	137	3	20	42	22	25	1	<1	23	30	1
04-5088	-	50	-	24	-	146	-	-	24	-	21	-	-	-	28	-	-
04-5061	<1	47	26	11	17	139	147	2	21	41	21	26	1	2	24	26	1
04-5062	3	40	19	10	11	139	147	3	41	44	24	26	<1	<1	12	23	1
04-5063	1	42	33	8	11	148	156	2	34	39	24	24	1	<1	19	29	2
04-5064	2	55	46	10	8	150	164	3	14	36	22	25	1	1	35	39	1
04-5065	<1	92	64	4	8	173	184	3	17	34	20	24	2	2	47	51	2
04-5066	<1	82	63	6	5	166	182	<1	12	27	21	24	1	<1	39	46	4
04-5067	<1	66	61	6	6	192	210	2	5	21	20	25	1	<1	39	49	2
04-5068	1	95	86	4	5	202	223	<1	4	14	22	27	1	<1	56	64	<1
04-5069	1	111	98	7	4	210	233	2	<1	13	23	27	1	<1	54	65	<1
04-5070	2	151	134	3	3	259	261	2	11	13	24	25	<1	<1	80	91	3
04-5071	<1	47	51	4	16	380	331	1	26	43	16	21	3	7	8	39	3
04-5072	<1	100	90	21	25	167	170	1	33	46	22	23	1	<1	43	49	1
04-5073	<1	63	42	14	14	117	135	5	25	49	22	24	<1	1	27	39	<1
04-5074	<1	45	39	15	13	122	134	5	32	49	23	23	1	2	26	30	<1
04-5075	1	40	33	8	10	105	117	4	37	44	22	23	2	2	9	22	<1
04-5089	<1	65	52	11	13	124	136	1	20	39	20	22	1	<1	28	36	<1
04-5076	<1	26	14	5	8	100	110	4	19	40	19	19	<1	<1	11	14	<1
04-5077	1	39	16	5	5	116	126	3	24	41	17	22	1	<1	7	16	<1
04-5078	<1	23	1	2	2	111	111	1	1	20	19	21	1	3	2	5	1
04-5079	<1	28	11	5	5	133	145	2	17	40	21	22	2	2	<1	16	1
04-5080	1	25	3	3	4	127	137	3	16	35	19	20	3	<1	<1	7	2
04-5081	2	26	7	4	2	141	142	3	15	20	20	25	2	1	1	10	1
04-5082	<1	28	4	3	1	140	134	2	3	12	22	23	2	3	2	9	2
04-5083	<1	34	7	4	2	103	117	<1	2	18	19	21	<1	2	6	11	<1
04-5084	<1	29	1	3	1	127	133	3	<1	8	22	22	1	<1	2	10	2
04-5085	1	32	4	<1	3	145	135	1	11	21	24	22	2	<1	3	9	1
04-5086	2	38	2	<1	1	176	127	2	1	17	26	22	1	2	5	10	2
04-5087	<1	29	3	3	1	84	71	2	<1	4	22	21	1	<1	4	8	<1

SAMPLE	Nb xrf ppm	Nb xrf(p) ppm	Nd xrf(p) ppm	Ni xrf ppm	Ni xrf(p) ppm	Pb xrf ppm	Pb xrf(p) ppm	Rb xrf ppm	Rb xrf(p) ppm	Sb xrf(p) ppm	Sc xrf(p) ppm	Se xrf(p) ppm	Sr xrf ppm	Sr xrf(p) ppm	V xrf ppm	V xrf(p) ppm	W xrf(p) ppm
04-5001	9	7	14	632	45	18	15	39	47	<1	17	3	30	31	156	181	<1
04-5002	9	8	14	82	47	22	14	40	47	<1	16	2	30	32	150	173	<1
04-5003	8	10	19	765	53	15	18	49	60	<1	18	3	40	39	156	174	<1
04-5004	8	8	20	120	57	22	18	49	54	3	18	2	39	42	157	174	<1
04-5005	7	7	27	58	70	11	9	51	59	3	16	<1	91	95	123	129	<1
04-5006	5	7	33	116	67	12	9	54	59	2	15	1	70	79	107	123	<1
04-5007	5	3	15	39	58	10	9	57	62	3	15	2	61	66	115	126	<1
04-5008	5	3	14	440	58	9	6	50	56	<1	13	2	55	66	97	111	<1
04-5009	5	1	12	66	60	14	7	52	59	<1	15	<1	59	66	107	110	<1
04-5010	5	5	5	90	48	13	10	56	64	<1	13	1	70	79	105	126	<1
04-5011	5	6	9	34	48	7	8	59	65	<1	13	<1	71	84	109	116	<1
04-5012	8	5	9	30	42	7	7	40	48	1	20	<1	125	134	87	106	<1
04-5013	5	<1	13	149	47	8	7	39	42	3	17	<1	131	143	85	101	<1
04-5014	3	1	4	165	56	7	9	44	47	<1	13	1	87	86	119	136	<1
04-5015	6	2	5	73	57	11	9	63	74	<1	14	<1	144	164	119	129	<1
04-5016	4	<1	4	56	68	11	10	48	53	1	13	<1	90	94	125	126	<1
04-5017	8	4	7	93	72	11	17	51	57	1	13	2	109	116	91	110	<1
04-5019	5	8	5	30	26	4	4	57	65	<1	15	1	58	64	138	158	<1
04-5020	10	5	<1	14	26	5	5	55	60	<1	14	<1	54	58	121	141	<1
04-5021	5	6	4	28	25	5	6	52	56	1	16	1	53	56	112	130	<1
04-5022	5	3	4	224	30	8	4	53	61	<1	14	1	61	63	113	135	<1
04-5023	5	7	<1	55	33	10	4	55	63	<1	14	2	98	106	104	117	<1
04-5024	6	8	<1	124	53	3	3	57	64	<1	14	1	65	73	118	131	<1
04-5025	6	5	<1	152	49	10	4	55	63	1	13	1	145	164	95	100	<1
04-5026	5	8	<1	259	71	7	6	54	63	3	13	1	67	74	114	120	<1
04-5027	5	5	2	67	58	3	5	59	65	<1	13	2	58	59	116	127	<1
04-5028	9	10	14	80	45	23	17	48	53	1	18	1	36	36	157	191	<1
04-5029	8	6	16	35	49	19	16	41	49	<1	17	2	36	38	153	181	<1
04-5030	9	8	24	151	62	9	10	39	48	2	15	<1	43	45	134	148	<1
04-5031	5	7	38	101	96	14	12	54	65	1	19	<1	67	70	135	149	<1
04-5032	8	5	33	194	92	14	12	52	59	<1	16	<1	64	72	126	132	<1
04-5033	3	7	17	40	61	7	12	45	54	1	15	2	64	70	120	132	<1
04-5034	6	6	10	33	52	8	4	49	56	<1	15	2	65	69	125	135	<1
04-5035	4	6	12	303	42	7	5	46	55	<1	13	2	62	68	100	113	<1
04-5036	7	6	6	37	24	<1	2	48	53	<1	13	2	74	82	104	107	<1
04-5037	5	8	3	10	19	2	1	59	63	1	12	1	59	62	103	113	<1
04-5038	4	4	7	56	26	5	3	50	55	2	11	1	56	62	96	101	<1
04-5039	4	5	2	29	17	5	2	40	46	<1	15	<1	91	100	81	100	<1
04-5040	6	5	2	9	28	3	<1	51	57	<1	14	<1	77	83	103	116	<1
04-5041	4	4	3	91	25	2	1	52	60	2	15	2	71	78	131	153	5
04-5042	11	9	13	63	40	18	15	46	52	<1	16	3	38	36	162	184	1
04-5043	7	6	26	357	59	15	12	39	45	1	14	2	43	47	117	135	<1
04-5044	8	3	64	109	93	15	11	44	52	3	16	2	72	73	127	146	<1
04-5045	6	10	29	71	94	14	13	58	64	<1	17	2	80	83	130	150	<1
04-5046	7	7	25	88	74	10	9	51	63	<1	18	<1	65	73	131	146	<1
04-5047	3	9	22	55	69	7	7	49	58	<1	16	<1	67	76	116	141	<1
04-5048	5	5	18	120	57	9	6	43	52	<1	14	2	59	64	112	120	1
04-5049	14	-	-	25	-	<1	-	35	-	-	-	-	413	-	133	-	-
04-5050	5	5	10	59	46	7	8	42	48	<1	12	<1	75	84	101	115	<1
04-5051	5	4	4	28	29	5	3	42	45	<1	11	<1	57	64	100	111	<1
04-5052	5	8	3	19	30	4	2	34	40	1	9	<1	59	64	96	106	<1
04-5053	7	4	2	19	36	6	4	40	41	<1	11	1	88	102	92	103	<1
04-5054	3	8	3	20	38	5	5	41	44	1	12	1	64	72	114	127	<1
04-5055	4	6	<1	144	37	2	5	51	55	<1	13	2	82	86	121	126	<1
04-5056	6	5	1	108	33	4	4	54	63	<1	13	<1	112	128	114	122	<1
04-5057	4	9	6	72	34	7	4	64	70	<1	13	<1	118	129	121	139	5
04-5058	8	11	19	68	49	18	13	42	51	<1	16	1	53	51	189	192	<1
04-5059	8	12	26	176	81	11	9	52	60	<1	16	<1	69	77	114	121	<1
04-5060	6	<1	18	56	75	6	9	54	59	2	16	1	75	80	107	118	<1
04-5088	6	-	-	101	-	13	-	48	-	-	-	-	72	-	119	-	-
04-5061	5	1	15	62	74	9	8	54	61	1	16	1	74	84	107	118	<1
04-5062	6	4	14	306	72	5	9	57	65	3	17	<1	66	78	104	128	<1
04-5063	5	3	16	161	57	12	8	42	47	<1	15	<1	79	92	125	146	<1
04-5064	4	3	19	36	56	9	12	39	43	<1	16	2	114	131	137	150	<1
04-5065	6	7	22	115	46	16	16	29	30	<1	16	2	204	235	136	157	<1
04-5066	5	8	21	63	48	8	13	25	25	<1	16	2	154	178	237	269	<1
04-5067	7	<1	27	69	40	11	15	30	32	2	19	<1	148	170	138	162	<1
04-5068	5	6	27	82	40	13	16	21	23	<1	18	2	189	213	167	185	<1
04-5069	7	8	34	20	38	15	17	24	29	<1	17	<1	188	217	141	162	<1
04-5070	9	<1	51	103	26	13	22	31	35	<1	18	<1	238	274	141	160	4
04-5071	4	1	23	28	45	12	14	46	51	3	17	3	36	39	159	177	1
04-5072	11	2	41	100	73	9	10	54	58	<1	15	1	77	89	108	126	<1
04-5073	6	7	26	109	92	6	10	58	67	1	16	<1	78	91	94	116	<1
04-5074	5	4	27	171	80	8	9	56	63	3	16	1	87	96	104	121	<1
04-5075	5	3	18	169	61	6	6	57	65	4	14	<1	89	98	107	120	<1
04-5089	6	5	20	82	63	11	8	44	49	<1	14	1	97	111	118	124	<1
04-5076	3	3	11	46	48	3	8	54	60	<1	14	<1	74	83	93	109	<1
04-5077	7	5	10	98	41	2	6	56	61	1	16	1	88	97	128	135	<1
04-5078	5	5	2	16	24	7	5	78	84	<1	19	<1	92	103	139	151	<1
04-5079	7	7	6	17	30	4	7	65	75	<1	20	1	97	108	162	193	<1
04-5080	4	6	3	7	21	<1	9	68	73	2	20	2	80	83	162	192	<1
04-5081	6	7	3	63	28	12	6	91	97	<1	23	<1	102	111	166	201	<1
04-5082	5	7	1	147	35	7	10	88	103	<1	23	<1	102	115	169	182	<1
04-5083	6	4	3	43	44	8	7	56	67	<1	22	1	103	115	150	172	<1
04-5084	6	7	1	37	19	8	8	94	109	<1	21	<1	90	105	180	189	4
04-5085	8	5	2	42	20	8	9	75	84	2	17	3	84	97	202	199	<1
04-5086	8	7	3	6	15	14	11	74	80	<1	14	1	103	112	238	179	1
04-5087	3	6	3	<1	15	7	9	89	90	<1	12	<1	124	128	114	98	<1

