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THE DISTRIBUTION OF GOLD AND OTHER ELEMENTS IN SURFICIAL MATERIALS FROM THE HIGGINSVILLE PALAEOCHANNEL GOLD DEPOSITS, NORSEMAN, WESTERN AUSTRALIA

M.J. Lintern, M.A. Craig, D.M. Walsh and N. C. Sheridan

CRC LEME OPEN FILE REPORT 102

June 2001

(CRC LEME Restricted Report 28R/
CSIRO Division of Exploration and Mining Report 275R, 1996.
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CRC LEME is an unincorporated joint venture between The Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining
Headquarters: CRC LEME c/o CSIRO Exploration and Mining, Private Bag No 5, PO Wembley, Western Australia, 6913.

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

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

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

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

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

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

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

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

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

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

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

This report (CRC LEME Open File Report 102) is a second impression (second printing) of CSIRO, Division of Exploration and Mining Restricted Report 275R, first issued in 1996, which formed part of the CSIRO/AMIRA Project P409.

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EXECUTIVE SUMMARY

The CRCLEME-AMIRA Project "Exploration in Areas of Transported Overburden, Yilgarn Craton and Environs" (Project 409) has, as its principal objective, development of geochemical methods for mineral exploration in areas with substantial transported overburden, through investigations of the processes of geochemical dispersion from concealed mineralization. The Project has two main themes. One of these, *'Surface and sub-surface expression of* concealed *mineral deposits'* is addressed by this report, which focuses on the soil geochemistry of palaeochannel Au deposits located 60 km south of Kambalda and 40 km north of Norseman.

The study area is located near Higginsville and encompasses the Mitchell and the Challenge-Swordsman palaeochannel Au deposits where the thicknesses of transported overburden and depth to mineralization vary from about 15 m to over 50 m. The study site is important since it provides several examples of a variably thick overburden, and extends the boundaries of Project 409 to an area well south of the Kalgoorlie study sites with which it can be contrasted. The great thicknesses of transported overburden are comparable to sites previously studied near Kalgoorlie but unlike many of them, the palaeochannels at Higginsville contain considerable economic deposits of Au, which are being extensively mined. It is considered that a detailed study of the nature of Au in surficial material from such an environment will enhance our understanding of the processes whereby Au may be enriched in the surficial environment in areas of substantially transported material.

The Higginsville palaeochannels are of considerable interest since it has been reported that at a number of locations there is a detectable surface expression of Au. One of the purposes of this research is to assess the validity of such reports by careful sampling and analysis and discuss the implications of the investigation for exploration in this area. The results indicate that:

(i) Specific targeting of the calcareous horizon maximizes the probability of sampling the most consistently auriferous sample. In relict and erosional regimes, such sampling may accurately define drilling targets. However, in depositional regimes, the results indicate that there is no direct link with mineralization. Here, although a soil carbonate anomaly discretely overlies buried mineralization, the data suggest that it is derived from detrital Fe granules in the soil.

(ii) Separate sampling of ferruginous granules may provide a local source of the Au found in the carbonate horizon. Gold in ferruginous granules usually indicates that Au is being shed from relict or erosional areas within the catchment, hence these areas are most prospective. Like carbonate, ferruginous granules do not in themselves provide an indication of underlying palaeochannel mineralisation.

It is concluded that, in depositional areas examined in this study, sampling of calcareous material at best may indicate the potential of the area. It is suggested, therefore, that for such landscape regimes, wider sampling intervals should be used *i.e.* soil sampling is a regional tool, with a follow-up requirement that deep samples be collected including basal sands or ferruginous material in saprolite. Sampling of Fe granules or lag is a possible alternative, but the distribution of Au within them is more erratic. The most cost-effective sampling procedure is by power auger drilling and compositing the cuttings through the carbonate-rich horizon. Surficial soil sampling or drilling and routinely sampling at a specified depth without regard to the sample type may be inappropriate because Au anomalies may be overlooked.

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

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1. INTRODUCTION

1.1 Previous research

The CRCLEME-AMIRA Project "Exploration in Areas of Transported Overburden, Yilgarn Craton and Environs" (Project 409) has, as its principal objective, development of geochemical methods for mineral exploration in areas with substantial transported overburden, through investigations of the processes of geochemical dispersion from concealed mineralization. The principal theme of the project, *'Surface and sub-surface expression of concealed mineral deposits'* is addressed by this investigation in the Higginsville area of the Eastern Goldfields, Western Australia.

Previous CSIRO-AMIRA Projects (240, 240A, 241, 241A) studied the geochemical expression of primary and supergene Au mineralization in the regolith. These studies demonstrated that in relict and erosional landform regimes, carefully directed shallow sampling is usually more cost and technically effective than routine drilling to deep saprolite in regional- and prospect-scale exploration. In some locations, it was found that there appeared to be a surface expression of mineralization concealed by up to 40 m of barren sediments and/or leached saprolite. In Project 409, outcomes of the previous projects are being further tested to determine whether similar procedures can be routinely applied in depositional regimes.

The resurgence in Au exploration during the past decade has been characterized by a considerable emphasis and dependence on geochemical procedures. This has been made possible, firstly, by marked improvements in analytical sensitivity over those previously available and, secondly, of particular importance to exploration in Australia, by a better understanding of the distribution of Au in the regolith, which has led to the optimization of sample media. These developments have given exploration companies the ability to seek and detect subtle and widespread geochemical signatures of concealed Au mineralization and provided an enhanced capability to interpret the data. As a consequence, several new discoveries have been made, even in areas that have been intensively explored in the past.

In the deeply weathered Yilgarn Craton of Western Australia, and in equivalent areas elsewhere in Australia and overseas, Au has accumulated in the upper lateritic gravels and duricrusts of the regolith, probably during humid climatic periods in the Tertiary. The laterites may not only be Au ores in themselves, but research by CSIRO has shown them to be very important sample media (Anand and Smith, 1992). In many areas, however, the laterite has been eroded, and hence is unavailable as a sample medium, and chemical modification under more arid conditions since the Tertiary has leached Au from the upper saprolite. This has greatly increased the difficulties of exploration, particularly where reliance was placed on sampling between 2 to 15 m of the surface. Further research, however, has demonstrated that, despite this leaching, recent remobilization of Au has caused it to concentrate in a specific soil component, pedogenic carbonate, usually in the top 1-2 m, thereby giving surface expression even to mineralization that is concealed by over 20 m of leached overburden.

Secondary carbonates, commonly referred to as calcrete, may precipitate as calcite and/or dolomite in regoliths where the average annual rainfall is less than about 600 mm. Pedogenic carbonates are those that form in unsaturated (vadose) soil horizons. They are widely distributed in the Yilgarn Craton south of about 30°S ("the Menzies Line"), seemingly more abundant over more basic rocks and towards the south east. In contrast, groundwater calcretes form in saturated (phreatic) environments, typically in the axes of major drainages north of the Menzies Line. These are known to accumulate U but not, apparently, Au.

In summary, as a result of the earlier CSIRO research, two groups of sample media have been identified to be of particular value for Au exploration in the Yilgarn Craton:

(i) calcareous soil horizons, which are widespread in the semi-arid parts of the southern Yilgarn. Gold concentrations are often much greater in pedogenic carbonate than in immediately adjacent horizons. Failure to sample this horizon in an exploration programme will result in ineffective soil surveys;

(ii) ferruginous materials, including lateritic residuum, ferruginous granules and lag.

In the Kalgoorlie-Kambalda area, the work programme has been to investigate potential sample media in the regolith overlying supergene and weathered mineralization within and beneath the transported cover. Specifically the studies have investigated:

(i) the distribution of gold in surface and subsurface horizons of the transported and residual regolith;

(ii) the association of gold with specific soil components by selective extractions and physical separations;

(iii) the distributions of pathfinder elements in transported and residual regolith and bedrock.

The Higginsville study complements existing studies undertaken as part of the Project 409 work programme.

1.2 Stratigraphy background

Gold deposits associated with sediments in palaeochannels have been known in the Eastern Goldfields, particularly Kalgoorlie, since late last century. The deposits (known as "leads") were important for the early prospectors although they were difficult to find. Exploration was very speculative, for usually Au could only be found by excavating shafts to several tens of metres in the vicinity of existing hard rock Au deposits, and then burrowing horizontally through the gravels. However, once the Au was found, it was commonly present at very high grades and easy to separate from the gangue minerals. To the early miners, therefore, the palaeochannel deposits represented an important resource and it was expected that many deposits of this type would be discovered, although not without a degree of pessimism:

> *"That other leads probably exist is obvious from the geological structure of the district (Eastern Goldfields), but owing to the completeness with which the old land surface has been buried beneath more recent accumulations, any other channels can only be tapped by a judicious system of boring, though they are hardly likely to even then to be discovered without many failures." Gibb Maitland (1919).*

However, since these early attempts, little systematic exploration of the palaeochannels has been reported until recently (Devlin and Crimeen, 1990; Fulwood and Barwick, 1990). The interest has been complemented by better interpretation of the stratigraphy (Kern and Commander, 1993; Clarke, 1994; Commander *et al.*, 1992; Devlin, 1990; Smyth and Button, 1989), and mining and processing techniques to treat the ore (Whincup *et al.*, 1989). One of the major reasons for this is economics: how to explore for Au beneath many metres of transported overburden over many kilometres without the use of systematic drilling.

In recent years, geophysical techniques have been used to delineate the palaeochannel boundaries. These have included gravity, seismic reflection and refraction, and down-hole gamma logs (Smyth and Button, 1989). Once the channel has been located, the deepest part (the thalweg) can be located by electromagnetic methods (*e.g.*, SIROTEM). The method assumes that the Tertiary sands located in the thalweg are more saline than those in shallower parts of the channel. Thalwegs are important for exploration as they appear to serve as depositional traps for Au. This can take place by either or both of two processes: (1) mechanically, when the stream or river was active, as primary micro nuggets shed from primary source material or (2) as chemically precipitated Au, because the usually sandy nature of the thalweg can provide a sub-surface aquifer. The chemical deposition of Au is thought still to be active in many cases. However, geophysics only solves part of the problem, since even after the location of a thalweg, it is still only by Gibb Maitland's "judicious system of boring" and analysis that the presence or absence of Au can be determined.

Considerable effort was spent by early geologists describing and recording the general stratigraphy of the sediments filling channels from further north in the Kalgoorlie area. Comparisons of the stratigraphy between alluvial deposits from various palaeochannels indicates a high degree of similarity which suggests that the channels were filled, and Au deposits formed, under similar environmental conditions. A typical description from Kanowna is quoted below from Gibb Maitland (1919):

> *"The deposits filling the old watercourse naturally vary somewhat in different portions; they consist first of a variable thickness of surface loam, etc., succeeded by ironstone gravels, partially cemented in places by kaolin and oxide of iron into solid rock; beneath this lies a bed or beds of practically pure kaolin ... and a varying thickness of pebbly quartz-wash. The wash contains rounded or sub-angular pebbles of quartz, which in the upper portion of the deposit is often associated with kaolin and sand. This wash is cemented by secondary silica into a hard compact rock which, in hand specimens, might easily be mistaken for quartzite."*

Recently, Commander *et al.* (1992) described a series of sections for the Roe Palaeodrainage to the north in the Kalgoorlie area (Figure 1). They suggest that the valley bottoms are generally V-shaped and that subsequent lateral erosion of the valley sides above the Tertiary sediments has occurred. They subdivide the Tertiary sediments into the Wollubar Sandstone and the Perkolilli Shale. The Wollubar Sandstone, found at the base of the channels, consists of grey, buff, yellow, and brown quartz sand, and minor amounts of conglomerate, clay, silt, carbonaceous silt, and lignite. The Wollubar Sandstone which rests unconformably on Archaean rocks, is overlain conformably by the Perkolilli Shale and corresponds to the sandy horizon in the Higginsville palaeochannels (Figure 4). The Perkolilli Shale consists of mottled, grey, dark-red, brown, and yellow clay with minor beds of sandy clay, and may be absent from the upper reaches of the drainage channels; it corresponds to the “beds of practically pure kaolin” described above and the puggy lacustrine clays described for the Higginsville palaeochannels. The Tertiary sediments are overlain by Quartenary sediments. Boundaries between the units may not be distinct.