SAMPLE	Y xrf ppm	Y xrf(p) ppm	Zn xrf ppm	Zn xrf(p) ppm	Zr xrf ppm	Zr xrf(p) ppm	QUARTZ xrd.d2T 26.7	KAOLINITE xrd.d2T 12.3	HEMATITE xrd.d2T 33.1	GOETHITE xrd.d2T 21.2	CALCITE xrd.d2T 29.5
04-5001	18	14	52	55	213	201	2632	183	129	129	n.d.
04-5002	12	17	48	53	214	192	-	-	-	-	-
04-5003	16	18	64	69	227	236	2406	239	103	154	n.d.
04-5004	18	16	67	72	216	200	-	-	-	-	-
04-5005	18	20	83	91	127	131	944	233	113	187	n.d.
04-5006	24	26	59	64	110	132	-	-	-	-	-
04-5007	21	20	50	52	107	125	1703	286	71	184	n.d.
04-5008	17	18	46	51	94	115	-	-	-	-	-
04-5009	18	18	50	53	97	113	1147	299	96	232	n.d.
04-5010	16	16	38	38	119	147	-	-	-	-	-
04-5011	12	13	49	58	124	150	2546	455	63	197	n.d.
04-5012	11	12	39	39	103	119	-	-	-	-	-
04-5013	17	17	46	48	96	111	1786	411	n.d.	136	743
04-5014	11	11	62	57	133	148	-	-	-	-	-
04-5015	12	10	62	65	129	160	3237	523	n.d.	146	107
04-5016	10	11	62	65	132	144	-	-	-	-	-
04-5017	9	9	91	95	131	138	2514	629	n.d.	192	199
04-5019	13	12	65	66	150	176	3305	457	74	168	79
04-5020	12	11	53	57	151	176	-	-	-	-	-
04-5021	12	12	42	45	141	167	3959	512	91	119	140
04-5022	10	10	45	47	135	162	-	-	-	-	-
04-5023	12	11	140	130	143	166	3661	493	n.d.	146	78
04-5024	10	10	78	85	152	186	-	-	-	-	-
04-5025	9	8	63	64	135	170	2724	601	n.d.	102	168
04-5026	10	9	58	61	142	175	-	-	-	-	-
04-5027	7	10	48	45	140	152	3728	458	85	100	161
04-5028	15	17	59	63	223	218	-	-	-	-	-
04-5029	19	16	59	62	222	198	2053	177	113	105	48
04-5030	20	20	65	68	140	133	-	-	-	-	-
04-5031	26	29	80	85	129	142	1295	343	118	207	n.d.
04-5032	29	33	62	72	117	132	-	-	-	-	-
04-5033	18	17	53	59	124	125	1350	258	112	190	n.d.
04-5034	17	16	45	53	127	142	-	-	-	-	-
04-5035	16	13	43	48	108	123	927	199	n.d.	132	66
04-5036	13	14	36	34	119	142	-	-	-	-	-
04-5037	12	13	34	35	134	160	2838	295	63	152	n.d.
04-5038	9	11	33	34	114	132	-	-	-	-	-
04-5039	9	11	26	24	109	119	3249	351	67	125	682
04-5040	10	9	37	37	126	145	-	-	-	-	-
04-5041	14	11	34	31	146	167	2674	295	n.d.	119	217
04-5042	16	16	54	56	242	229	-	-	-	-	-
04-5043	17	16	65	72	156	151	3731	186	147	152	38
04-5044	45	47	80	89	116	119	-	-	-	-	-
04-5045	35	39	74	80	148	166	1219	292	118	190	n.d.
04-5046	21	22	69	72	147	151	-	-	-	-	-
04-5047	19	21	58	61	125	136	1116	271	101	195	n.d.
04-5048	18	20	53	56	103	109	-	-	-	-	-
04-5049	<1	-	63	-	80	-	-	-	-	-	-
04-5050	14	13	43	45	110	118	-	-	-	-	-
04-5051	9	10	36	38	114	132	2961	398	101	200	n.d.
04-5052	8	8	36	37	119	144	-	-	-	-	-
04-5053	9	10	38	40	115	134	2055	316	95	212	110
04-5054	11	10	42	46	144	160	-	-	-	-	-
04-5055	8	8	39	42	131	156	2615	473	73	162	n.d.
04-5056	9	8	38	38	138	161	-	-	-	-	-
04-5057	14	14	32	34	135	161	-	-	-	-	-
04-5058	15	16	64	65	182	175	-	-	-	-	-
04-5059	23	25	77	90	96	116	955	328	78	216	n.d.
04-5060	15	16	68	75	96	102	-	-	-	-	-
04-5088	17	-	66	-	105	-	-	-	-	-	-
04-5061	14	14	59	67	96	97	960	355	90	225	n.d.
04-5062	14	13	57	64	93	94	-	-	-	-	-
04-5063	11	12	53	59	111	133	1048	411	83	240	n.d.
04-5064	13	14	52	57	122	147	-	-	-	-	-
04-5065	11	14	41	46	128	154	1576	439	87	239	n.d.
04-5066	12	13	53	59	149	178	-	-	-	-	-
04-5067	15	14	38	41	165	210	4307	964	n.d.	480	282
04-5068	15	18	36	40	186	223	-	-	-	-	-
04-5069	20	18	35	35	171	201	5775	921	132	442	372
04-5070	20	21	25	23	209	248	-	-	-	-	-
04-5071	13	15	53	53	218	197	4715	442	216	265	n.d.
04-5072	29	32	73	82	130	152	-	-	-	-	-
04-5073	23	29	61	66	89	108	949	462	214	455	n.d.
04-5074	25	28	56	63	92	106	-	-	-	-	-
04-5075	16	18	51	61	84	93	1522	439	211	473	n.d.
04-5089	17	18	58	63	98	113	-	-	-	-	-
04-5076	13	15	44	48	74	93	-	-	-	-	-
04-5077	14	15	31	33	108	123	3430	513	163	443	n.d.
04-5078	15	16	11	8	116	148	-	-	-	-	-
04-5079	17	16	19	19	140	162	5821	803	154	329	255
04-5080	13	15	11	8	132	152	-	-	-	-	-
04-5081	13	16	11	8	143	177	7423	980	107	304	219
04-5082	17	17	11	7	134	175	-	-	-	-	-
04-5083	16	14	9	7	127	151	8072	838	106	226	809
04-5084	17	16	10	5	148	181	-	-	-	-	-
04-5085	18	15	13	7	155	180	7942	1039	109	281	n.d.
04-5086	22	18	11	9	158	183	-	-	-	-	-
04-5087	13	10	10	6	161	173	7368	967	n.d.	206	902

SAMPLE	MUSCOVITE xrd.d2T 8.8	RUTILE xrd.d2T 27.4	HALITE xrd.d2T 31.7	ALBITE xrd.d2T 27.9	ALUNITE xrd.d2T 29.9	ILLITE xrd.d2T 34.6	SIDERITE? xrd.d2T 32.2	TALC xrd.d2T 9.3
04-5001	60	93	-	-	-	-	-	-
04-5002	-	-	-	-	-	-	-	-
04-5003	71	117	-	-	-	-	-	-
04-5004	-	-	-	-	-	-	-	-
04-5005	89	n.d.	-	-	-	-	-	-
04-5006	-	-	-	-	-	-	-	-
04-5007	168	n.d.	-	-	-	-	-	-
04-5008	-	-	-	-	-	-	-	-
04-5009	149	n.d.	-	-	-	-	-	-
04-5010	-	-	-	-	-	-	-	-
04-5011	202	110	-	-	-	-	-	-
04-5012	-	-	-	-	-	-	-	-
04-5013	139	n.d.	-	-	-	-	-	-
04-5014	-	-	-	-	-	-	-	-
04-5015	309	82	-	-	-	-	-	-
04-5016	-	-	-	-	-	-	-	-
04-5017	238	86	-	-	-	-	-	-
04-5019	212	89	76	n.d.	-	-	-	-
04-5020	-	-	-	-	-	-	-	-
04-5021	226	90	75	n.d.	-	-	-	-
04-5022	-	-	-	-	-	-	-	-
04-5023	279	95	104	n.d.	-	-	-	-
04-5024	-	-	-	-	-	-	-	-
04-5025	322	77	113	n.d.	-	-	-	-
04-5026	-	-	-	-	-	-	-	-
04-5027	261	82	173	n.d.	-	-	-	-
04-5028	-	-	-	-	-	-	-	-
04-5029	55	93	n.d.	n.d.	-	-	-	-
04-5030	-	-	-	-	-	-	-	-
04-5031	139	135	n.d.	n.d.	-	-	-	-
04-5032	-	-	-	-	-	-	-	-
04-5033	117	n.d.	n.d.	n.d.	-	-	-	-
04-5034	-	-	-	-	-	-	-	-
04-5035	89	n.d.	n.d.	n.d.	-	-	-	-
04-5036	-	-	-	-	-	-	-	-
04-5037	210	96	58	n.d.	-	-	-	-
04-5038	-	-	-	-	-	-	-	-
04-5039	173	78	87	n.d.	-	-	-	-
04-5040	-	-	-	-	-	-	-	-
04-5041	157	65	152	n.d.	-	-	-	-
04-5042	-	-	-	-	-	-	-	-
04-5043	66	116	n.d.	76	-	-	-	-
04-5044	-	-	-	-	-	-	-	-
04-5045	120	118	n.d.	97	-	-	-	-
04-5046	-	-	-	-	-	-	-	-
04-5047	119	95	n.d.	96	-	-	-	-
04-5048	-	-	-	-	-	-	-	-
04-5049	-	-	-	-	-	-	-	-
04-5050	-	-	-	-	-	-	-	-
04-5051	148	128	n.d.	n.d.	-	-	-	-
04-5052	-	-	-	-	-	-	-	-
04-5053	100	132	n.d.	112	-	-	-	-
04-5054	-	-	-	-	-	n.d.	-	-
04-5055	191	75	n.d.	111	-	-	-	-
04-5056	-	-	-	-	-	-	-	-
04-5057	-	-	-	-	-	-	-	-
04-5058	-	-	-	-	-	-	-	-
04-5059	113	n.d.	n.d.	n.d.	n.d.	-	-	-
04-5060	-	-	-	-	-	-	-	-
04-5088	-	-	-	-	-	-	-	-
04-5061	120	167	n.d.	n.d.	107	-	-	-
04-5062	-	-	-	-	-	-	-	-
04-5063	n.d.	n.d.	n.d.	104	101	-	-	-
04-5064	-	-	-	-	-	-	-	-
04-5065	101	n.d.	n.d.	n.d.	490	-	-	-
04-5066	-	-	-	-	-	-	-	-
04-5067	182	238	n.d.	211	448	-	-	-
04-5068	-	-	-	-	-	-	-	-
04-5069	194	216	n.d.	178	212	-	-	-
04-5070	-	-	-	-	-	-	-	-
04-5071	169	292	n.d.	124	95	n.d.	n.d.	-
04-5072	-	-	-	-	-	-	-	-
04-5073	223	n.d.	n.d.	283	n.d.	n.d.	n.d.	-
04-5074	-	-	-	-	-	-	-	-
04-5075	228	n.d.	n.d.	260	210	n.d.	n.d.	-
04-5089	-	-	-	-	-	-	-	-
04-5076	-	-	-	-	-	-	-	-
04-5077	254	259	n.d.	273	290	n.d.	169	-
04-5078	-	-	-	-	-	-	-	-
04-5079	377	221	n.d.	305	402	225	189	-
04-5080	-	-	-	-	-	-	-	-
04-5081	533	220	n.d.	406	530	258	228	-
04-5082	-	-	-	-	-	-	-	-
04-5083	411	186	n.d.	275	391	n.d.	160	-
04-5084	-	-	-	-	-	-	-	-
04-5085	535	195	200	356	423	202	251	148
04-5086	-	-	-	-	-	-	-	-
04-5087	693	223	640	367	501	208	256	-

Summary of statistics for chemical data for profiles (majors in %, traces in ppm, Au in ppb, conductivity in μS)