For the Cowan Palaeodrainage (to the south and east of the Higginsville), the basal sediments consist of sand, silt and carbonaceous clay with lenses of lignite (Werrilup Formation), and is overlain by the Princess Royal Spongolite in the northern end of Lake Cowan (Clarke, 1993). The Norseman Limestone interfingers with the Werrilup Formation and ranges from skeletal wackestone and grainstone to calcareous sandstone, and is up to 37 m thick beneath Lake Cowan (Clarke, 1993). Cowan Dolomite occurs within the later Tertiary lacustrine sequence, and is thus part of the overlying Redmine Group which is also present in the Lefroy Palaeodrainage (Clarke, 1993).

The age of the sediments has not been established in this study but the lignites from the deeper parts of the channel have been dated from near Coolgardie as Late Eocene (Balme and Churchill, 1959). The Wollubar Sandstone has been dated palynologically as late Middle to early Late Eocene (Commander *et al.*, 1992). Bunting *et al.* (1974) suggested that the absence of clastic sediments younger than Middle Miocene in the Eucla Basin indicates that the palaeodrainages had been filled by sediments, and had largely ceased to flow, by that time. In contrast, the uppermost units contain detrital components derived from lateritic regoliths in adjacent higher ground. Sedimentation thus may partly predate, be partly contemporaneous with, and partly post-date the main period of Tertiary deep weathering.

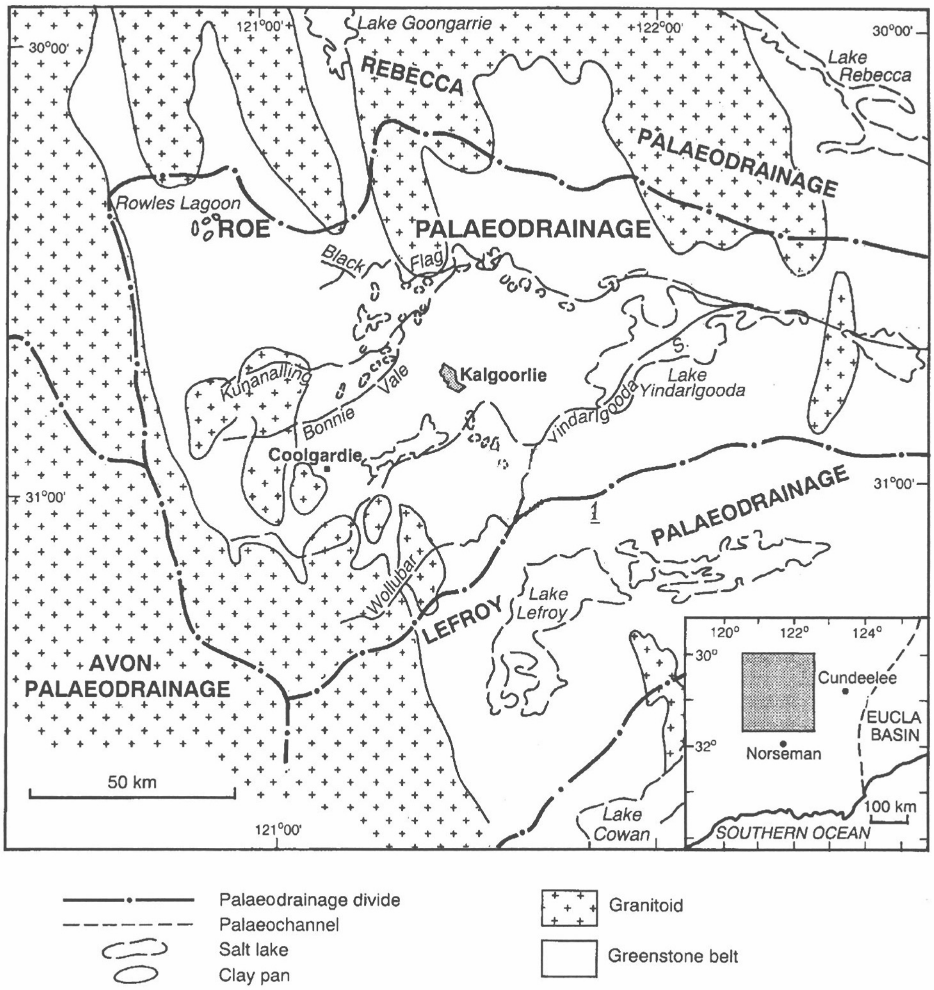


Figure 1: Palaeochannel distribution in the Kalgoorlie area, Eastern Goldfields (after Kern and Commander, 1993)

1.3 Research objectives

The principal objective of this study was to determine whether surficial geochemical techniques can be used to locate economic quantities of Au located in the palaeochannels and thereby reduce the amount of scout drilling that has to be undertaken. The rationale behind this approach has developed from previous studies in the Yilgarn at Panglo (Lintern and Scott, 1990), Bounty (Lintern, 1989) and Mulline (Lintern and Butt, 1991) which indicated that there is an enrichment of Au in the soil above or close to hard rock mineralization. These previous studies demonstrated that there may be surficial Au enrichment despite the presence of depleted or poorly mineralized overburden or sediments. Typically, the enrichment is associated with a pedogenic carbonate horizon.

This research involved an integrated geomorphological and geochemical study of the area, including a detailed study and comparison of the soils and vegetation from above palaeochannel mineralization with areas adjacent and distant to it. A variety of sample media were examined, including shallow drill cuttings, topsoils, ferruginous granules and vegetation.

Specifically, the objectives of the Higginsville study were to:

(i) determine the nature and probable origin of the soil anomalies overlying mineralization at selected sites;

(ii) assess materials from within the transported regolith as potential exploration sample media;

(iii) examine the relationship between soil anomalies and underlying mineralization;

(iv) report upon exploration methods suitable for areas of transported cover in the Higginsville area.

2. GEOLOGICAL AND GEOMORPHOLOGICAL SETTING

The study area is located in the Higginsville Gold Mining Centre at the southern end of the Norseman-Wiluna belt (Figure 2). The Zuleika Shear (boundary of Kambalda and Coolgardie domains) is interpreted to cross cut the study area and, as with the Boulder-Lefroy Fault, mineralization is associated with second order splays. Two such structures, the Poseidon South Fault and the Mission Fault, bound a major sedimentary sequence that dominates the area between the Mitchell and Challenge palaeochannels. These are possibly equivalent to the Black Flag group. To the east and west of the sedimentary units, and representing the limbs of a syncline, is a package of high Mg basalts and ultramafics with minor sediments, intruded by gabbros, dolerites and acid porphyries. The Archaean rocks are steeply dipping and have a N-NW strike. The sequence is folded into a regional syncline at the NE corner of the Pioneer Dome, which has a generally low angle, northerly plunge.

Outcrop is generally poor, due to extensive ferruginization, calcareous soils, aeolian sands, and extensive areas of remnant Tertiary lacustrine and fluvial sediments overlying deeply weathered Archaean basement. The result is a complex, layered regolith, with considerable chemical re-mobilisation and re-deposition.

Deep lead gold mineralization has been located at the base of the Tertiary sediments associated with sands, grits and conglomerates (Figure 3 and 4). The deep lead is interpreted to represent an old river bed that was buried beneath estuarine and lake sediments during a period of sea level rise in the late Eocene. The palaeorivers, locally known as the Mitchell and Challenge-Swordsman palaeochannels, are thought to be tributaries to the Cowan Palaeochannel, now buried beneath Lake Cowan. Both channels overlie the mafic and ultramafic rocks that form on the limbs of the regional syncline. It is yet to be ascertained whether the palaeochannel gold deposits are sourced from:

(a) remobilised alluvial gold washed into the river from an unknown source;

(b) chemical, supergene gold remobilised from a primary Archaean source proximal to the palaeochannel; and/or

(c) Tertiary-gold bearing fluids injected up underlying basement faults into the sandy sediment during the Tertiary.

However, as (i) the palaeochannels appear to directly overlie major north-south trending shears, (ii) the underlying basement contains significant amounts of biotite, silica and carbonate due to regional hydrothermal alteration and, (iii) anomalous gold in the palaeochannel appears to intercept patchy basement mineralization, a remobilised primary source model for palaeochannel gold deposition (b, above) is suggested although some contribution from (a) and (c) cannot be entirely discounted.