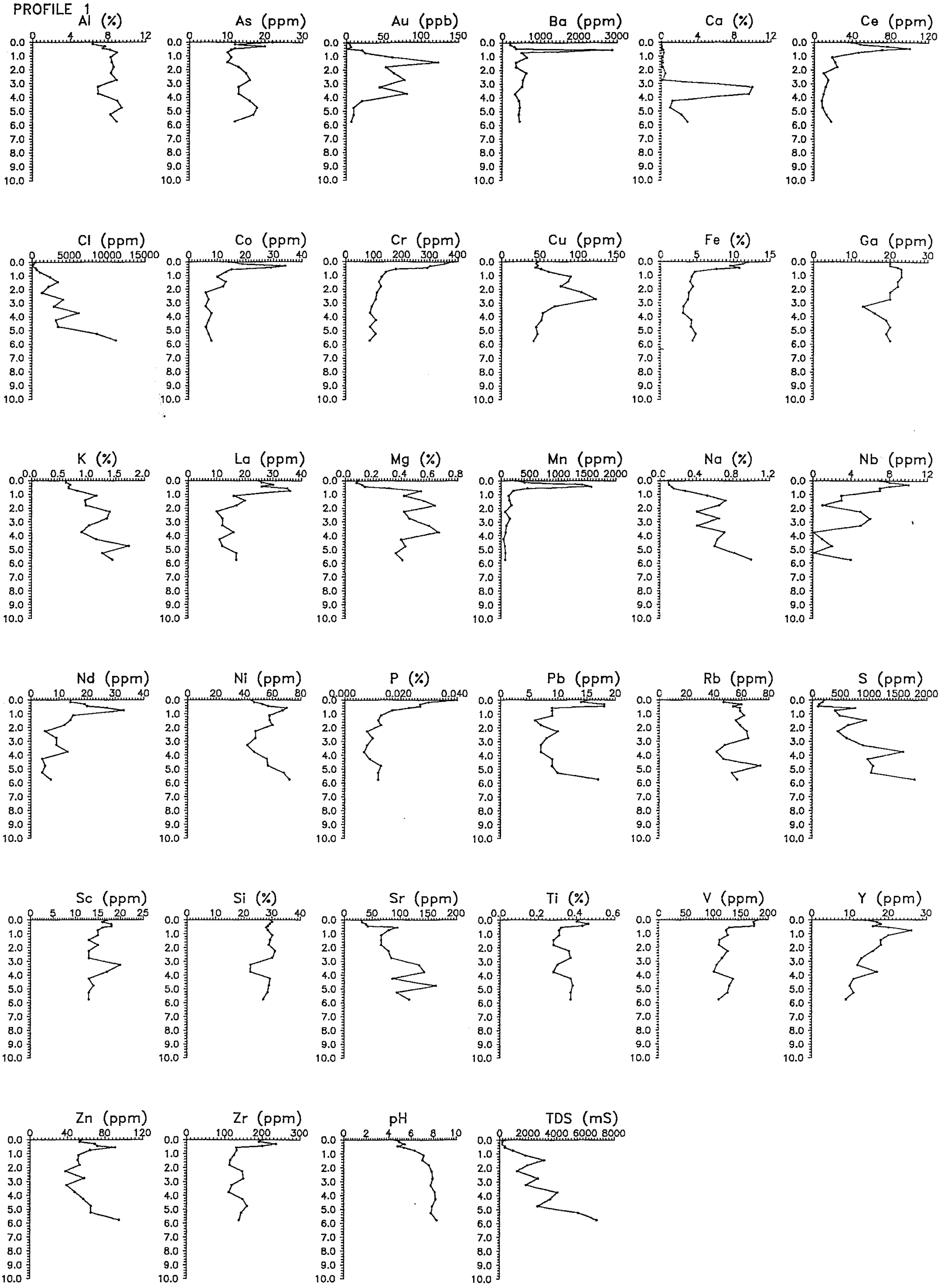
topsoil	pH	cond	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	As	Au	Ba	Ce	Co	Cr	Cu	Ga	La	Nd	Ni	Pb	Rb	Sc	Sr	V	Y	Zn	Zr
Mean	5.74	221	7.00	0.10	484	10.43	0.66	0.18	653	0.14	0.03	255	29.26	0.39	18	9	528	56	21	299	47	21	29	20	53	14	52	16	47	166	17	65	184
Median	5.43	164	6.70	0.09	410	11.06	0.66	0.13	496	0.13	0.03	210	29.28	0.40	18	5	317	51	19	308	46	21	29	19	49	14	51	16	39	174	16	64	197
St.Dev	0.96	280	0.87	0.08	505	2.11	0.07	0.12	440	0.06	0.01	189	0.73	0.06	5	8	722	18	6	78	5	1	5	6	9	3	5	1	19	24	3	10	37
Minimum	4.64	1	6.03	0.03	40	4.71	0.55	0.08	197	0.09	0.02	90	27.99	0.30	10	3	195	35	13	144	42	20	22	13	40	9	45	14	31	123	14	53	131
Maximum	7.58	919	8.98	0.29	1900	12.81	0.81	0.54	1566	0.28	0.04	750	30.58	0.46	27	25	2864	100	34	382	61	24	39	33	70	18	60	18	95	192	26	91	236
Count	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
hardpan	pH	cond	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	As	Au	Ba	Ce	Co	Cr	Cu	Ga	La	Nd	Ni	Pb	Rb	Sc	Sr	V	Y	Zn	Zr
Mean	6.53	564	8.77	0.31	1614	5.15	0.94	0.57	337	0.38	0.015	1135	28.46	0.32	15	58	466	36	13	141	54	23	28	20	63	8	58	15	85	128	20	60	127
Median	6.57	1	8.83	0.25	1360	4.48	0.87	0.47	182	0.33	0.014	480	28.11	0.31	13	41	360	33	12	143	44	23	25	17	60	9	59	15	79	126	17	59	125
St.Dev	1.00	902	0.86	0.25	961	1.81	0.22	0.22	340	0.17	0.005	2627	1.85	0.04	11	46	302	23	6	27	22	3	15	12	20	3	8	2	31	14	9	16	21
Minimum	4.84	1	6.90	0.11	150	2.93	0.64	0.28	68	0.19	0.008	220	25.12	0.26	3	3	202	5	5	85	34	17	8	3	19	1	30	12	62	107	12	33	93
Maximum	8.37	3110	10.37	1.51	4160	10.67	1.48	1.25	1551	0.80	0.034	14820	32.87	0.39	68	191	1753	90	25	191	123	26	70	64	96	16	67	19	235	157	47	90	166
Count	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
saprolite	pH	cond	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	As	Au	Ba	Ce	Co	Cr	Cu	Ga	La	Nd	Ni	Pb	Rb	Sc	Sr	V	Y	Zn	Zr
Mean	7.98	1320	9.00	1.75	4035	3.10	1.42	0.35	53	0.61	0.01	1757	29.36	0.44	33	20	402	15	4	128	30	21	16	7	36	7	60	15	111	143	12	40	164
Median	7.96	1	9.04	0.84	3175	3.43	1.40	0.31	52	0.58	0.01	1390	29.81	0.43	21	17	410	5	4	118	29	22	10	3	33	6	60	14	103	131	11	40	162
St.Dev	0.50	2181	1.17	2.41	3425	1.20	0.48	0.12	28	0.25	0.01	1447	2.26	0.09	32	15	78	30	2	45	13	3	19	11	15	5	20	4	49	38	3	27	27
Minimum	6.14	1	6.87	0.03	270	0.33	0.63	0.16	9	0.30	0.00	240	22.32	0.28	8	3	283	0	1	71	4	13	2	0	15	0	23	9	56	98	8	5	111
Maximum	8.80	8750	11.44	10.01	14850	4.91	2.49	0.67	124	1.31	0.03	6920	33.13	0.67	142	81	654	134	8	261	69	27	91	51	72	22	109	23	274	269	21	130	248
Count	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

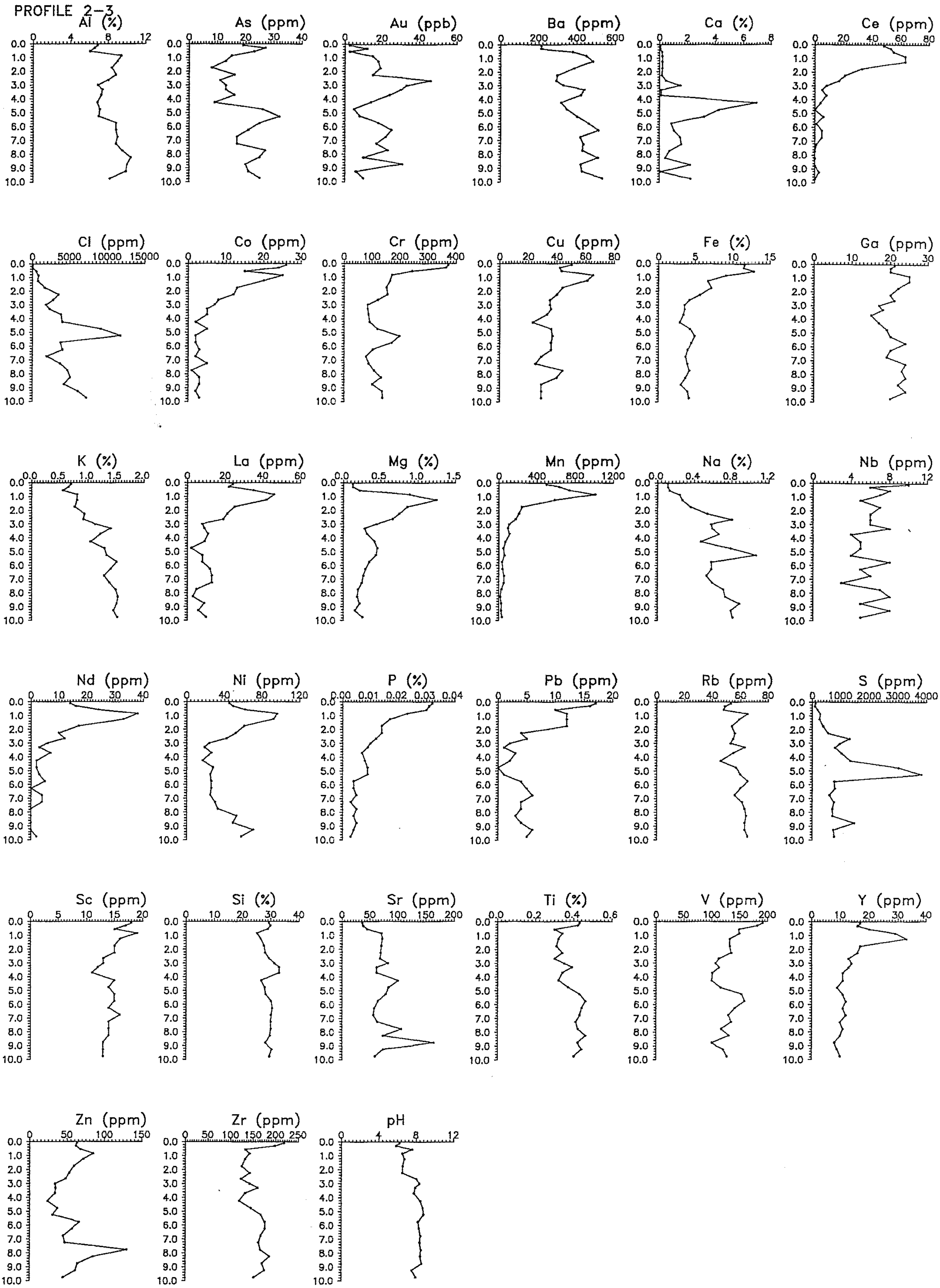
Correlation matrix for profile samples. Highly significant (99.9%) values in bold.

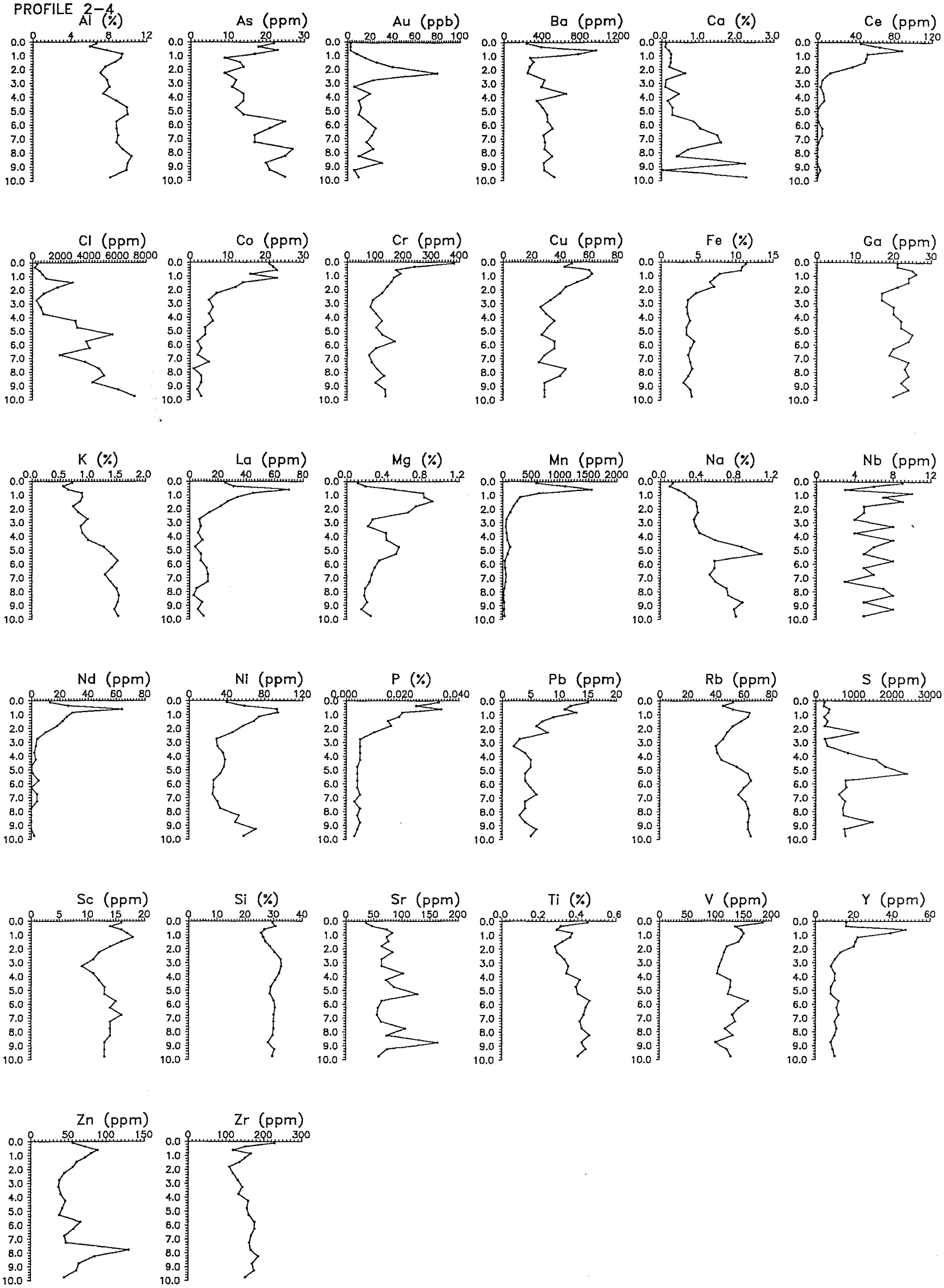
all	pH	cond	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	As	Au	Ba	Ce	Co	Cr	Cu	Ga	La	Nd	Ni	Pb	Rb	Sc	Sr	V	Y	Zn
pH	1.00																															
cond	0.23	1.00																														
Al	0.1	0.22	1.00																													
Ca	**0.39**	0.34	-0.21	1.00																												
Cl	**0.54**	**0.61**	0.1	**0.47**	1.00																											
Fe	**-0.53**	-0.32	**-0.61**	-0.28	**-0.36**	1.00																										
K	**0.53**	**0.50**	**0.54**	0.2	**0.50**	**-0.66**	1.00																									
Mg	0.1	0.0	0.2	0.1	0.0	-0.1	-0.20	1.00																								
Mn	**-0.52**	-0.24	-0.32	-0.24	**-0.39**	**0.70**	**-0.52**	0.0	1.00																							
Na	**0.70**	**0.50**	0.29	0.34	**0.87**	**-0.55**	**0.60**	0.1	**-0.55**	1.00																						
P	**-0.63**	-0.27	**-0.44**	-0.29	**-0.45**	**0.80**	**-0.70**	-0.1	**0.63**	**-0.67**	1.00																					
S	0.1	0.0	0.29	0.1	0.1	-0.34	0.22	0.0	-0.26	0.2	0.0	1.00																				
Si	0.2	-0.2	-0.1	**-0.53**	-0.19	-0.2	0.23	**-0.51**	-0.22	0.0	-0.19	-0.1	1.00																			
Ti	0.31	0.21	**0.39**	-0.1	0.2	-0.31	**0.66**	**-0.46**	-0.26	0.18	-0.2	0.26	0.32	1.00																		
As	0.19	0.27	0.30	0.0	0.1	-0.32	**0.58**	-0.25	-0.22	0.1	-0.23	0.21	0.21	**0.70**	1.00																	
Au	-0.22	0.1	0.1	0.0	-0.1	-0.28	-0.1	0.2	-0.1	-0.1	-0.20	-0.1	0.0	**-0.42**	-0.1	1.00																
Ba	-0.2	-0.1	0.0	-0.1	-0.1	0.1	-0.1	0.0	0.26	-0.1	0.1	-0.1	-0.1	-0.2	-0.1	0.0	1.00															
Ce	**-0.55**	-0.28	-0.1	-0.28	**-0.46**	**0.48**	**-0.63**	0.1	**0.65**	**-0.63**	**0.82**	0.1	-0.23	-0.1	-0.2	-0.1	0.23	1.00														
Co	**-0.69**	-0.25	**-0.38**	-0.29	**-0.47**	**0.81**	**-0.68**	0.1	**0.86**	**-0.64**	**0.74**	-0.31	-0.29	**-0.40**	**-0.36**	-0.1	0.2	**0.64**	1.00													
Cr	**-0.55**	-0.32	**-0.41**	-0.31	**-0.39**	**0.76**	**-0.48**	-0.33	**0.49**	**-0.59**	**0.85**	0.0	0.0	0.2	0.0	-0.32	-0.1	**0.61**	**0.62**	1.00												
Cu	-0.20	0.0	-0.24	-0.1	-0.2	**0.35**	**-0.36**	0.33	0.27	-0.2	0.21	-0.30	-0.24	**-0.55**	**-0.38**	0.30	0.2	0.1	**0.42**	0.0	1.00											
Ga	-0.32	-0.21	**0.60**	**-0.49**	-0.21	0.0	-0.1	0.1	0.2	-0.22	0.23	0.19	-0.1	0.2	0.1	-0.1	0.1	**0.45**	0.2	0.21	-0.1	1.00										
La	**-0.45**	-0.25	0.0	-0.24	**-0.40**	0.30	**-0.54**	0.19	**0.46**	**-0.54**	**0.73**	0.24	-0.29	-0.1	-0.1	-0.1	0.18	**0.92**	**0.45**	**0.46**	0.0	**0.55**	1.00									
Nd	**-0.50**	-0.24	-0.1	-0.23	**-0.44**	**0.43**	**-0.62**	0.30	**0.63**	**-0.58**	**0.73**	0.0	-0.34	-0.30	-0.21	0.0	0.28	**0.89**	**0.61**	**0.41**	0.22	**0.47**	**0.93**	1.00								
Ni	**-0.51**	-0.1	0.1	-0.22	-0.25	**0.44**	**-0.53**	**0.44**	**0.54**	**-0.37**	**0.41**	-0.22	**-0.50**	**-0.59**	**-0.41**	0.2	0.27	**0.46**	**0.63**	0.1	**0.50**	**0.41**	**0.46**	**0.60**	1.00							
Pb	**-0.49**	0.1	0.0	-0.22	-0.31	**0.44**	-0.34	-0.1	**0.44**	**-0.51**	**0.76**	0.2	-0.21	0.19	0.0	-0.18	0.0	**0.76**	**0.51**	**0.70**	0.1	0.34	**0.70**	**0.59**	0.30	1.00						
Rb	0.1	**0.38**	**0.41**	-0.1	0.23	-0.29	**0.74**	-0.1	-0.1	0.26	**-0.46**	-0.30	0.1	**0.37**	**0.42**	0.1	0.0	**-0.47**	-0.20	-0.30	-0.1	0.0	**-0.47**	**-0.37**	-0.1	-0.28	1.00					
Sc	-0.26	0.0	0.19	0.1	-0.33	0.0	0.1	0.0	0.2	**-0.45**	0.23	0.1	-0.26	**0.43**	**0.41**	0.0	-0.1	0.30	0.2	**0.35**	-0.1	0.30	0.30	0.24	0.0	**0.41**	0.30	1.00				
Sr	0.23	0.2	**0.45**	0.23	0.1	**-0.57**	0.23	0.1	**-0.36**	0.2	-0.1	**0.67**	-0.2	0.30	0.22	0.0	0.0	0.23	**-0.45**	-0.20	**-0.36**	0.28	**0.40**	0.2	-0.2	0.24	-0.21	0.20	1.00			
V	-0.24	-0.1	0.1	-0.28	-0.30	0.21	0.1	-0.34	0.1	**-0.39**	**0.36**	0.27	0.1	**0.66**	**0.51**	-0.33	-0.1	0.32	0.1	**0.60**	-0.26	0.32	0.29	0.1	-0.2	**0.52**	0.1	**0.63**	0.1	1.00		
Y	**-0.40**	-0.1	0.0	-0.23	**-0.39**	0.34	**-0.35**	**0.39**	**0.62**	**-0.49**	**0.47**	-0.2	-0.32	-0.23	0.0	0.1	0.31	**0.60**	**0.56**	0.22	0.32	**0.40**	**0.64**	**0.81**	**0.63**	**0.36**	0.0	0.32	-0.1	0.1	1.00	
Zn	**-0.35**	-0.24	-0.1	-0.22	-0.1	**0.55**	**-0.57**	0.2	**0.50**	-0.24	**0.40**	-0.23	-0.33	**-0.55**	**-0.55**	0.0	0.32	**0.37**	**0.56**	0.20	**0.46**	0.26	0.30	**0.41**	**0.71**	0.19	-0.30	-0.23	-0.25	-0.22	0.32	1.00
Zr	0.1	-0.1	0.0	-0.2	0.0	0.2	0.1	**-0.50**	0.1	-0.1	0.33	0.18	0.26	**0.75**	0.29	**-0.59**	-0.1	0.29	0.0	**0.60**	-0.34	0.1	0.20	0.0	**-0.39**	**0.49**	-0.1	0.28	0.2	**0.63**	-0.1	-0.2

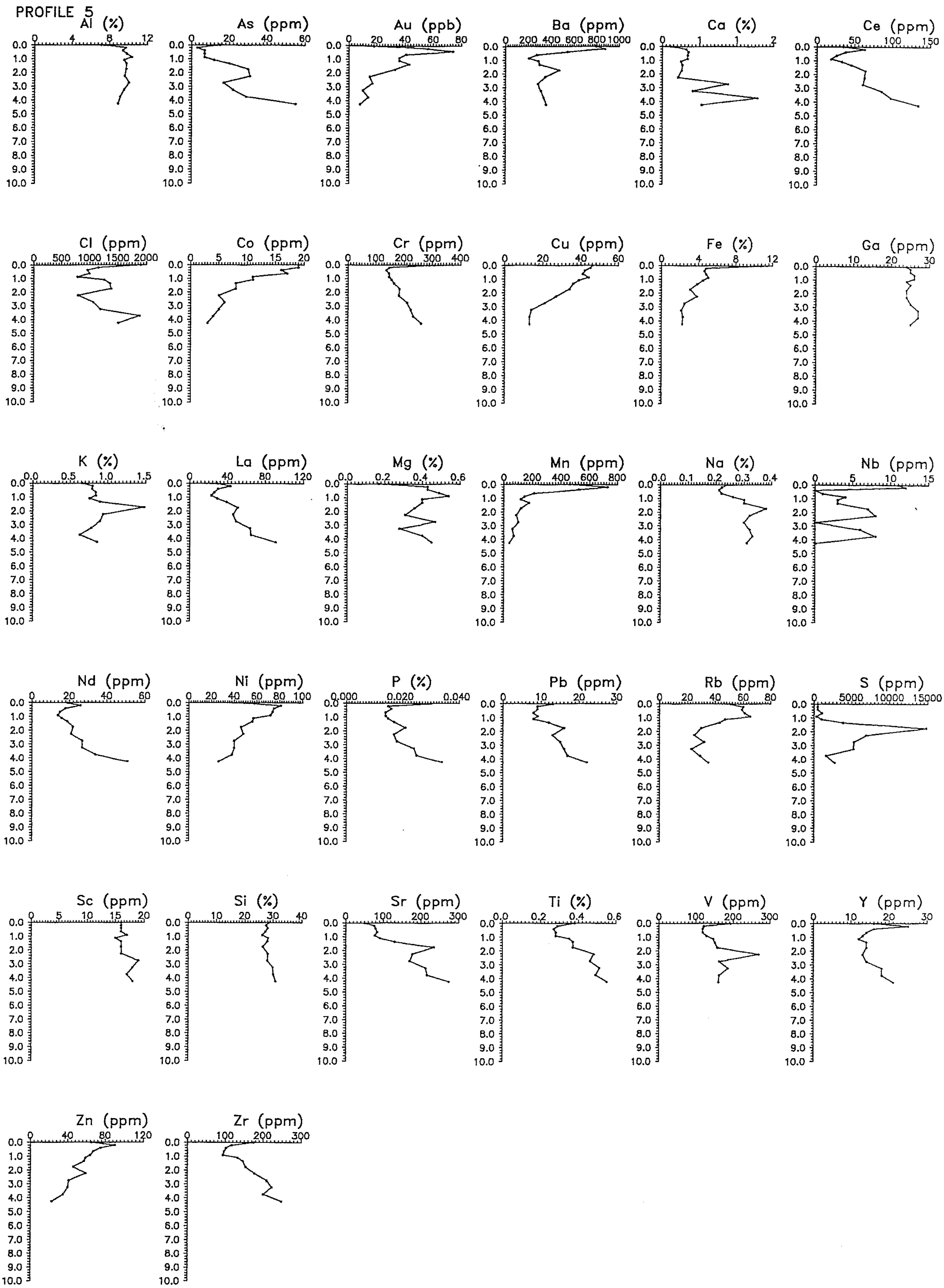
all	pH	cond	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti
QUARTZ	**0.38**	**0.35**	0.2	0.21	0.21	**-0.41**	**0.65**	**-0.44**	-0.33	0.19	-0.30	0.1	0.31	**0.85**
KAOLINITE	**0.38**	**0.44**	**0.58**	0.20	0.25	**-0.67**	**0.66**	-0.19	**-0.46**	0.27	**-0.41**	0.23	0.1	**0.74**
HEMATITE	**-0.61**	-0.29	-0.2	**-0.43**	**-0.60**	**0.36**	**-0.37**	-0.1	0.32	**-0.69**	**0.39**	-0.21	0.25	-0.1
GOETHITE	-0.25	0.1	**0.37**	-0.23	-0.26	-0.31	0.0	0.1	-0.1	-0.30	0.0	0.1	0.1	0.1
CALCITE	**0.48**	**0.51**	-0.1	**0.86**	**0.54**	**-0.47**	**0.37**	0.0	-0.32	**0.39**	-0.33	0.1	**-0.35**	0.31
DOLOMITE	-0.2	-0.1	-0.27	-0.1	-0.1	**0.37**	-0.2	-0.21	0.20	-0.20	0.30	-0.1	0.1	0.1
MUSCOVITE	**0.46**	**0.60**	**0.46**	0.24	**0.44**	**-0.61**	**0.88**	-0.21	**-0.43**	**0.48**	**-0.57**	0.0	0.1	**0.66**
RUTILE	0.1	0.1	0.1	0.0	0.0	-0.1	0.29	-0.30	-0.1	-0.1	0.0	0.0	0.29	**0.65**
HALITE	**0.36**	**0.55**	0.1	0.34	**0.71**	-0.33	**0.60**	-0.18	-0.25	**0.63**	**-0.37**	0.0	-0.1	**0.36**
ALBITE	0.0	0.34	**0.37**	0.0	0.0	**-0.43**	**0.44**	-0.1	-0.20	0.0	-0.24	0.0	0.1	**0.52**
ALUNITE	0.0	0.31	**0.44**	0.0	0.0	**-0.51**	**0.55**	-0.18	-0.29	0.0	-0.19	**0.53**	0.0	**0.61**
ILLITE	0.19	**0.43**	**0.37**	0.0	0.2	**-0.38**	**0.69**	-0.19	-0.20	0.19	-0.34	0.1	0.1	**0.66**
SIDERITE	0.2	**0.48**	0.31	0.1	0.2	**-0.45**	**0.71**	-0.21	-0.24	0.18	**-0.39**	0.1	0.1	**0.66**
TALC	0.1	0.2	0.19	-0.1	0.0	-0.1	0.32	-0.1	-0.1	0.1	-0.2	0.0	0.1	**0.36**