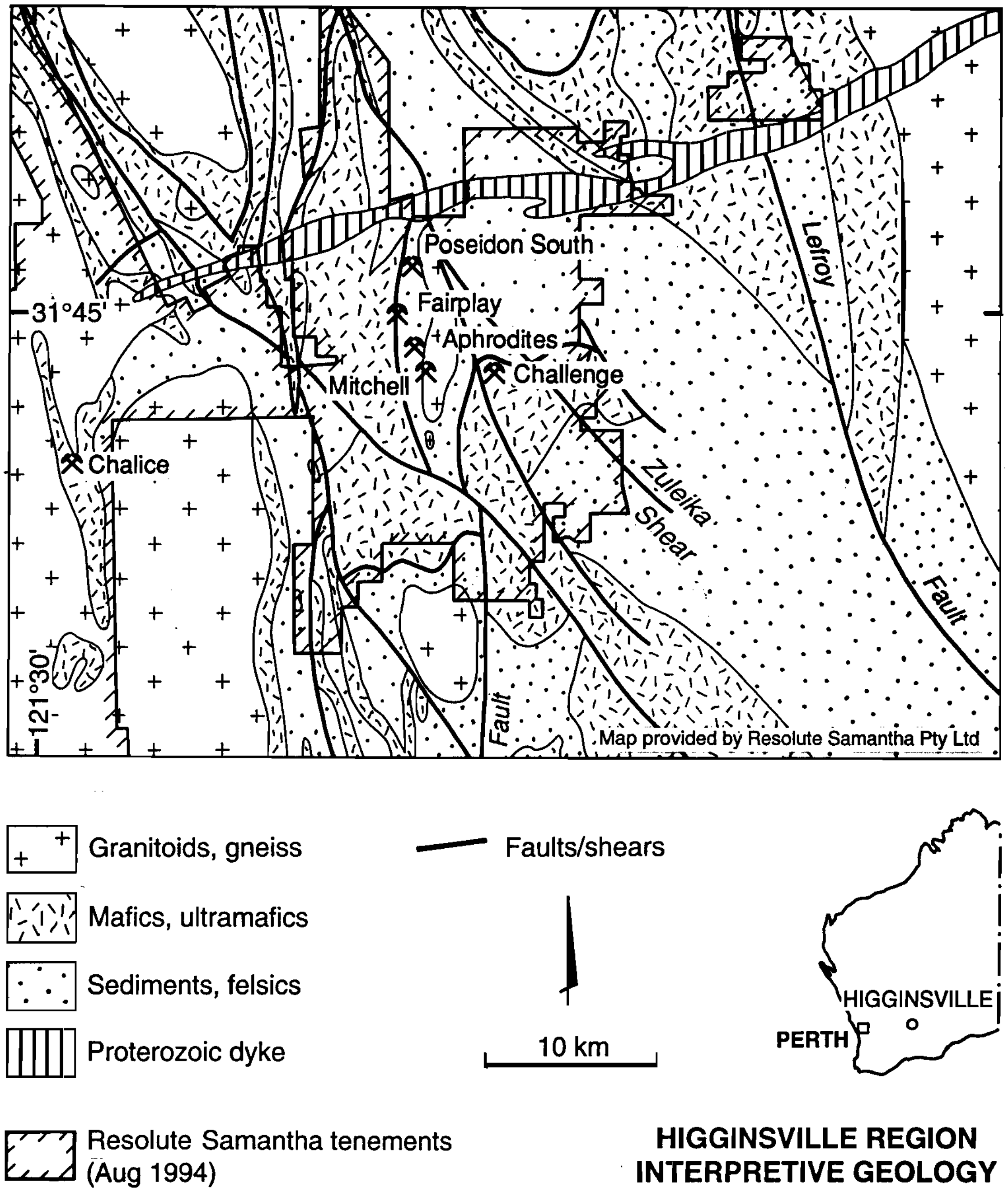


Figure 2: **Location and interpretive geology of the Higginsville area (map provided by Resolute-Samantha Ltd).**

A typical regolith from over palaeochannel mineralization consists of the following units:

0-2 m	Dense red, calcareous clays with abundant ferruginous granules.
2-6 m	Red, non-calcareous clays with some grey mottling.
6-12 m	Multi-coloured clays with abundant ferruginous nodules and some pisoliths.
12-18 m	Red and khaki puggy clays becoming paler with depth; some ferruginous nodules
18-34 m	Cream to white silty sandy clays.
34-40 m	Sandy clays with carbonaceous (including fossil wood) and sulphidic material.
40-80 m	Clay saprolite consisting of variably coloured clays with quartz and rock fragments. Fresh rock occurs at variable depth often below 80 m.

The study area is dominantly within a depositional terrain in which soils consist of dense red clays with variable amounts of carbonate (calcite and dolomite) and gypsum. The carbonate occurs within the top 1-2 m as nodules, pisoliths, concretions and as coatings on clay particles. Gypsum occurs as discrete crystals, nodules and coatings on clay particles. Throughout the soil, there are variable quantities of magnetic and non-magnetic, dark red ferruginous granules, ferruginous nodules, quartzofelspathic sands, and gravels of partially weathered rock. Discrete lenses of ferruginous granules in soil profiles suggest they have been transported rather than formed *in situ.* Individual soil profiles are described in detail in Appendix A1. Soils in relict/erosional terrains consist of calcareous, clays containing abundant, variably-sized lithorelics. These soils were not studied in detail, but the presence of detrital, part cutaneous, lateritic materials, including fragments of packed or re-cemented duricrust and lithorelics were noted in polished sections of ferruginous granules from the depositional soils.

The vegetation is varied and consists of open eucalypt woodland of salmon gum (*Eucalyptus salmonophloia*), gimlet (*E. salubris*) and mallee (*Eucalyptus* spp.) and small trees of ?boree (*Melaleuca pauperiflora*). The understorey consists of a variety of small shrubs including bluebush (*Maireana* spp.), false bluebush (*Cratystylis conocephala*), saltbush (*Atriplex* spp.) and poverty bush (*Eremophila* spp).

The climate is semi-arid with hot, dry summers and cool to mild winters. January is the hottest month with an average maximum of 33° C and minimum of 18° C (Kalgoorlie). July is the coolest month with an average maximum of 17° C and minimum of 5° C. Frost occasionally occurs during the winter months. Average rainfall for Widgiemooltha is 270 mm with most of the rain falling between March and August during the passage of cold fronts. Summer rainfall occurs intermittently as a result of remnant tropical cyclones and thunderstorms. Average potential evaporation is about 2300 mm with the greatest occurring during January and February (Kern, 1996).

LEGEND

- Calcareous red-brown sandy clay with Ca-rich nodules; becoming non-calcareous with depth. Indurated siliceous/ferruginous hardpan often present at base of horizon
- Ferruginous/siliceous horizon with some Fe mottling towards base
- Puggy lacustrine clays of various colours (yellow, red and/or grey). In areas with deeper cover, lenses of lignite present. Quartz sands and gravels increase with depth, and mark base of horizon
- Clays, undifferentiated
- Sandy horizon or lens
- Saprolitic clays with some partially weathered rock, not further classified
- Saprolitic clays, strongly oxidized with >50% clay minerals
- Saprolitic clays, moderately oxidized with <50% clay minerals
- Weathered rock, joint oxidation only
- Lignite
- Weakly mineralized (Au 0-2 ppm)
- Moderately mineralized (Au 2-10 ppm)
- Strongly mineralized (>10 ppm)
- Sample points
- Unconformity

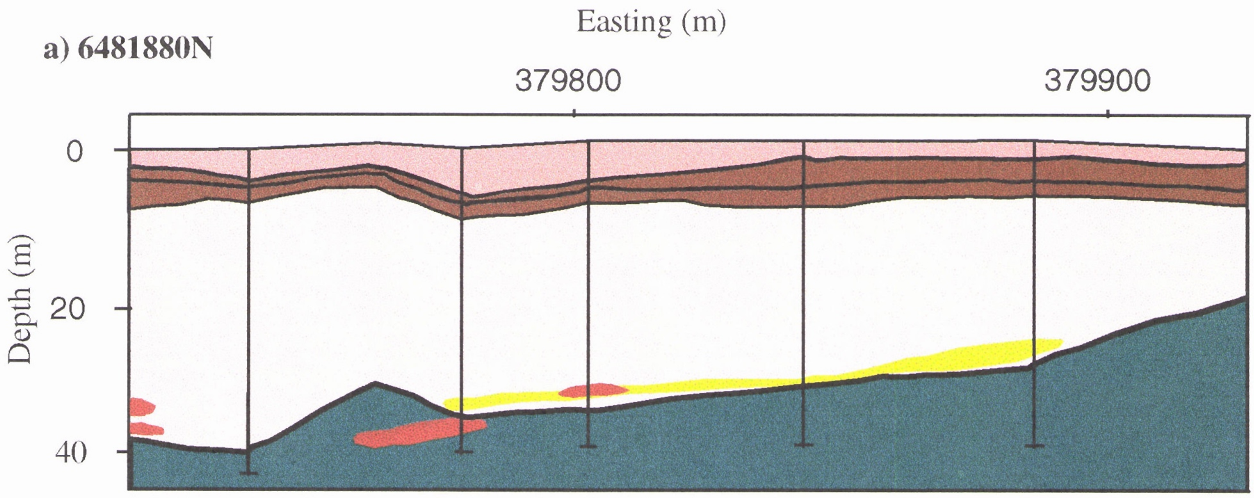
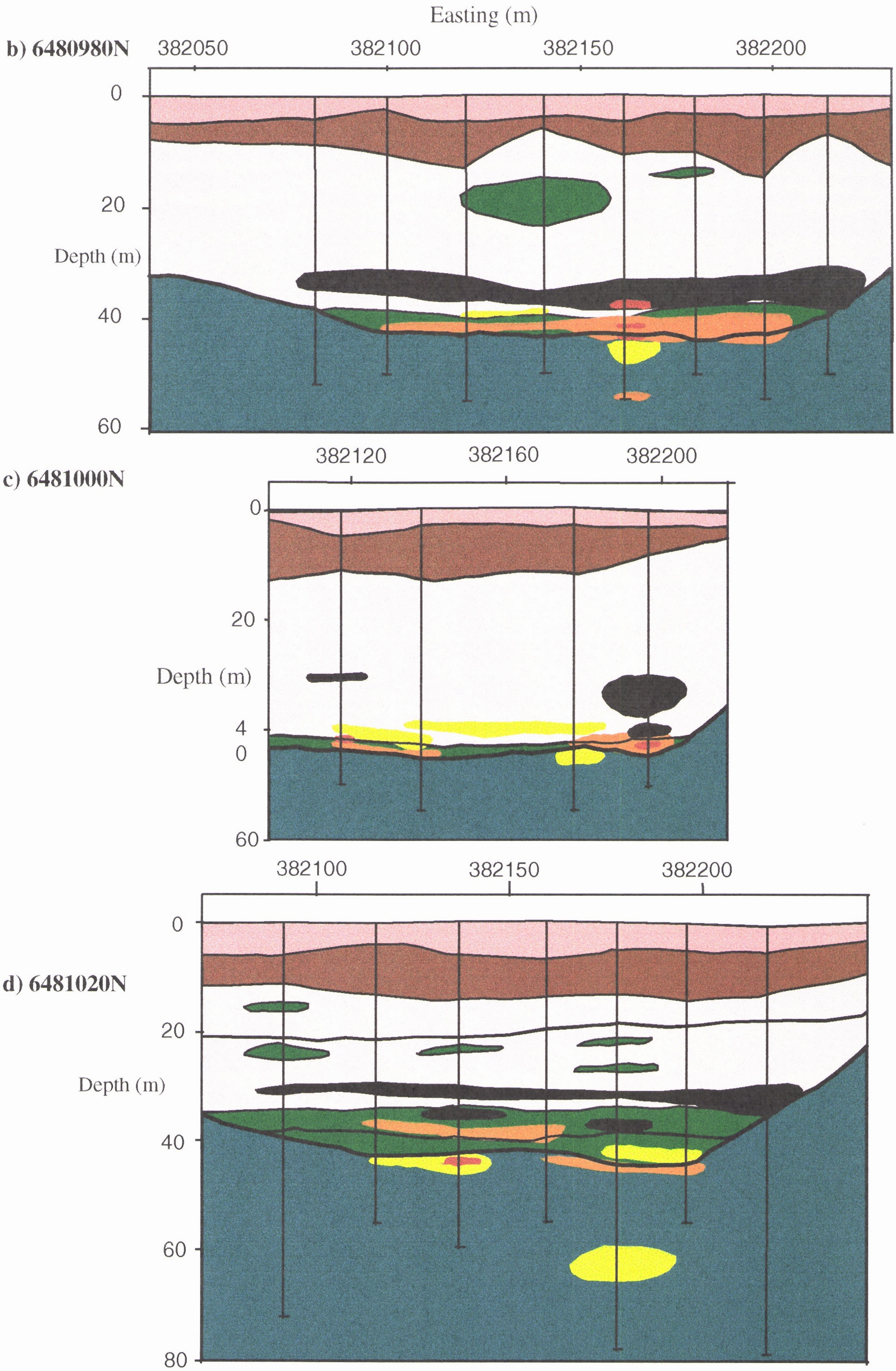


Figure 3: Typical regolith stratigraphy for the Vine-Graveyard, Mitchell and Challenge Swordsman (Pluto) study sites. Constructed with the assistance of company data.