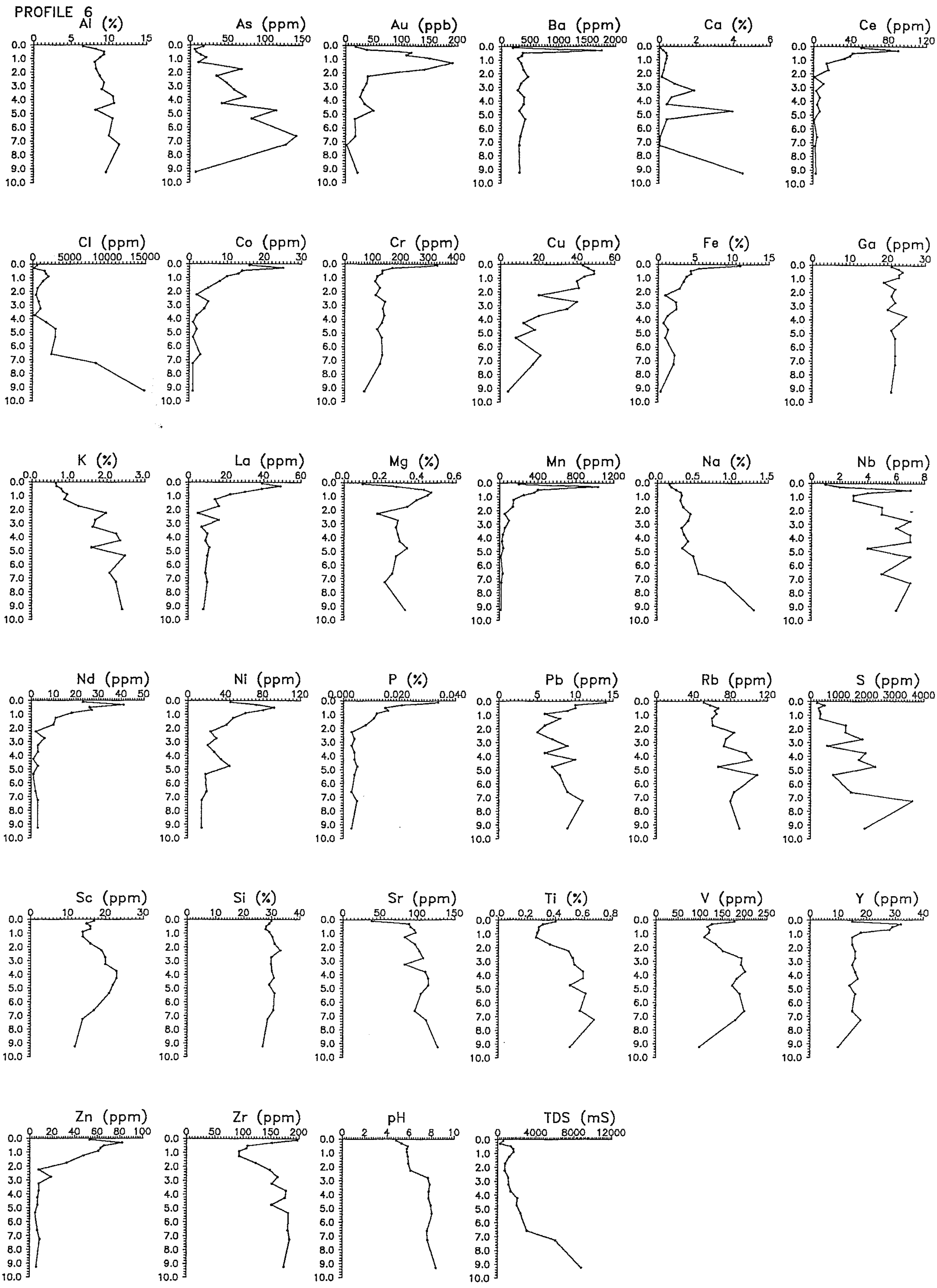
all	As	Au	Ba	Ce	Co	Cr	Cu	Ga	La	Nd	Ni	Pb	Rb	Sc	Sr	V	Y	Zn	Zr
QUARTZ	**0.71**	-0.19	-0.24	-0.27	**-0.49**	0.0	**-0.53**	-0.1	-0.25	**-0.38**	**-0.61**	0.0	**0.40**	**0.37**	0.22	**0.47**	-0.31	**-0.64**	**0.49**
KAOLINITE	**0.58**	0.0	-0.20	-0.20	**-0.56**	-0.27	**-0.49**	0.23	0.0	-0.23	**-0.40**	0.0	**0.35**	**0.35**	**0.56**	0.31	-0.21	**-0.52**	0.31
HEMATITE	0.2	0.34	0.0	**0.39**	**0.37**	**0.39**	0.1	0.25	**0.36**	**0.42**	0.27	0.23	0.0	0.31	-0.31	**0.38**	**0.45**	-0.1	-0.1
GOETHITE	0.23	**0.56**	-0.1	0.32	-0.1	0.0	-0.1	**0.51**	**0.44**	**0.38**	0.1	0.22	0.0	0.32	**0.37**	0.22	0.27	-0.21	-0.1
CALCITE	0.18	0.0	-0.2	-0.27	**-0.43**	-0.28	**-0.44**	-0.29	-0.20	-0.28	**-0.39**	-0.1	0.1	0.18	**0.38**	-0.1	-0.24	**-0.48**	0.1
DOLOMITE	0.0	-0.1	-0.1	0.2	0.31	**0.44**	0.0	-0.1	0.0	0.0	0.0	0.25	-0.1	0.1	-0.20	0.23	0.0	0.1	0.23
MUSCOVITE	**0.56**	0.1	-0.1	**-0.49**	**-0.57**	**-0.42**	**-0.39**	0.0	**-0.41**	**-0.49**	**-0.43**	-0.22	**0.74**	0.2	0.29	0.1	-0.23	**-0.52**	0.2
RUTILE	**0.45**	-0.18	-0.27	0.0	-0.2	0.19	**-0.36**	0.1	0.0	-0.1	**-0.36**	0.1	0.19	**0.36**	0.1	**0.46**	-0.1	**-0.43**	**0.52**
HALITE	0.1	-0.2	-0.1	**-0.36**	**-0.37**	-0.24	**-0.39**	-0.1	-0.33	**-0.38**	**-0.42**	-0.20	**0.44**	-0.28	0.1	-0.18	-0.28	-0.33	0.18
ALBITE	**0.59**	0.31	-0.18	-0.1	-0.28	-0.1	**-0.41**	0.29	0.0	-0.1	-0.22	0.0	**0.45**	**0.41**	0.24	**0.39**	0.1	**-0.58**	0.1
ALUNITE	**0.60**	0.1	-0.2	0.0	-0.34	0.0	**-0.46**	0.30	0.1	-0.1	**-0.36**	0.2	0.26	**0.49**	**0.52**	**0.47**	-0.1	**-0.61**	0.23
ILLITE	**0.50**	-0.1	-0.1	-0.26	-0.28	-0.1	-0.32	0.1	-0.24	-0.29	**-0.39**	-0.1	**0.66**	**0.35**	0.1	**0.41**	-0.1	**-0.54**	0.21
TALC	**0.73**	0.1	0.0	-0.1	-0.1	0.0	-0.2	0.0	-0.1	-0.2	-0.22	0.0	0.29	0.1	0.0	0.33	0.0	-0.28	0.1


PROFILE 1
Al (%)
As (ppm)
Au (ppb)
Ba (ppm)
Ca (%)
Ce (ppm)
Cl (ppm)
Co (ppm)
Cr (ppm)
Cu (ppm)
Fe (%)
Ga (ppm)
K (%)
La (ppm)
Mg (%)
Mn (ppm)
Na (%)
Nb (ppm)
Nd (ppm)
Ni (ppm)
P (%)
Pb (ppm)
Rb (ppm)
S (ppm)
Sc (ppm)
Si (%)
Sr (ppm)
Ti (%)
V (ppm)
Y (ppm)
Zn (ppm)
Zr (ppm)
pH
TDS (mS)


PROFILE 2-3
Al (%)
As (ppm)
Au (ppb)
Ba (ppm)
Ca (%)
Ce (ppm)
Cl (ppm)
Co (ppm)
Cr (ppm)
Cu (ppm)
Fe (%)
Ga (ppm)
K (%)
La (ppm)
Mg (%)
Mn (ppm)
Na (%)
Nb (ppm)
Nd (ppm)
Ni (ppm)
P (%)
Pb (ppm)
Rb (ppm)
S (ppm)
Sc (ppm)
Si (%)
Sr (ppm)
Ti (%)
V (ppm)
Y (ppm)
Zn (ppm)
Zr (ppm)
pH


PROFILE 2-4
Al (%)
As (ppm)
Au (ppb)
Ba (ppm)
Ca (%)
Ce (ppm)
Cl (ppm)
Co (ppm)
Cr (ppm)
Cu (ppm)
Fe (%)
Ga (ppm)
K (%)
La (ppm)
Mg (%)
Mn (ppm)
Na (%)
Nb (ppm)
Nd (ppm)
Ni (ppm)
P (%)
Pb (ppm)
Rb (ppm)
S (ppm)
Sc (ppm)
Si (%)
Sr (ppm)
Ti (%)
V (ppm)
Y (ppm)
Zn (ppm)
Zr (ppm)


PROFILE 5
Al (%)
As (ppm)
Au (ppb)
Ba (ppm)
Ca (%)
Ce (ppm)
Cl (ppm)
Co (ppm)
Cr (ppm)
Cu (ppm)
Fe (%)
Ga (ppm)
K (%)
La (ppm)
Mg (%)
Mn (ppm)
Na (%)
Nb (ppm)
Nd (ppm)
Ni (ppm)
P (%)
Pb (ppm)
Rb (ppm)
S (ppm)
Sc (ppm)
Si (%)
Sr (ppm)
Ti (%)
V (ppm)
Y (ppm)
Zn (ppm)
Zr (ppm)


PROFILE 6
Al (%)
As (ppm)
Au (ppb)
Ba (ppm)
Ca (%)
Ce (ppm)
Cl (ppm)
Co (ppm)
Cr (ppm)
Cu (ppm)
Fe (%)
Ga (ppm)
K (%)
La (ppm)
Mg (%)
Mn (ppm)
Na (%)
Nb (ppm)
Nd (ppm)
Ni (ppm)
P (%)
Pb (ppm)
Rb (ppm)
S (ppm)
Sc (ppm)
Si (%)
Sr (ppm)
Ti (%)
V (ppm)
Y (ppm)
Zn (ppm)
Zr (ppm)
pH
TDS (mS)

DRILL CORE DATA

DRILL HOLE	DESCRIPTION	DEPOSIT	E.	N.	D.	Si xrf %	Al xrf %	Fe xrf %	Fe xrf.p %	Mn xrf ppm	Mg xrf %	Ca xrf %	Na xrf %
GSD-150	SEDIMENT	GOANNA	443315	6813258	77.5	22.13	6.85	13.29	13	2354	0.49	0.29	4.80
GSD-78	BIF	GOANNA	443042	6814022	99.5	22.00	4.02	27.02	26.3	310	0.19	0.02	0.04
GSD-72	SEDIMENT	GOANNA	443275	6813608	101.5	21.99	9.27	11.26	11.6	2695	0.49	0.06	2.47
GSD-75	SEDIMENT	GOANNA	443080	6813940	113.5	23.55	9.75	11.44	10.9	70	0.17	0.05	1.06
GSD-75	SEDIMENT	GOANNA	443080	6813940	114.5	29.88	9.47	3.22	3.7	39	0.40	0.09	1.74
GSD-18	ALT.SEDIMENT	GRANNY	443640	6812620	61.5	25.08	7.45	5.29	5.8	1371	1.11	2.56	4.70
GSD-124	ALT. DIORITE	GRANNY	443677	6812185	91.5	28.41	7.50	2.36	2.7	457	1.10	2.72	4.96
GSD-109	ALT.SEDIMENT	GRANNY	443758	6812420	93.5	23.47	7.17	5.55	5.5	852	1.18	2.66	2.12
GSD-57	ALT.SEDIMENT	GRANNY	443679	6812220	101.5	26.45	7.04	5.83	6.5	937	1.29	2.12	2.28
GSD-57	ALT. DIORITE	GRANNY	443679	6812220	110.5	26.93	7.50	2.78	3	596	1.28	3.31	5.57
GSD-68	ALT.SEDIMENT	GRANNY	443755	6812300	135.5	22.90	7.75	6.80	7.5	1526	1.78	3.46	2.78
GRC-820	ALT.SEDIMENT	WINDICH	443760	6811180	99.5	28.73	7.96	5.78	5.9	1727	0.55	0.4	1.37
GSD-101	ALT.SEDIMENT	WINDICH	443730	6811460	112.5	28.24	6.79	4.08	4.3	627	0.83	1.92	2.63
GSD-104	ALT. DIORITE	WINDICH	443682	6811380	86.5	27.98	8.07	2.48	2.5	449	0.99	2.51	5.61
GSD-149	ALT. DIORITE	WINDICH	443643	6811303	68.5	26.82	8.64	4.43	5.1	767	1.81	3.32	3.54
GSD-153	GRANODIORITE	WINDICH	443479	6811420	46.5	30.52	7.74	1.75	1.9	341	0.77	1.92	5.04

DRILL HOLE	K xrf %	Ti xrf %	Ti xrf.p %	P xrf %	Ag xrf.p ppm	As xrf.p ppm	Au fa ppm	Ba xrf ppm	Ba xrf.p ppm	Bi xrf.p ppm	Cd xrf.p ppm	Ce xrf ppm	Ce xrf.p ppm
GSD-150	1.15	0.43	0.49	0.086	5	244	4.11	342	384	0.5	0.5	69	52
GSD-78	1.30	0.17	0.20	0.138	0.5	50	4.63	252	274	0.5	0.5	76	93
GSD-72	0.27	0.41	0.44	0.008	0.5	29	8.03	37	68	0.5	0.5	79	62
GSD-75	0.40	0.44	0.51	0.044	0.5	235	12.3	115	143	0.5	0.5	83	71
GSD-75	2.52	0.43	0.47	0.006	2	67	3.35	465	573	0.5	0.5	59	47
GSD-18	2.22	0.39	0.43	0.113	3	24	5.21	506	558	0.5	1	108	83
GSD-124	2.06	0.2	0.27	0.093	0.5	1	4.84	567	609	0.5	0.5	98	79
GSD-109	6.45	0.43	0.47	0.0	1	42	6.95	415	493	5	0.5	39	19
GSD-57	3.90	0.36	0.38	0.031	2	22	8.20	343	402	0.5	0.5	35	19
GSD-57	1.11	0.28	0.32	0.112	0.5	0.5	7.25	200	246	0.5	1	122	99
GSD-68	3.76	0.51	0.55	0.051	1	9	16.4	345	389	0.5	0.5	29	21
GRC-820	3.35	0.4	0.34	0.1	0.5	46	8.55	249	261	2	0.5	44	27
GSD-101	4.23	0.3	0.37	0.0	1	6	5.75	248	291	1	1	41	21
GSD-104	1.76	0.2	0.28	0.1	1	0.5	3.24	787	862	0.5	3	109	97
GSD-149	2.91	0.49	0.54	0.224	0.5	0.5	13.5	1074	1188	0.5	1	179	162
GSD-153	2.13	0.19	0.20	0.085	0.5	0.5	2.83	967	1103	0.5	0.5	86	72

DRILL HOLE	Cl xrf ppm	Co xrf ppm	Co xrf.p ppm	Cr xrf ppm	Cr xrf.p ppm	Cs xrf.p ppm	Cu xrf ppm	Cu xrf.p ppm	Ga xrf ppm	Ga xrf.p ppm	Ge xrf.p ppm	In xrf.p ppm	La xrf ppm
GSD-150	360	22	32	65	79	1	42	51	17	19	1	1	8
GSD-78	310	2	22	21	30	6	81	105	7	8	1	0.5	22
GSD-72	1110	114	141	68	89	0.5	33	25	22	23	4	0.5	26
GSD-75	330	19	36	107	128	3	41	37	22	27	0.5	2	27
GSD-75	500	48	42	169	198	8	74	70	22	23	1	0.5	25
GSD-18	250	22	18	72	78	1	41	41	20	20	1	0.5	34
GSD-124	260	13	5	29	30	2	29	21	19	20	2	0.5	50
GSD-109	150	32	24	130	140	0.5	41	31	16	18	1	1	11
GSD-57	170	22	24	105	111	2	69	81	16	17	1	0.5	4
GSD-57	270	15	10	36	31	2	17	13	21	23	1	0.5	44
GSD-68	80	32	32	166	176	10	107	116	19	20	1	0.5	3
GRC-820	3510	31	21	64	66	7	61	61	18	20	1	0.5	17
GSD-101	180	18	17	73	78	1	51	61	15	18	2	0.5	7
GSD-104	180	15	7	19	21	2	18	0.5	18	20	1	0.5	47
GSD-149	340	19	19	6	3	9	46	47	19	21	1	0.5	81
GSD-153	200	11	7	20	11	0.5	24	20	21	20	1	2	37

DRILL HOLE	La xrf.p ppm	Mn xrf.p ppm	Mo xrf.p ppm	Nb xrf ppm	Nb xrf.p ppm	Nd xrf.p ppm	Ni xrf ppm	Ni xrf.p ppm	Pb xrf ppm	Pb xrf.p ppm	Rb xrf ppm	Rb xrf.p ppm
GSD-150	35	2593	0.5	3	7	22	69	50	24	19	30	38
GSD-78	49	261	1	3	1	35	22	11	10	8	63	70
GSD-72	32	2852	3	8	11	32	179	195	9	9	6	9
GSD-75	48	35	0.5	5	6	47	145	146	8	7	12	18
GSD-75	31	10	6	3	9	27	139	150	6	7	98	115
GSD-18	46	1580	16	5	9	42	39	45	12	7	53	63
GSD-124	47	525	27	4	7	42	11	22	15	12	52	58
GSD-109	14	1032	12	4	5	8	81	62	12	12	173	200
GSD-57	9	1035	12	3	6	9	53	43	13	9	125	143
GSD-57	53	697	69	1	6	50	23	23	11	10	23	29
GSD-68	14	1689	5	2	8	10	119	80	10	3	135	152
GRC-820	17	1784	8	4	5	13	66	63	13	9	131	147
GSD-101	17	718	15	4	8	9	38	42	80	76	123	138
GSD-104	56	503	29	4	8	46	67	14	11	13	40	48
GSD-149	87	817	1	9	10	86	22	29	13	16	111	119
GSD-153	43	384	2	3	6	36	1	10	11	13	56	62

DRILL HOLE	S xrf ppm	Sb xrf.p ppm	Sc xrf.p ppm	Se xrf.p ppm	Sr xrf.p ppm	V xrf ppm	V xrf.p ppm
GSD-150	20750	4	15	0.5	115	108	131
GSD-78	140	0.5	7	1	30	283	327
GSD-72	22740	3	16	0.5	70	72	90
GSD-75	27190	14	18	0.5	38	82	106
GSD-75	11000	0.5	22	0.5	86	141	186
GSD-18	22720	3	15	0.5	548	58	62
GSD-124	10280	3	9	0.5	635	58	60
GSD-109	36770	5	22	0.5	382	74	80
GSD-57	19100	5	18	0.5	328	109	132
GSD-57	15580	0.5	12	0.5	544	61	59
GSD-68	18620	3	27	1	312	177	225
GRC-820	15660	0.5	12	1	66	95	107
GSD-101	20420	0.5	14	1	297	53	69
GSD-104	15320	3	7	1	829	39	51
GSD-149	3120	6	11	0.5	1201	96	118
GSD-153	5780	1	6	0.5	489	34	32

DRILL HOLE	W xrf.p ppm	Y xrf.p ppm	Zn xrf ppm	Zn xrf.p ppm	Zr xrf ppm	Zr xrf.p ppm
GSD-150	76	14	134	148	104	107
GSD-78	21	9	70	59	65	57
GSD-72	58	25	325	376	151	167
GSD-75	129	69	173	177	142	149
GSD-75	43	20	137	163	122	147
GSD-18	90	26	106	121	153	163
GSD-124	68	10	51	53	137	156
GSD-109	98	13	121	139	89	93
GSD-57	48	10	99	103	92	97
GSD-57	106	12	68	73	139	151
GSD-68	75	14	193	215	98	102
GRC-820	12	14	175	183	116	133
GSD-101	57	9	456	541	105	115
GSD-104	62	10	26	23	146	170
GSD-149	14	19	88	95	230	226
GSD-153	59	7	28	24	120	138

DRILL HOLE	MICROCLINE xrd.d2T 27.04	MICROCLINE xrd.d2T 27.42	MUSCOVITE xrd.d2T 8.72	PYRITE xrd.d2T 33.06	QUARTZ xrd.d2T 20.84	SIDERITE xrd.d2T 31.84
GSD-150	119	1822	145	724	162	719
GSD-78	n.d.	n.d.	224	n.d.	728	n.d.
GSD-72	n.d.	n.d.	n.d.	383	485	1109
GSD-75	n.d.	157	n.d.	244	909	n.d.
GSD-75	n.d.	n.d.	513	n.d.	976	n.d.
GSD-18	259	698	n.d.	295	301	342
GSD-124	280	717	138	118	527	n.d.
GSD-109	652	1342	n.d.	426	n.d.	n.d.
GSD-57	n.d.	755	380	198	608	n.d.
GSD-57	179	610	n.d.	138	315	n.d.
GSD-68	n.d.	442	712	153	335	n.d.
GRC-820	n.d.	n.d.	633	181	1143	537
GSD-101	453	1201	160	223	764	n.d.
GSD-104	227	812	n.d.	234	382	n.d.
GSD-149	277	726	1371	143	390	125
GSD-153	n.d.	1108	121	97	667	n.d.

DRILL HOLE	ALBITE xrd.d2T 27.9	ANKERITE xrd.d2T 30.88	CALCITE xrd.d2T 29.44	GOETHITE xrd.d2T 21.24	HEMATITE xrd.d2T 33.14	KAOLINITE xrd.d2T 12.44
GSD-150	1822	n.d.	n.d.	n.d.	n.d.	n.d.
GSD-78	n.d.	n.d.	n.d.	349	360	137
GSD-72	991	n.d.	n.d.	n.d.	n.d.	607
GSD-75	478	n.d.	n.d.	n.d.	n.d.	801
GSD-75	1078	n.d.	n.d.	n.d.	n.d.	n.d.
GSD-18	2515	946	n.d.	n.d.	n.d.	n.d.
GSD-124	2904	n.d.	125	n.d.	n.d.	n.d.
GSD-109	935	968?	200	n.d.	n.d.	n.d.
GSD-57	1351	732	109	n.d.	n.d.	n.d.
GSD-57	4046	1264	74	n.d.	n.d.	n.d.
GSD-68	1402	1018	144	n.d.	n.d.	n.d.
GRC-820	731	137	n.d.	n.d.	n.d.	199
GSD-101	1704	789	177	n.d.	n.d.	124
GSD-104	3943	904	103	n.d.	n.d.	n.d.
GSD-149	2444	256	248	n.d.	n.d.	133?
GSD-153	4088	768	121	n.d.	n.d.	n.d.

SEPARATIONS DATA

SAMPLE	PROFILE	DEPTH m	DESCRIPTION	Al xrf %	Ca xrf %	Cl xrf ppm	Fe xrf %	K xrf %	Mg xrf %	Mn xrf ppm	Na xrf %	P xrf %	S xrf %
5007H	1	1.10	Saprolite	-	-	-	-	-	-	-	-	-	-
5007A	1	1.10	Saprolite	8.36	0.08	1840	3.74	1.43	0.28	70	0.36	0.011	0.037
5008C	1	1.45	Saprolite - some hardpan	8.51	0.09	2280	3.52	1.29	0.30	62	0.36	0.009	0.037
5009C	1	1.80	Saprolite	9.44	0.06	850	5.28	2.32	0.37	62	0.38	0.013	0.017
5010B	1	2.25	Saprolite	8.77	0.08	630	3.66	1.64	0.26	46	0.30	0.009	0.022
5011C	1	2.75	Saprolite	9.21	0.05	1610	3.63	1.73	0.28	54	0.36	0.009	0.013
5012C	1	3.25	Saprolite	8.94	0.81	2930	3.58	1.45	0.30	46	0.42	0.009	0.041
5013C	1	3.75	Saprolite	9.45	0.19	1170	3.46	1.34	0.26	62	0.68	0.009	0.059
5014B	1	4.25	Saprolite	8.95	0.06	1440	3.84	1.05	0.28	46	0.55	0.010	0.073
5007B	1	1.10	Cemented hardpan	8.53	0.19	3350	4.27	0.80	0.50	170	0.62	0.016	0.052
5007C	1	1.10	Cemented hardpan-dk stained	8.47	0.19	3980	5.12	0.86	0.58	240	0.65	0.018	0.043
5008A	1	1.45	Cemented hardpan-dk stained	8.21	0.17	8530	3.86	0.84	0.60	186	0.88	0.014	0.077
5008B	1	1.45	Hardpan - some saprolite	8.45	0.16	5610	4.01	0.90	0.66	139	0.80	0.013	0.065
5009B	1	1.80	Hardpan	8.37	0.19	4130	4.32	0.81	0.68	186	0.69	0.014	0.041
5010C	1	2.25	Hardpan	8.30	0.31	1880	3.80	1.19	0.63	108	0.45	0.010	0.023
5011B	1	2.75	Hardpan - difficult to separate	8.85	0.41	5360	4.39	1.07	0.59	232	0.76	0.011	0.068
5012B	1	3.25	Hardpan-difficult to separate	5.19	17.40	3080	2.60	0.65	0.81	54	0.43	0.007	0.109
5013B	1	3.75	Hardpan-difficult to separate	6.29	12.29	3370	2.68	0.77	0.81	77	0.76	0.008	0.192
5007D	1	1.10	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5008D	1	1.45	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5009A	1	1.80	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5010A	1	2.25	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5011A	1	2.75	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5012A	1	3.25	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5013A	1	3.75	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5014A	1	4.25	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5007G	1	1.10	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5008E	1	1.45	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5009D	1	1.80	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5010D	1	2.25	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5011D	1	2.75	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5012D	1	3.25	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5013D	1	3.75	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5014C	1	4.25	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5007E	1	1.10	Opaline skins	6.35	0.19	1950	3.15	0.65	0.49	116	0.66	0.009	0.048
5007F	1	1.10	Pale concretionary material	-	-	-	-	-	-	-	-	-	-
5014D	1	4.25	Pale concretionary material	4.13	20.62	3100	1.76	0.51	0.99	46	0.56	0.007	0.191
5050A	4	2.25	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5050B	4	2.25	Dark lag	-	-	-	-	-	-	-	-	-	-
5050C	4	2.25	Pale concretionary material	-	-	-	-	-	-	-	-	-	-
5050D	4	2.25	>2mm size fraction	-	-	-	-	-	-	-	-	-	-
5060A	5	0.40	Saprolite	3.84	0.11	270	1.23	0.33	0.11	287	0.10	0.018	0.231
5060B	5	0.40	Dark stained hardpan	9.57	0.36	640	5.04	0.77	0.48	968	0.21	0.014	0.02
5062A	5	0.90	<2mm size fraction	-	-	-	-	-	-	-	-	-	-
5062B	5	0.90	Saprolite	9.34	0.23	870	3.51	1.00	0.26	70	0.27	0.019	0.685
5062C	5	0.90	Hardpan	10.34	0.33	1040	5.08	0.81	0.55	186	0.24	0.013	0.019
5076A	6	1.25	Saprolite in hardpan	-	-	-	-	-	-	-	-	-	-
5076B	6	1.25	Saprolite	7.63	0.16	200	2.19	1.77	0.18	54	0.24	0.004	0.058
5077B	6	1.75	Saprolite - "pure"	8.99	0.10	160	1.17	2.58	0.14	31	0.33	0.003	0.074
5077C	6	1.75	Saprolite - "impure"	-	-	-	-	-	-	-	-	-	-
5078B	6	2.25	Saprolite	8.54	0.11	210	2.09	1.68	0.16	46	0.39	0.003	0.04
5079C	6	2.75	Saprolite	9.21	3.27	1110	1.69	1.97	0.33	163	0.38	0.003	0.108
5076C	6	1.25	Red hardpan	7.86	0.30	660	3.40	0.75	0.43	132	0.25	0.011	0.034
5076D	6	1.25	Red hardpan + carbonate (?)	8.23	0.35	480	3.75	0.81	0.46	139	0.24	0.012	0.019
5077D	6	1.75	Hardpan	8.14	0.26	870	3.28	1.02	0.43	132	0.38	0.010	0.062
5078A	6	2.25	Hardpan, soil, skins	7.46	0.29	2100	3.17	1.00	0.57	372	0.50	0.010	0.042
5071B	6	0.10	<2mm size - wet sieved	-	-	-	-	-	-	-	-	-	-
5071C	6	0.10	>2mm size - wet sieved	-	-	-	-	-	-	-	-	-	-
5077A	6	1.75	Coatings on saprolite	7.54	0.28	1940	3.41	0.97	0.44	124	0.36	0.012	0.03
5079A	6	2.75	<2mm size fraction	7.49	1.73	2850	2.73	1.05	0.66	488	0.49	0.009	0.054
5079B	6	2.75	Carbonate segregation	4.47	18.10	1120	1.50	0.61	0.99	132	0.22	0.003	0.12