Figure 3 (continued)



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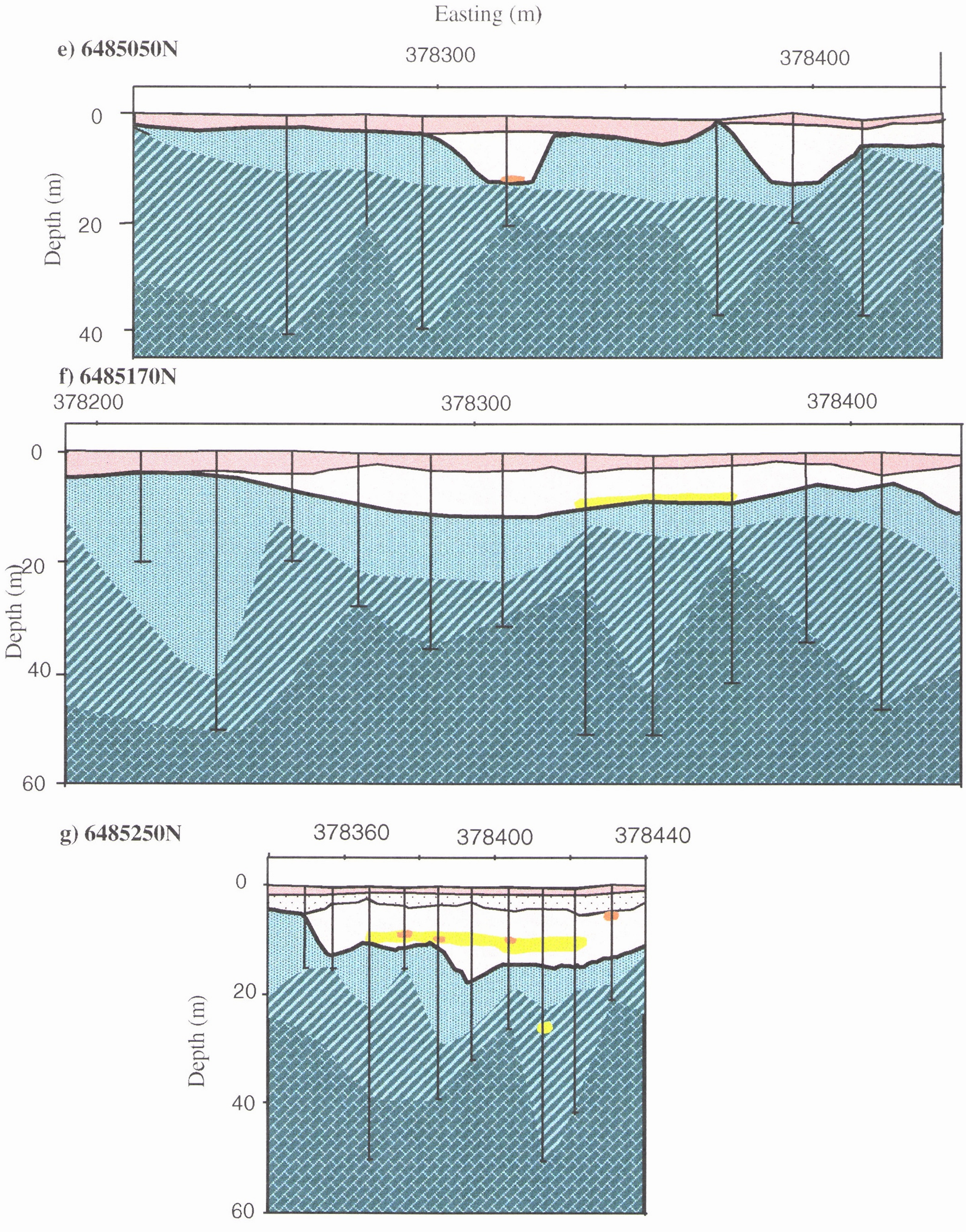

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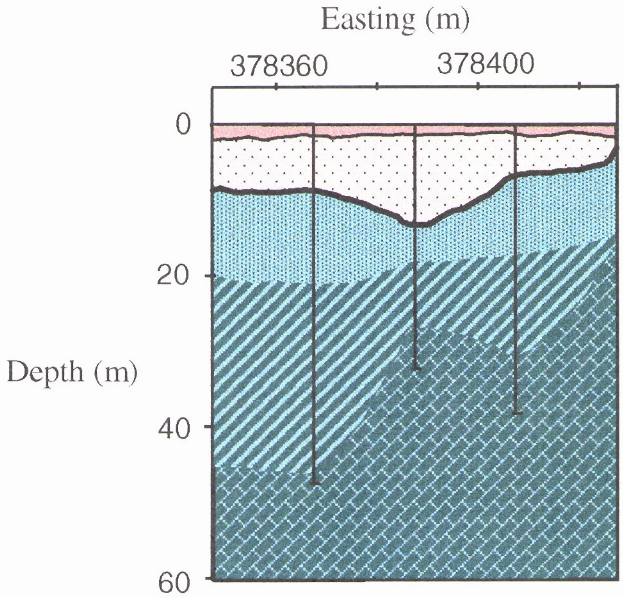

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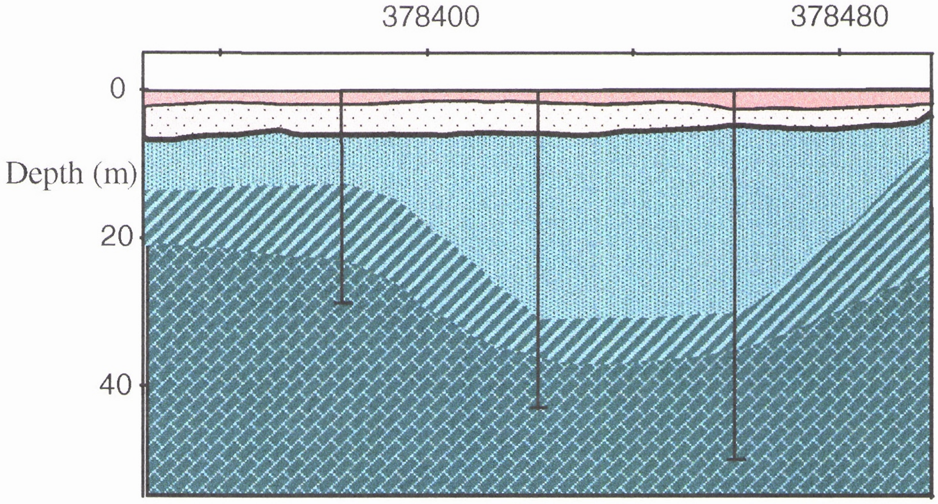

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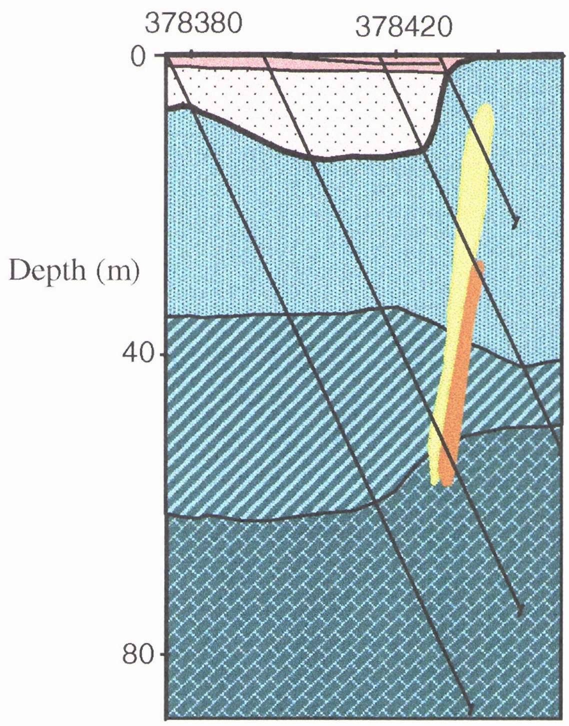

Figure 3 (continued)

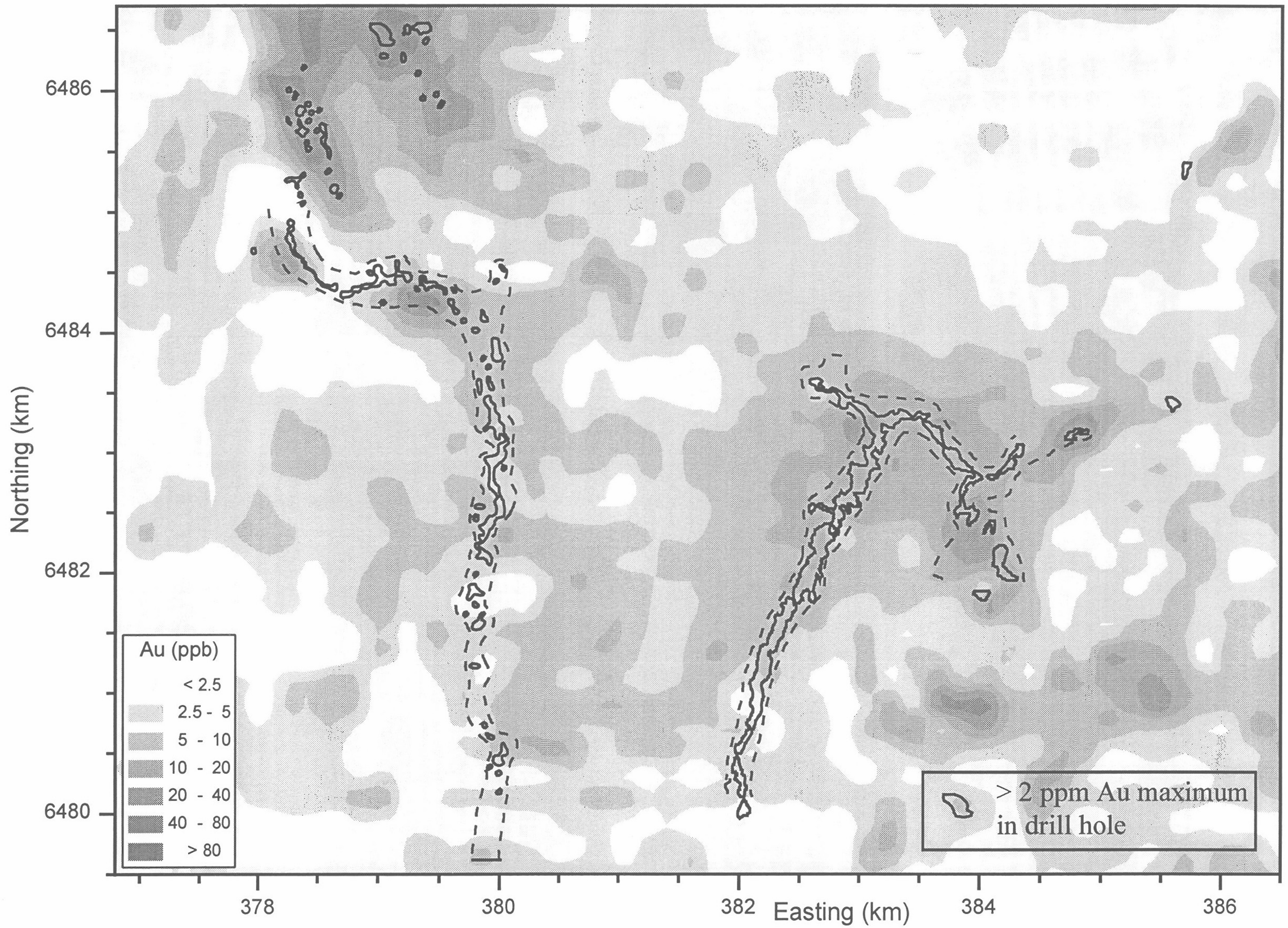

Figure 4: Plan showing relationship between Au in soils (contours), and Au mineralization in the palaeochannels and adjacent areas.

3. REGOLITH LANDFORM MAPS

3.1 Methods

For regolith landform map construction, 1:86000 RC9 black and white aerial photographs were used. Approximately 130 locations were visited and observations recorded to assist with regolith interpretations and map construction. The data were used to construct regolith landform units from calibrated photopatterns and used to modulate data interpreted from satellite imagery. Compilations were performed at photoscale by scanning aerial photographs with overlays attached without the intricate removal of radial distortion. All photographs with overlays were edge-matched then compiled into one composite sheet. The regolith polygons were scanned and imported into ARC/Info to allow the automatic diagram layout and automatic legend planning.

3.2 Interpretation

The dominant regolith landform unit for the Higginsville area is depositional which comprises 82% of the total mapped area (TMA) with colluvial sediments providing nearly 47% of the TMA (Figure 5, Table 1). Erosional areas comprise 17% of the TMA; the dominant erosional regolith landform unit is "slightly weathered bedrock" and represents 13% of the TMA. Relict area comprise 1% of the TMA.

Table 1: Principal regolith landform regimes

REGOLITH LANDFORM UNIT	% OF TOTAL MAPPED AREA (TMA)
RELICT	1
EROSIONAL	16.7
Saprolite	0.3
Very highly weathered	1.7
Moderately weathered	2.4
Slightly weathered	12.7
DEPOSITIONAL	82.3
Alluvial sediments	12.2
Dunefield	1.8
Colluvial sediments	47.3
Lacustrine	21
TOTAL	100

An interpretation was made of the nature of the material expressed directly at the actual land surface (Table 2); this was possible for approximately 53% of the TMA at this level of investigation. These materials represent the source of regolith compositional information as determined by Landsat TM imagery. These surface materials do not indicate the full nature of regolith materials at depth. A complete explanation of the regolith materials and landforms comprising each unit is provided in the legend on the regolith landform map located at the back of this document.

HIGGINSVILLE INTERPRETED LANDSCAPE CLASSES

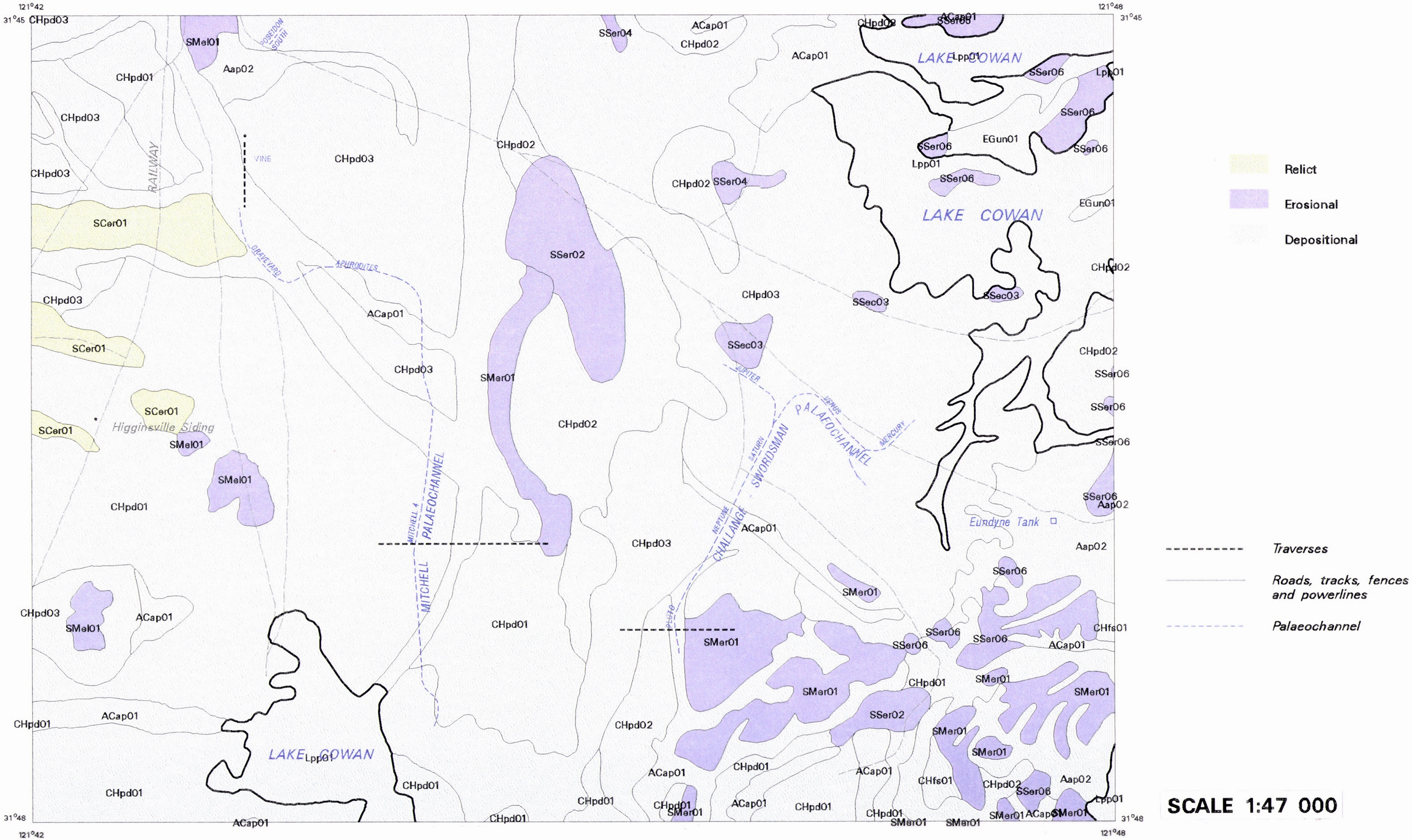

Figure 5: Simplified regolith diagram of the Higginsville area. See back of report for full size detailed diagram.

Table 2: Surface material, Higginsville area

	UNIT	% of TOTAL MAPPED AREA
1.	Calcareous earths, soil carbonate, calcareous nodules	14.3
2.	Lag:-variable composition, but dominantly gravel-sized lithic fragments	2.8
3.	Lag gravels: dominantly quartzofeldspathic sand or granules, or mixtures	23.6
4.	Ferruginous fragments - mixed composition: lateritic residuum, duricrust, Fe segregations, Fe saprolite and Fe-stained hardpan	1.0
5.	Fine ferruginous gravel lags	1.9
6.	Black, slightly magnetic, hematite- maghemite rich ferruginous granules	9.7
7.	Unassigned	46.6
	Total map area	100.00

4. SAMPLE COLLECTION, PREPARATION AND ANALYSIS

4.1 Introduction

The methodology behind this study, as with other studies in Project 409, was primarily concerned with the collection and analysis of high-quality, surficial samples, enabling results from Higginsville to be compared with similar sites from Kalgoorlie. In addition, information and knowledge on geochemical relationships between elements, and appropriate sampling techniques for exploration in terrain with a substantial sedimentary cover, will also be advanced.

Three principal sites in the Higginsville area were studied; the Pluto deposit located in the Challenge-Swordsman palaeochannel, the toposequence from the Vine deposit, terminating in the Mitchell palaeochannel containing the Graveyard-Aphrodites deposits; and the Mitchell 4 deposit located in the Mitchell palaeochannel (Figure 6).

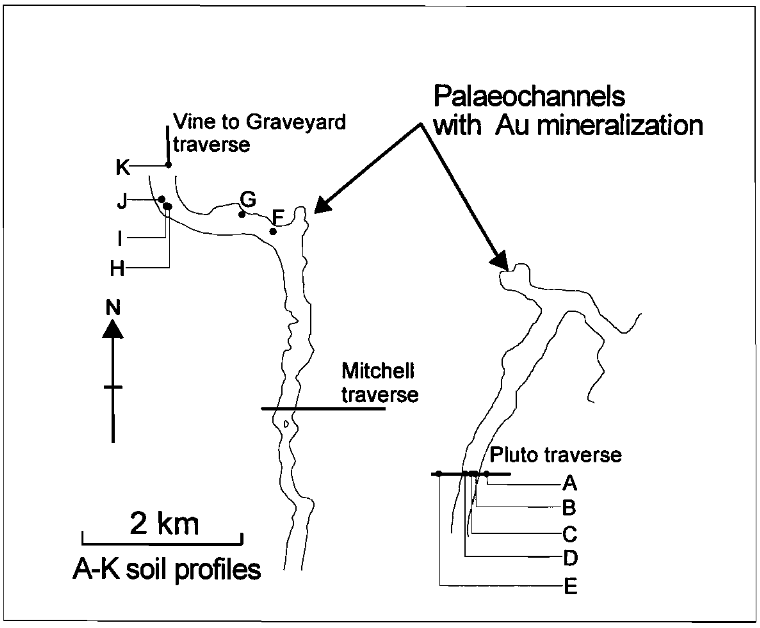

Figure 6: Location plan of samples collected.

Samples were analysed for selected elements (including Au) and some tested for soluble Au using in-house and commercially-available partial extraction procedures. Selected size fractions and specific regolith components such as ferruginous granules and nodules were also examined.

4.2 Sample collection

Soil composite samples. One to two kilos of soil samples were collected using a vehicle-mounted auger drill rig and stored in calico bags. Thirty-five 0-1 m composites (and some deeper samples) were collected across the northern end of the Pluto deposit (6481000N, Challenge-Swordsman palaeochannel), thirty one 0-1 m composites (and some deeper samples) between Vine and Graveyard (378320E), and fifty 0-1 m and 0-0.1 m composites (an some deeper samples) from the Mitchell 4 deposit (6481880N, Mitchell palaeochannel).

Soil profile samples. A back hoe was used to excavate soil pits about 2 m deep in selected areas. Composite samples (131) were taken at regular 0.1-0.2 m intervals down 11 soil profiles and/or at recognisable soil horizons.

Ferruginous granules. Selected profile samples were wet-sieved in order to isolate ferruginous granules for detailed microscopic study.

Down-hole material. Ferruginous material (21 samples) was hand-picked from drill cuttings from transported overburden. About 150 samples of drill cuttings were collected using a hand trowel for establishing regolith stratigraphy.

Vegetation. Bluebush samples (25) consisting of leaves and branches were collected by hand and stored briefly in calico bags to minimize mould growth before laboratory processing.

4.3 Sample preparation and analysis

Soil. Soil samples (auger and profile) were dried at 70°C, split and jaw-crushed (as required) before a 100-200 g sub-sample was pulverized in a K1045 steel ring mill to nominal <75 µm.