SAMPLE	Si xrf %	Ti xrf %	Au inaa ppb	Au inaa ppb	Ba xrf ppm	Ce xrf ppm	Cr xrf ppm	Co xrf ppm	Cu xrf ppm	Ga xrf ppm	La xrf ppm	Ni xrf ppm	Nb xrf ppm	Pb xrf ppm	Rb xrf ppm	Sr xrf ppm	V xrf ppm	Y xrf ppm	Zn xrf ppm	Zr xrf ppm
5007H	-	-	114	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5007A	31.8	0.37	24	62	747	19	112	19	100	17	9	51	1	14	56	55	108	17	52	129
5008C	31.9	0.35	92	123	387	14	95	1	93	18	6	38	3	18	54	53	100	16	40	126
5009C	29.4	0.43	38	53	764	21	163	1	93	26	7	46	1	16	88	75	155	23	34	149
5010B	31.8	0.38	47	64	536	7	99	42	109	20	2	43	1	19	65	64	117	14	33	136
5011C	31.7	0.40	48	78	516	21	85	2	135	20	7	38	4	20	68	87	112	11	53	144
5012C	30.6	0.38	17	45	455	16	92	51	71	19	2	53	1	16	60	70	113	12	46	137
5013C	30.1	0.36	43	81	458	25	92	29	357	20	8	86	2	39	48	76	106	10	414	128
5014B	30.7	0.34	9	21	398	25	85	45	46	16	9	65	1	18	40	67	105	11	59	121
5007B	29.6	0.25	68	62	580	31	120	7	37	19	25	61	1	15	52	62	91	20	54	84
5007C	27.0	0.28	38	62	759	36	444	10	45	19	19	65	2	15	53	80	111	24	53	103
5008A	29.6	0.25	76	123	210	34	213	8	53	19	20	50	1	11	44	54	95	25	48	88
5008B	29.0	0.26	124	123	392	31	122	73	51	19	17	51	3	11	48	59	91	19	47	101
5009B	28.4	0.24	39	53	223	29	104	5	34	21	15	50	1	15	48	56	95	16	50	81
5010C	30.4	0.32	96	64	375	17	104	4	79	19	13	44	2	11	53	59	98	17	54	115
5011B	28.5	0.34	72	78	331	24	106	7	106	19	9	47	2	17	53	58	104	13	69	123
5012B	15.5	0.14	72	45	286	17	67	6	16	11	5	13	1	6	32	165	74	10	33	81
5013B	19.6	0.18	69	81	238	28	72	65	68	11	18	19	2	5	36	143	78	12	74	90
5007D	-	-	70	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5008D	-	-	116	123	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5009A	-	-	60	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5010A	-	-	123	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5011A	-	-	149	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5012A	-	-	72	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5013A	-	-	73	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5014A	-	-	37	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5007G	-	-	52	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5008E	-	-	74	123	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5009D	-	-	40	53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5010D	-	-	75	64	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5011D	-	-	72	78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5012D	-	-	49	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5013D	-	-	52	81	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5014C	-	-	16	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5007E	32.5	0.15	87	62	485	53	210	5	1	13	34	66	2	33	23	20	84	1	65	56
5007F	-	-	124	62	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5014D	13.0	0.10	36	21	151	19	44	3	56	8	19	21	2	1	22	196	62	8	29	67
5050A	-	-	76	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5050B	-	-	98	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5050C	-	-	77	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5050D	-	-	62	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5060A	39.4	0.17	40	74	282	112	33	9	1	10	86	25	1	22	10	107	44	9	27	67
5060B	26.9	0.25	37	74	599	51	130	16	26	22	31	71	2	20	53	67	106	15	69	90
5062A	-	-	61	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5062B	28.9	0.42	25	36	366	68	148	4	20	21	69	37	2	23	26	139	140	14	48	134
5062C	25.2	0.26	23	36	196	39	131	47	33	22	16	66	1	17	54	62	106	12	58	83
5076A	-	-	32	191	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5076B	33.7	0.41	34	191	635	15	95	29	27	20	4	17	3	12	72	92	129	12	14	106
5077B	33.5	0.51	7	141	553	26	106	3	40	20	3	23	1	13	93	92	159	12	15	124
5077C	-	-	18	141	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5078B	33.1	0.51	20	40	350	11	120	3	22	22	3	18	2	11	68	71	175	18	11	130
5079C	28.6	0.51	48	38	350	14	114	10	77	22	7	24	4	15	76	113	154	16	86	130
5076C	30.4	0.21	252	191	578	26	93	34	65	17	15	52	1	13	46	74	85	12	45	69
5076D	30.9	0.22	152	191	356	30	107	6	40	20	14	55	1	13	46	80	90	12	49	72
5077D	31.6	0.29	130	141	469	32	118	6	24	17	9	39	1	16	53	79	97	13	37	91
5078A	31.5	0.31	286	40	339	23	127	21	38	18	16	51	2	16	47	70	94	18	41	107
5071B	-	-	10	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5071C	-	-	15	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5077A	31.3	0.28	83	141	445	30	113	4	16	16	7	33	1	16	46	76	94	15	46	100
5079A	29.4	0.31	257	38	327	34	120	6	21	17	9	39	1	12	46	92	98	16	33	104
5079B	16.0	0.13	210	38	206	14	60	5	23	10	9	6	2	1	30	306	60	33	22	54

Summary of statistics for chemical data for separations of lithorelics and matrix from hardpan (majors in %, traces in ppm, Au in ppb)

Lithorelic	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	Au	Au(bulk)
Mean	8.51	0.39	1112	3.04	1.54	0.25	79	0.37	0.009	0.107	31.81	0.40	35	75
Median	8.94	0.11	990	3.51	1.54	0.27	58	0.36	0.009	0.050	31.72	0.39	36	63
St. Dev	1.43	0.85	840	1.18	0.56	0.08	67	0.14	0.005	0.175	2.71	0.09	21	47
Minimum	3.84	0.05	160	1.17	0.33	0.11	31	0.10	0.003	0.013	28.63	0.17	7	21
Maximum	9.45	3.27	2930	5.28	2.58	0.37	287	0.68	0.019	0.685	39.42	0.51	92	191
Count	14	14	14	14	14	14	14	14	14	14	14	14	14	14

Matrix	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	Au	Au(bulk)
Mean	8.15	2.21	3005	3.92	0.87	0.59	222	0.52	0.012	0.058	27.60	0.25	102	91
Median	8.30	0.30	3080	3.86	0.81	0.58	170	0.50	0.012	0.043	28.98	0.25	72	74
St. Dev	1.21	5.22	2288	0.81	0.14	0.12	220	0.23	0.003	0.045	4.52	0.05	77	51
Minimum	5.19	0.16	480	2.60	0.65	0.43	54	0.21	0.007	0.019	15.46	0.14	23	36
Maximum	10.34	17.40	8530	5.12	1.19	0.81	968	0.88	0.018	0.192	31.57	0.34	286	191
Count	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Lithorelic	Ba	Ce	Co	Cr	Cu	Ga	La	Nb	Ni	Pb	Rb	Sr	V	Y	Zn	Zr
Mean	486	28	18	103	85	19	16	2	40	18	59	83	123	14	67	126
Median	457	20	10	97	74	20	7	2	38	17	63	76	115	13	43	130
St. Dev	149	28	18	30	88	4	26	1	19	7	23	24	33	4	102	20
Minimum	282	7	1	33	1	10	2	1	17	11	10	53	44	9	11	67
Maximum	764	112	51	163	357	26	86	4	86	39	93	139	175	23	414	149
Count	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14

Matrix	Ba	Ce	Co	Cr	Cu	Ga	La	Nb	Ni	Pb	Rb	Sr	V	Y	Zn	Zr
Mean	395	30	21	137	48	18	16	2	49	13	48	78	94	16	52	92
Median	356	30	8	118	40	19	16	1	51	15	48	67	95	15	50	90
St. Dev	168	9	23	91	24	3	6	1	16	4	7	32	10	5	12	15
Minimum	196	17	4	67	16	11	5	1	13	5	32	54	74	10	33	69
Maximum	759	51	73	444	106	22	31	3	71	20	54	165	111	25	74	123
Count	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Correlation matrix for separations of sample matrix from hardpan. Highly significant (99.9%) values in bold.

hardpan	Au	Au(bulk)	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	Ba	Ce	Cr	Co	Cu	Ga	La	Ni	Nb	Pb	Rb	Sr	V	Y	Zn	Zr
Au	1																													
Au(bulk)	0.45	1																												
Al	-0.3	0.0	1																											
Ca	-0.2	-0.2	**-0.82**	1																										
Cl	-0.3	-0.1	-0.1	0.0	1																									
Fe	-0.52	-0.2	**0.87**	-0.63	0.0	1																								
K	0.2	-0.1	0.3	-0.47	0.0	0.1	1																							
Mg	-0.3	-0.50	-0.61	0.74	0.47	-0.4	-0.2	1																						
Mn	-0.1	-0.2	0.4	-0.3	-0.2	0.48	-0.1	-0.3	1																					
Na	-0.2	-0.2	-0.2	0.1	**0.92**	-0.1	0.2	0.54	-0.3	1																				
P	-0.3	-0.1	0.64	-0.64	0.2	**0.82**	-0.1	-0.4	0.3	0.1	1																			
S	-0.1	-0.1	-0.70	0.76	0.4	-0.61	-0.3	0.71	-0.4	0.52	-0.51	1																		
Si	0.4	0.4	0.57	**-0.92**	-0.1	0.3	0.56	-0.75	0.1	-0.1	0.4	-0.66	1																	
Ti	0.1	-0.1	0.60	-0.74	0.1	0.44	**0.88**	-0.4	0.2	0.2	0.3	-0.47	0.71	1																
Ba	0.1	0.2	0.2	-0.3	-0.3	0.3	0.0	-0.51	0.4	-0.2	0.55	-0.3	0.3	0.2	1															
Ce	-0.4	0.0	0.65	-0.4	-0.1	0.68	-0.3	-0.4	0.69	-0.2	0.61	-0.3	0.1	0.1	0.3	1														
Cr	-0.2	-0.1	0.2	-0.3	0.3	0.52	0.0	-0.1	0.1	0.2	0.72	-0.2	0.1	0.3	0.53	0.3	1													
Co	0.1	0.1	0.0	0.2	0.0	-0.1	-0.2	0.3	-0.1	0.1	-0.2	0.4	-0.2	-0.2	-0.2	0.1	-0.2	1												
Cu	0.1	0.1	0.1	-0.2	0.3	0.0	0.52	0.1	-0.2	0.4	-0.1	0.2	0.2	0.4	-0.1	-0.4	-0.1	0.1	1											
Ga	-0.2	0.0	**0.92**	**-0.88**	-0.1	**0.84**	0.3	-0.60	0.46	-0.2	0.69	**-0.84**	0.67	0.58	0.2	0.55	0.3	-0.2	0.0	1										
La	-0.2	-0.1	0.46	-0.4	0.0	0.52	-0.2	-0.3	0.68	0.0	0.63	-0.2	0.2	0.1	0.4	0.75	0.3	0.1	-0.2	0.45	1									
Ni	-0.1	0.0	**0.88**	**-0.84**	-0.1	**0.86**	0.1	-0.69	0.54	-0.2	**0.83**	**-0.79**	0.62	0.48	0.46	0.67	0.44	-0.1	-0.1	**0.91**	0.64	1								
Nb	0.0	-0.2	0.1	-0.1	0.2	0.1	0.4	0.3	0.3	0.4	0.0	0.1	0.0	0.4	0.2	0.0	0.2	0.49	0.4	0.0	0.2	0.1	1							
Pb	0.0	-0.1	**0.81**	-0.76	-0.3	0.72	0.3	-0.73	0.63	-0.3	0.56	-0.74	0.60	0.62	0.4	0.57	0.2	-0.3	-0.1	**0.82**	0.4	**0.82**	0.0	1						
Rb	-0.1	-0.1	**0.88**	**-0.86**	-0.2	**0.77**	0.55	-0.67	0.4	-0.2	0.62	-0.73	0.70	**0.81**	0.4	0.4	0.3	-0.2	0.1	**0.83**	0.3	**0.80**	0.1	**0.84**	1					
Sr	-0.1	-0.1	**-0.83**	**0.96**	-0.1	-0.65	-0.49	0.60	-0.3	-0.1	-0.61	0.72	**-0.86**	-0.75	-0.1	-0.3	-0.2	0.2	-0.2	**-0.89**	-0.4	**-0.79**	-0.1	-0.71	**-0.83**	1				
V	-0.3	-0.2	**0.84**	-0.72	0.0	**0.87**	0.44	-0.46	0.49	-0.1	0.67	-0.62	0.48	0.75	0.3	0.56	0.59	-0.2	0.1	**0.79**	0.3	**0.78**	0.2	**0.81**	**0.88**	-0.70	1			
Y	-0.1	-0.1	0.2	-0.45	0.62	0.4	0.2	0.0	0.1	0.56	0.69	-0.2	0.4	0.4	0.3	0.2	0.71	-0.1	0.0	0.3	0.47	0.4	0.2	0.1	0.3	-0.48	0.4	1		
Zn	-0.47	-0.2	0.4	-0.1	0.1	0.4	0.1	0.1	0.4	0.2	0.2	0.2	-0.1	0.2	0.0	0.4	0.0	0.3	0.51	0.2	0.48	0.2	0.4	0.2	0.2	-0.1	0.3	0.0	1	
Zr	-0.1	-0.4	0.1	-0.2	0.3	0.2	**0.80**	0.2	0.1	0.4	0.0	0.0	0.2	0.76	0.0	-0.2	0.2	-0.1	0.57	0.1	-0.1	0.0	0.70	0.2	0.4	-0.3	0.45	0.3	0.3	1

Correlation matrix for separations of lithorelics from hardpan. Highly significant (99.9%) values in bold.