(i) Gold, Sb, As, Ba, Br, Ce, Cs, Cr, Co, Eu, Hf, Ir, Fe, Au, La, Lu, Mo, K, Rb, Sm, Sc, Se, Ag, Na, Ta, Th, W, U, Yb and Zn were analysed on a 10 g sub-sample by Instrumental Neutron Activation Analysis (INAA) at Becquerel Laboratories, Lucas Heights, NSW.

(ii) Calcium and Mg were analysed on a 1g sub-sample by atomic absorption spectrophotometry (AAS) at CSIRO Division of Minerals (Waterford, WA) after first digesting in 5M HCl for 15 minutes and then diluting to 1M HCl. This procedure dissolves the carbonate present.

(iii) Bismuth, Cu, Mn, Ni, Pb, Sr, Ti and Zr were analysed on pressed powders by in-house XRF using a Philips PW1220C instrument by the methods of Norrish and Chappell (1977) and Hart (1989), with Fe determined for matrix correction (CSIRO Exploration & Mining, Floreat Park).

Size fraction study of soils. Nine samples with high Au contents (determined from earlier analyses) were dry sieved into 4 size fractions (>1000 µm, 1000-250 µm, 250-63 µm and <63 µm) using a ROTAP testing sieve shaker (International Combustion Australia Ltd). Samples were analysed for Ca, Mg and Au. In addition, some of the >1000 µm material was wet sieved, the finer material discarded, and analysed for Au separately.

Ferruginous granules. Fifty ferruginous granules (>1000 µm), randomly picked from a soil sample rich in total Au (402 ppb, 09-4748, Profile G, adjacent to Aphrodites mine pit) were analysed in more detail. They were broken with a geological hammer with some of the sample being sent for INAA, and some retained for cementing in epoxy and polishing for microscope studies.

Down-hole material. Ferruginous and down-hole material samples were wet sieved (>1000 µm) to remove fine material. Samples were prepared for analysis as for soils and analyzed by INAA.

Vegetation. Samples were washed with hot water and deionised water before drying at 90°C. They were macerated through a cross-beater mill. The samples were then re-dried at 105°C for at least 24 hours, to prevent smearing during milling, before being passed through a four-bladed cross-beater mill twice - firstly without, and secondly with, a 1 mm mesh screen in place to ensure a suitably homogenized and macerated sample. The samples were then weighed, step-wise-ashed to 550°C before being re-weighed and sent for INAA (see above for elements).

4.4 Partial extractions

Three in-house partial extraction solutions, discussed in detail in Gray and Lintern (1993), were used to examine the solubility of Au. In all cases, a 25 g portion of un-pulverized sample material was mixed with 50 mL of extractant in a screw-cap, polyethylene bottle, and then gently agitated for one week, after which the total Au extracted was determined. Total Au was measured by adding a 1 g carbon sachet with the sample and analyzing the carbon using INAA; in-house experiments have shown that the carbon sachet procedure reduces re-adsorption of the dissolved Au on components within the sample. The three solutions are:

(i) deionised water: dissolves the most soluble Au;

(ii) iodide: a 0.1 M KI solution dissolves more Au than water alone;

(iii) cyanide: 0.2% KCN / 0.2 M NaOH solution dissolves all but the most refractory Au, such as large particles of Au and that encapsulated within resistant material such as quartz.

The partial extraction tests were performed sequentially, using 3 different carbon sachets, commencing with deionised water and finishing with cyanide. The results from the three extraction tests for a particular sample can be summed to give a quasi-total Au content with a detection limit of <0.1 ppb.

Mobile Metal Ion analysis uses two leachant solutions to dissolve "target metals". The technique involves (1) acid solution analysis by ICPMS for: Cd, Cu, Pb, Zn, and (2) alkaline solution analysis by ICPMS for: Ag, Au, Co, Ni and Pd. Only the alkaline solution was used on these samples.

5. RESULTS

5.1 Gold

The principal Au results (Figure 7) indicate that:

(i) there is a general association between Au and Ca (as carbonate) in the soils. The strongest associations are observed over mineralization at Vine, the Pluto traverse and soil profiles E, B, F and I, and, to a lesser extent, profiles G, H and J;

(ii) Au content of soils is not directly related to underlying mineralization at Mitchell or Pluto; there may be a relationship at Vine and North Graveyard, although the latter is possibly related to higher Ca contents;

(iii) the highest Au concentrations (maximum of 425 ppb) are found in Profile G, which is located immediately to the east of the Aphrodite pit;

(iv) no Au was detected in many samples over mineralization at Mitchell and Pluto (detection limit of 5 ppb);

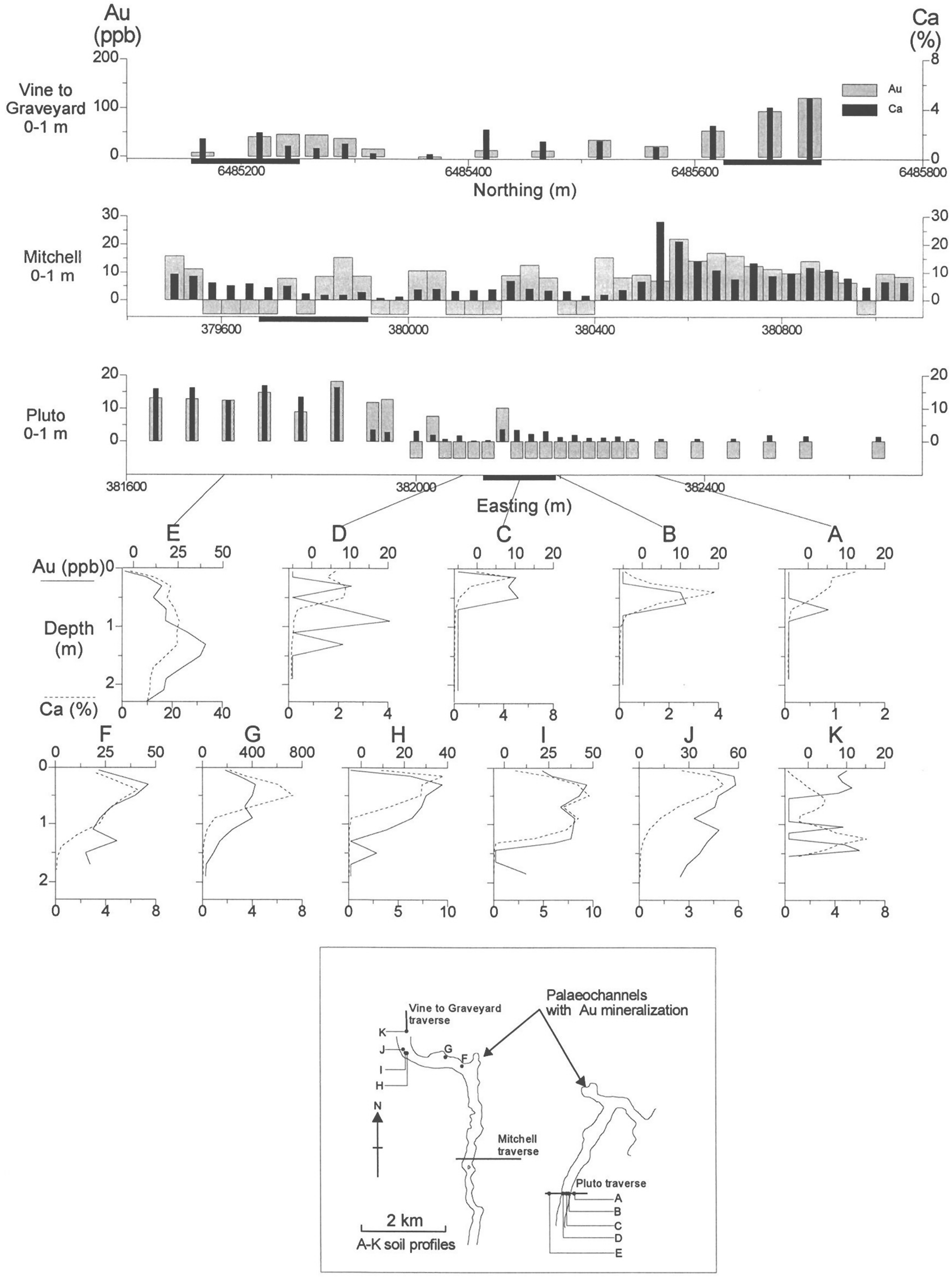

Figure 7: Gold and Ca distributions for soils at Higginsville. Black bar under traverse axis locates mineralization. Negative Au data indicate concentrations below detection (5ppb).

Using data with the lower detection limit for Au (<0.1 ppb, by summing results from the partial extractions of individual samples, Section 3.4), the results suggest there are two linear trends between Au and Ca (Figure 8) and that samples closer to sub-cropping mineralization (Vine-Graveyard) have higher Au/Ca ratios than samples from Pluto and Mitchell. One sample is particularly rich in Ca (28%).

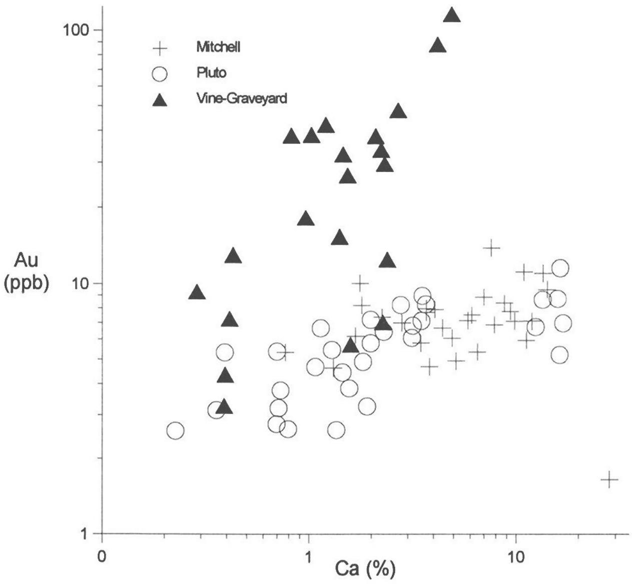

Figure 8: Gold versus Ca scatter plot for composite samples, Higginsville.

Shallow soils (0-0.1 m composites) were collected from the Mitchell palaeochannel only; they have lower Au contents than the 0-1 m composite soils and similarly do not locate buried mineralization (Figure 9). Gold concentrations for 0-0.1 m and 0-1 m composite samples are associated indicating that, for this traverse at least, samples taken carefully from the surface are representative of deeper composite samples (Figure 10). However, this relationship may not always be dependable as can be observed from the highly variable Au content of individual soil samples taken from the soil profiles at Pluto (Figure 7).

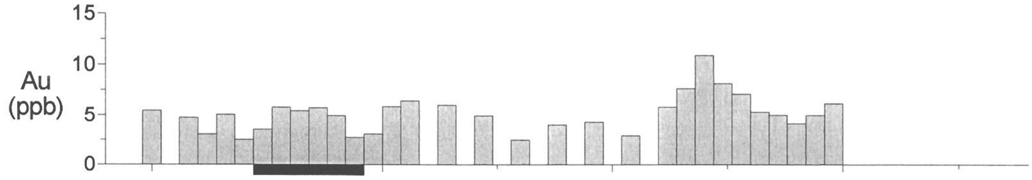

Figure 9: Gold concentrations for 0-0.1 m composite samples from Mitchell palaeochannel, Higginsville. Gold analysed by summing the data from the partial extractions *i.e.* effectively a cyanide digestion.

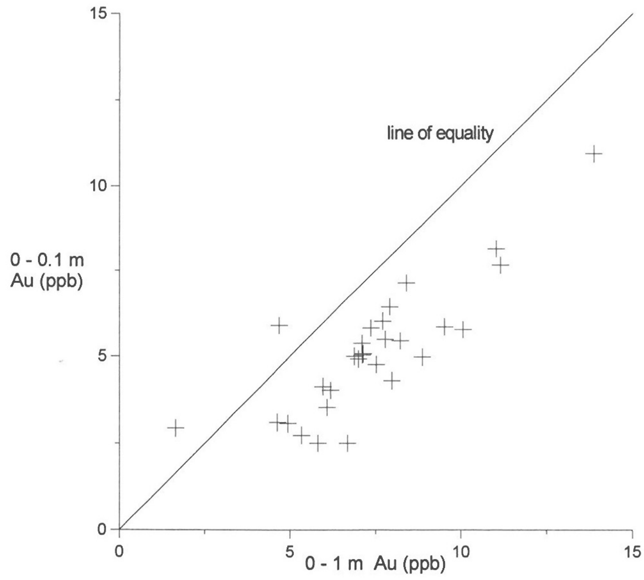

Figure 10: Comparison of 0-1 m and 0-0.1 m Au data for Mitchell palaeochannel, Higginsville.

The distribution of Au in ferruginous materials and that extracted using partial digests is discussed in later chapters.

5.2 Other elements

Results for other selected elements indicate:

(i) Magnesium concentrations are related to Ca concentrations, and probably occurs as dolomite (Figure 11); some gypsum was also observed in soils from Pluto. Iron concentrations are inversely related to Ca, which is consistent with the observation that carbonate is a late-stage diluent of Fe oxides and associated elements in soils at Higginsville (Figure 11).

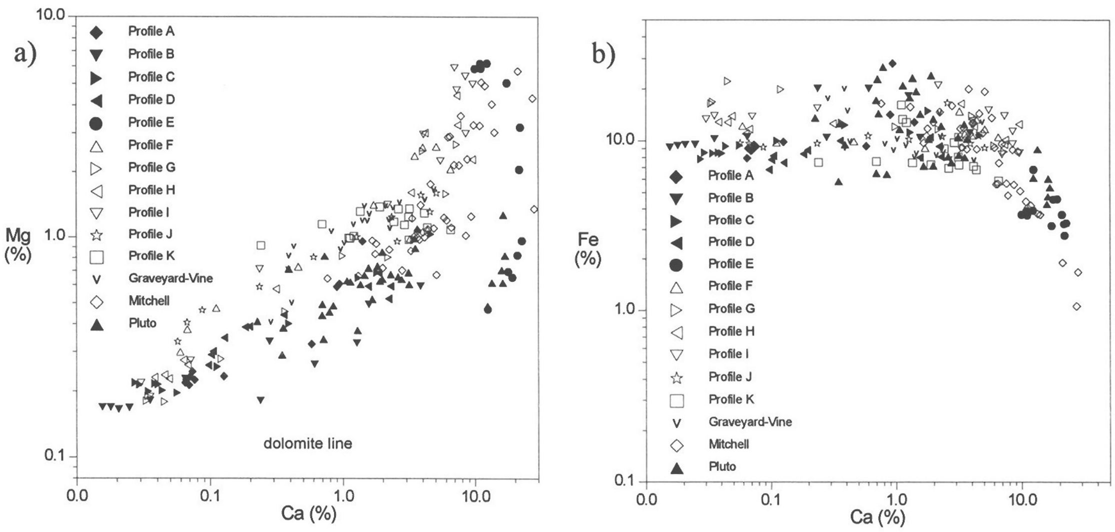

Figure 11: Scatter plots for Ca versus a) Mg and b) Fe.

(ii) Iron concentrations strongly control the distributions of Sb, Cr, As and Sc (Figure 12). Furthermore, the data suggest two catchment-related populations are present, which presumably reflects the provenance of the samples. The highest As/Fe ratios are associated with sub-cropping mineralization at Vine.

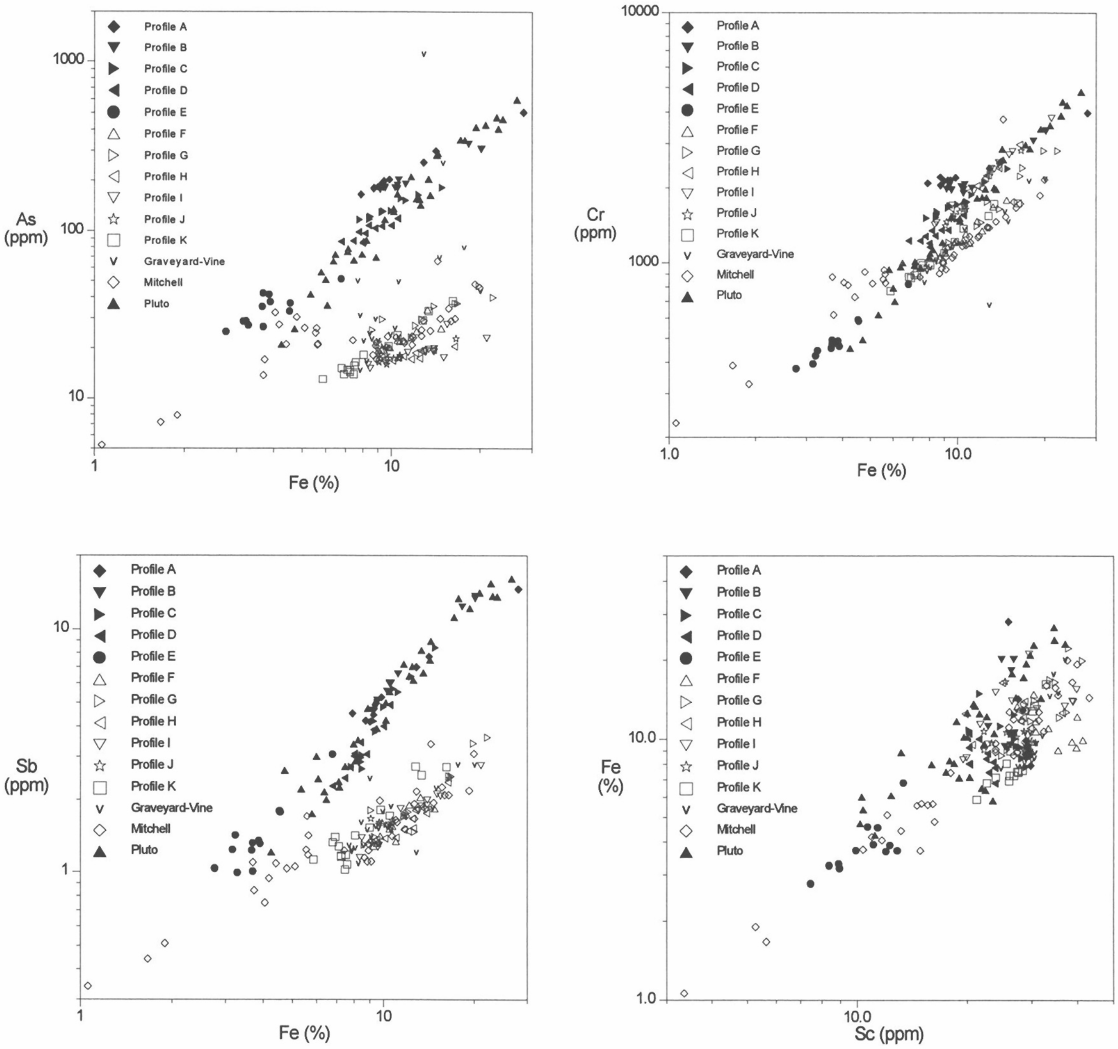

Figure 12: Scatter plots for Fe versus selected elements (As, Sb, Cr, Sc).

(iii) There is an association between Na and Br, consistent with Na-rich salts derived from deflation of the nearby playa and variably diluted by meteoric water (Figure 13).

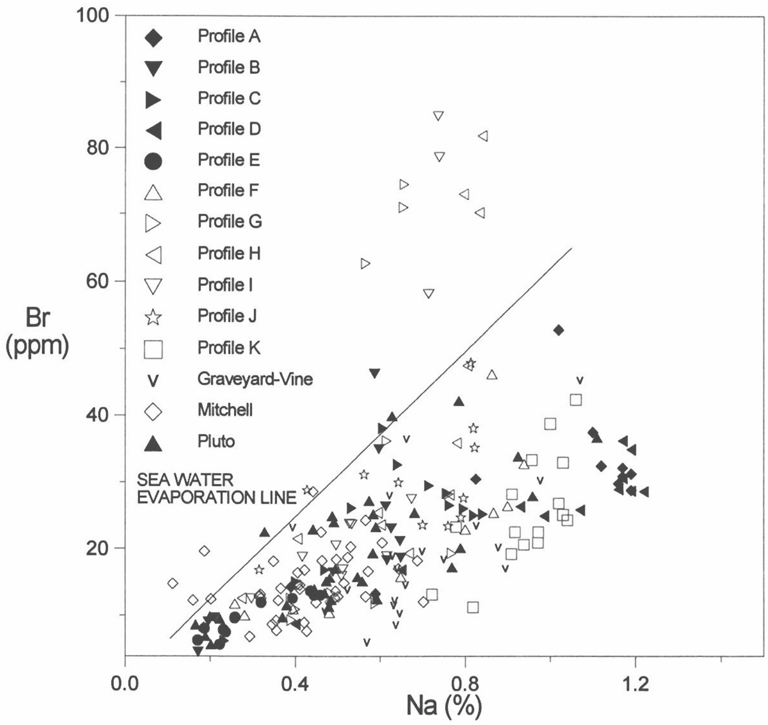

Figure 13: Scatter plot for Na versus Br.

(iv) Rare earth data indicate that the two catchments (Mitchell and Challenge-Swordsman) have little difference in their Ce to Sm ratios. However, Ce and Th appear to be associated in the Mitchell catchment (and Profile E), which may indicate the presence of detrital monazite (Figure 14). Ytterbium to Sm ratios are also different for the two catchments and either suggest differential fractionation during weathering processes or a different provenance for these samples.

5.3 Partial extractions

For the Mitchell traverse, the water, iodide and cyanide sequential partial extraction data in the 0-1 and 0-0.1 m samples indicate (Figure 15 and Figure 16):

(i) The two 0-1 m samples with the highest percentage of water-extractable Au (mean 46%) occur over mineralization. This does not occur with 0-0.1 m samples.

(ii) Gold concentrations are significantly higher in 0-1 m samples (7 ppb) than 0-0.1 m samples (5 ppb). This Au is more extractable in water (26% compared to 12%), but less totally-extractable Au (22% with 28%).

(iii) One sample has a particularly low extractable Au content (380540E, 1.6 ppb) compared with the absolute total Au content (7 ppb, Figure 7) and other samples on the traverse. The reason(s) for this are unclear.