lithorelics	Au	Au(bulk)	Al	Ca	Cl	Fe	K	Mg	Mn	Na	P	S	Si	Ti	Ba	Ce	Cr	Co	Cu	Ga	La	Ni	Nb	Pb	Rb	Sr	V	Y	Zn	Zr
Au	1																													
Au(bulk)	0.2	1																												
Al	-0.1	-0.2	1																											
Ca	0.1	-0.3	0.2	1																										
Cl	0.2	-0.3	0.3	0.1	1																									
Fe	0.1	-0.4	0.51	-0.3	0.51	1																								
K	-0.1	0.3	0.60	0.2	-0.2	0.0	1																							
Mg	0.3	-0.4	0.64	0.3	0.64	**0.79**	0.2	1																						
Mn	0.2	-0.1	**-0.80**	0.3	-0.2	-0.48	-0.54	-0.3	1																					
Na	-0.1	-0.3	0.65	0.1	0.4	0.4	0.2	0.4	-0.51	1																				
P	0.1	-0.4	-0.4	-0.3	0.1	0.3	-0.68	0.1	0.4	-0.3	1																			
S	-0.1	-0.2	-0.1	0.0	-0.2	-0.1	-0.4	-0.1	0.2	-0.3	0.64	1																		
Si	0.0	0.4	**-0.91**	-0.4	-0.4	-0.59	-0.4	**-0.82**	0.56	-0.60	0.1	-0.1	1																	
Ti	-0.2	0.0	0.73	0.4	-0.2	-0.1	**0.82**	0.2	-0.58	0.2	-0.68	-0.1	-0.56	1																
Ba	-0.1	0.3	0.3	-0.3	0.0	0.48	0.56	0.3	-0.5	0.0	-0.1	-0.4	-0.2	0.2	1															
Ce	-0.1	-0.1	-0.73	-0.2	-0.3	-0.3	-0.67	-0.46	0.76	-0.52	0.75	0.64	0.56	-0.65	-0.4	1														
Cr	-0.1	-0.2	0.70	0.1	0.0	0.47	0.56	0.51	-0.52	0.2	-0.1	0.2	-0.72	0.69	0.4	-0.4	1													
Co	-0.3	-0.1	0.1	0.0	0.3	0.2	-0.2	0.1	-0.2	0.3	-0.1	-0.2	-0.1	-0.2	0.0	-0.2	-0.3	1												
Cu	0.3	0.0	0.4	0.0	0.3	0.4	0.1	0.3	-0.2	0.73	-0.1	-0.3	-0.4	0.0	0.2	-0.3	0.0	0.2	1											
Ga	0.0	-0.1	**0.79**	0.2	-0.1	0.4	0.77	0.49	-0.59	0.3	-0.4	-0.1	-0.72	**0.82**	0.4	-0.62	**0.86**	-0.2	0.2	1										
La	0.0	-0.2	-0.65	-0.1	-0.3	-0.3	-0.70	-0.4	0.71	-0.56	**0.80**	0.78	0.4	-0.58	-0.5	**0.97**	-0.3	-0.3	-0.3	-0.53	1									
Ni	0.0	-0.4	0.4	-0.2	0.50	0.63	-0.2	0.48	-0.3	**0.78**	0.3	-0.1	-0.4	-0.3	0.1	-0.1	0.0	0.50	0.75	0.0	-0.2	1								
Nb	0.54	0.2	0.2	0.47	0.1	-0.2	0.1	0.2	0.0	0.0	-0.3	0.0	-0.2	0.3	-0.2	-0.2	0.0	-0.4	0.1	0.2	-0.2	-0.3	1							
Pb	0.2	-0.1	0.0	-0.1	0.1	0.2	-0.4	0.1	0.1	0.46	0.4	0.2	-0.1	-0.4	-0.2	0.3	-0.2	0.1	0.78	-0.2	0.3	0.70	0.0	1						
Rb	-0.1	0.3	0.56	0.2	-0.1	0.1	**0.98**	0.2	-0.54	0.2	-0.76	-0.58	-0.3	0.77	0.57	-0.76	0.48	-0.1	0.1	0.73	**-0.80**	-0.2	0.2	-0.48	1					
Sr	-0.2	0.0	-0.2	0.4	-0.4	-0.4	-0.1	-0.2	0.4	-0.4	0.3	**0.79**	0.0	0.1	-0.4	0.59	0.1	-0.3	-0.3	0.0	0.66	-0.4	0.3	0.1	-0.3	1				
V	-0.3	0.0	0.67	0.3	-0.3	0.0	**0.78**	0.2	-0.55	0.2	-0.57	0.0	-0.54	**0.96**	0.2	-0.56	**0.79**	-0.3	-0.1	**0.86**	-0.48	-0.3	0.2	-0.4	0.73	0.1	1			
Y	0.1	-0.2	0.4	0.1	0.0	0.4	0.47	0.49	-0.2	0.0	-0.1	-0.1	-0.4	0.5	0.4	-0.4	**0.79**	-0.4	-0.1	0.66	-0.3	-0.2	0.0	-0.4	0.48	-0.2	0.59	1		
Zn	0.1	-0.1	0.2	0.1	0.1	0.1	-0.1	0.2	0.0	0.72	0.0	-0.1	-0.3	-0.1	-0.1	0.0	-0.1	0.2	**0.91**	0.1	-0.1	0.73	0.1	**0.87**	-0.2	-0.1	-0.2	-0.3	1	
Zr	0.0	-0.3	**0.93**	0.1	0.4	0.65	0.59	0.71	-0.75	0.50	-0.2	-0.2	**-0.84**	0.65	0.4	-0.71	0.73	0.0	0.3	**0.81**	-0.62	0.3	0.1	-0.1	0.58	-0.3	0.63	0.53	0.1	1

SEQUENTIAL EXTRACTION DATA

Summary of results in ppm for sequential extractions (see section 3.4)
A exchangeable, B carbonate,C amorphous Fe oxides, D crystalline Fe oxides, E bulk XRF data.

	5071A	5071B	5071C	5071D	5071E
Fe	99	33	1042	45834	110600
Ni	0.21	0.21	1.04	2.92	45.00
Pb	0.33	1.67	2.08	2.08	14.00
Mg	248	13	8	10	1000
Mn	7.92	2.92	8.33	50.6	197
Ca	642	21	63	38	400
Co	0.21	0.21	0.10	0.83	16
Cu	31	2	6	3	26
Zn	49	5	39	11	53
K	207	20	22	39	6400
P	146	1	19	144	340
Ce	4.50	2.17	3.79	2.63	47

	5072A	5072B	5072C	5072D	5072E
Fe	36.7	57.5	2642	36042	55500
Ni	0.2	0.2	3.8	16.7	100
Pb	0.3	0.3	2.1	2.1	10
Mg	763	50.0	37.5	120	2800
Mn	52.9	17.5	325	144	1030
Ca	1029	95.8	79.2	217	2000
Co	1.3	0.2	3.3	8.3	25
Cu	31.7	3.3	6.3	2.3	46
Zn	16.7	4.6	14.6	13.8	82
K	110	79.6	91.7	122	660
P	4.2	1.0	16.7	89.6	209
Ce	8.4	6.9	19.8	8.2	90

	5073A	5073B	5073C	5073D	5073E
Fe	50.0	52.5	875	24167	44200
Ni	1.7	0.2	6.3	16.7	92
Pb	1.3	0.3	2.1	2.1	10
Mg	983	84.2	47.9	151	4300
Mn	36.7	27.5	125	75.0	396
Ca	2375	221	25.0	338	3700
Co	0.2	0.2	2.1	8.3	14
Cu	8.3	2.9	0.8	1.7	49
Zn	2.9	2.1	4.2	14.2	66
K	197	93.0	66.1	139	7900
P	1.0	1.0	4.2	64.6	153
Ce	8.8	1.1	2.1	11.3	42

	5076A	5076B	5076C	5076D	5076E
Fe	33.8	50.8	625	19625	34500
Ni	0.8	0.2	1.0	8.3	48
Pb	0.8	0.8	2.1	2.1	8
Mg	767	119	52.9	158	3900
Mn	6.3	5.8	12.5	41.7	142
Ca	1717	238	20.8	417	3100
Co	0.2	0.2	0.1	2.1	8
Cu	2.1	2.9	4.2	2.5	40
Zn	1.7	4.6	4.2	8.3	48
K	189	106	64.0	110	8700
P	1.0	1.0	8.3	50	1090
Ce	0.5	0.5	0.6	3.8	14

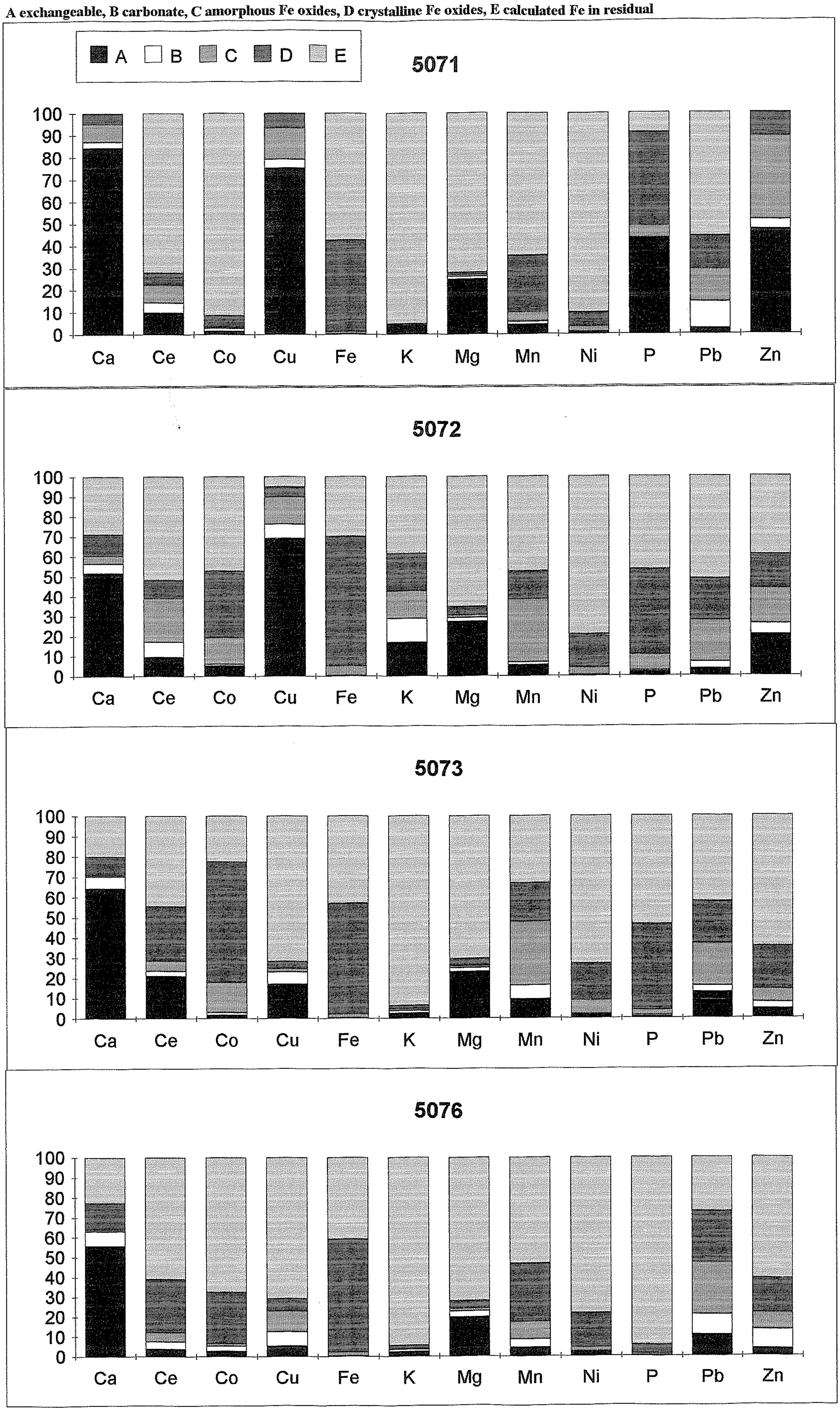
	5080A	5080B	5080C	5080D	5080E
Fe	20.0	10.8	308	19083	24600
Ni	0.4	0.8	1.0	2.1	21
Pb	0.3	0.3	2.1	2.1	9
Mg	704	542	42.5	75.4	2800
Mn	2.5	5.4	29.2	4.2	54
Ca	7417	10454	16.7	133	18900
Co	0.2	0.2	0.1	2.1	4
Cu	3.3	2.9	0.8	3.3	35
Zn	1.7	2.9	4.2	4.2	8
K	77.1	42.2	38.7	54.7	16300
P	1.0	1.0	2.1	20.8	31
Ce	0.0	0.2	0.1	0.6	3

	5083A	5083B	5083C	5083D	5083E
Fe	11.3	73.8	375	7083	13600
Ni	0.2	0.4	1.0	2.1	44
Pb	0.8	0.3	2.1	2.1	7
Mg	896	1146	65.4	77.9	3400
Mn	2.5	10.4	8.3	4.2	36
Ca	10513	26800	25.0	163	39600
Co	0.2	0.2	0.1	4.2	2
Cu	5.8	3.8	2.5	1.7	18
Zn	2.1	3.3	4.2	4.2	7
K	356	34.9	52.2	43.2	15900
P	1.0	1.0	4.2	29.2	48
Ce	0.0	0.3	0.1	0.6	7

	5084A	5084B	5084C	5084D	5084E
Fe	18.3	22.9	175	4250	9700
Ni	0.2	0.2	1.0	1.0	19
Pb	0.3	2.1	2.1	2.1	8
Mg	658	128	22.5	42.5	2800
Mn	1.3	1.3	4.2	0.0	10
Ca	3125	704	16.7	37.5	4100
Co	0.2	0.2	0.1	0.1	1
Cu	3.8	1.7	0.8	0.4	8
Zn	2.1	2.1	2.5	2.5	5
K	304	27	35.3	31.5	24900
P	1.0	1.0	2.1	14.6	39
Ce	0.0	0.0	0.1	0.3	1

Summary of results expressed as percentage of total for sequential extraction.

A exchangeable, B carbonate, C amorphous Fe oxides, D crystalline Fe oxides, E calculated Fe in residual



Summary of results expressed as percentage of total for sequential extraction (continued).