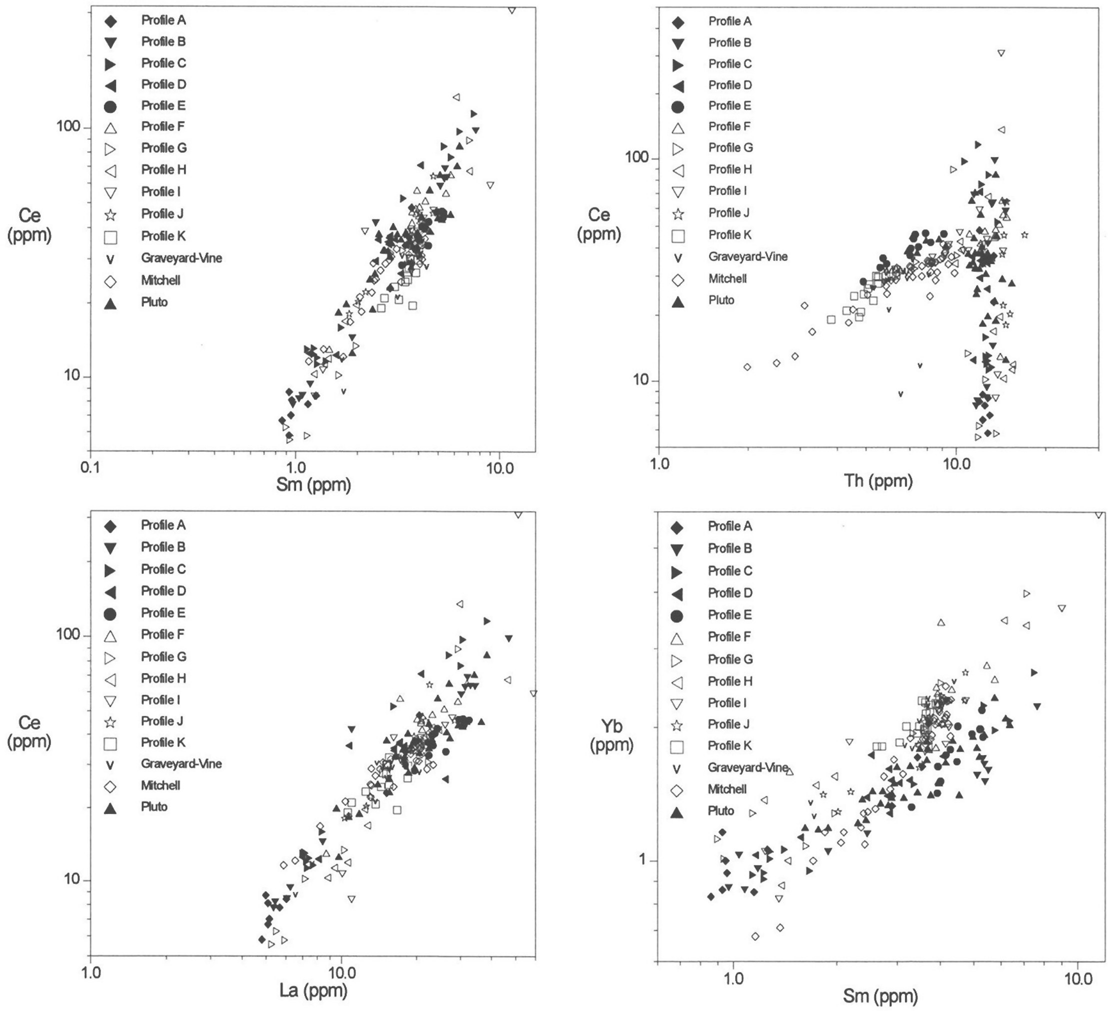

Figure 14: Scatter plots for REE versus selected elements. Cerium v La, Sm and Th, and Sm v Yb.

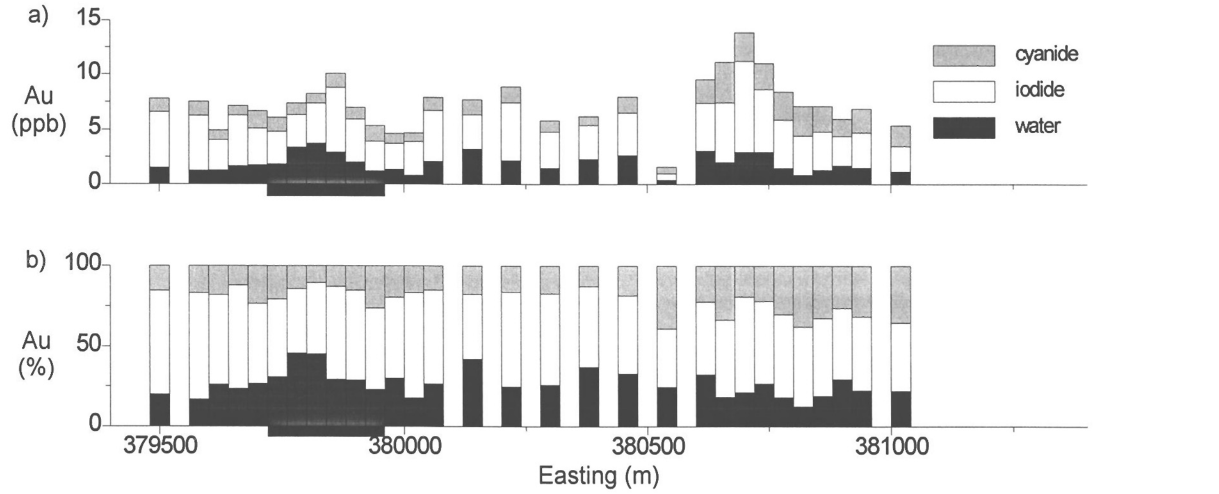

Figure 15: Stacked histograms of partially-extractable Au expressed as a) concentration and b) percentage for 0-1 m samples from Mitchell palaeochannel, Higginsville. Black bar under axes indicates position of mineralization.

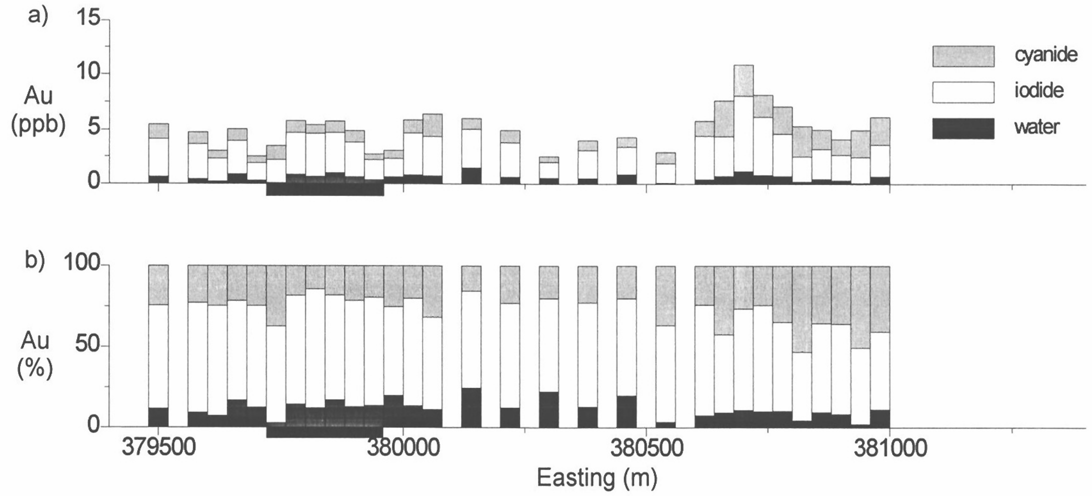

Figure 16: Stacked histograms of partially-extractable Au expressed as a) concentration and b) percentage for 0-0.1 m samples from Mitchell palaeochannel, Higginsville. Black bar under axes indicates position of mineralization.

For the Pluto traverse, the water, iodide and cyanide partial extraction data indicate (Figure 17):

(i) samples with the highest total extractable Au concentrations (all extractions summed) occur in the western portion of the traverse (maximum of 12 ppb), although the samples with the highest *proportion* of water-extractable Au occur in the central and eastern parts of the traverse;

(ii) the sample with the highest proportion of water-extractable Au (81%) occurs adjacent to mineralization. However, this particular sample has an unusually low concentration of total-extractable Au (3 ppb) compared with adjacent samples (5 ppb);

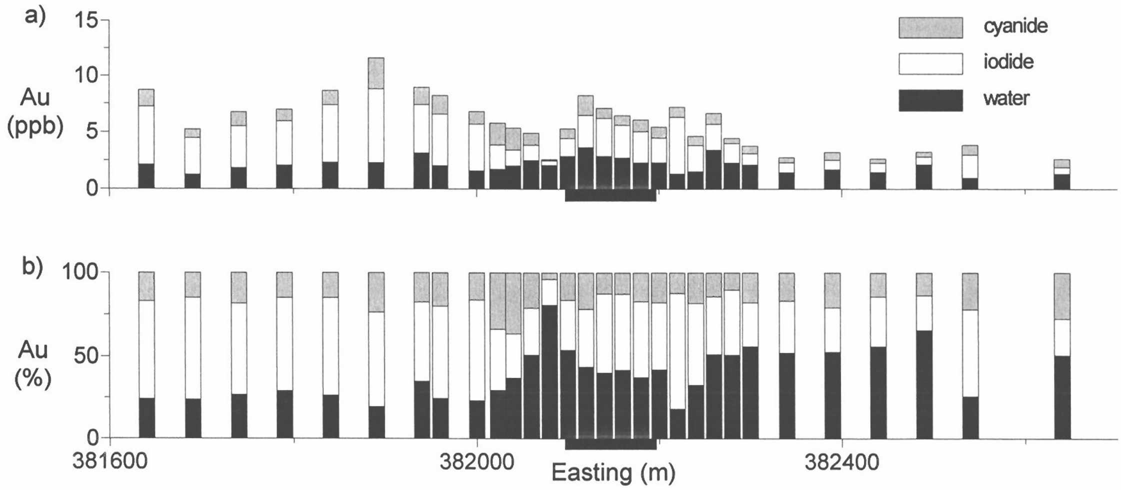

Figure 17: Stacked histograms of partially-extractable Au expressed as a) concentration and b) percentage for 0-1 m samples from Pluto deposit, Challenge-Swordsman palaeochannel, Higginsville.

Mobile Metal Ion extractions were performed on 0-0.1 m samples from Mitchell (Figure 18). There is a strong correlation between MMI-extractable and iodide-extractable Au, suggesting that the two extraction procedures are dissolving the same type of Au (Figure 19).

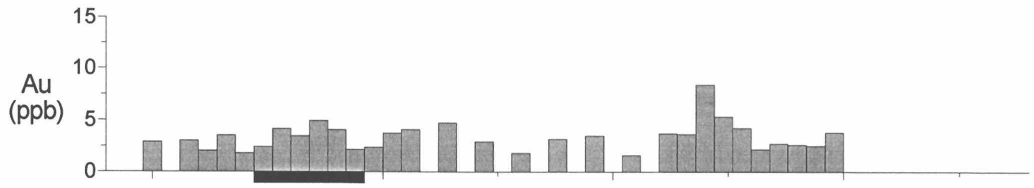

Figure 18: MMI-extractable Au distributions for 0-0.1 m samples from the Mitchell palaeochannel, Higginsville.

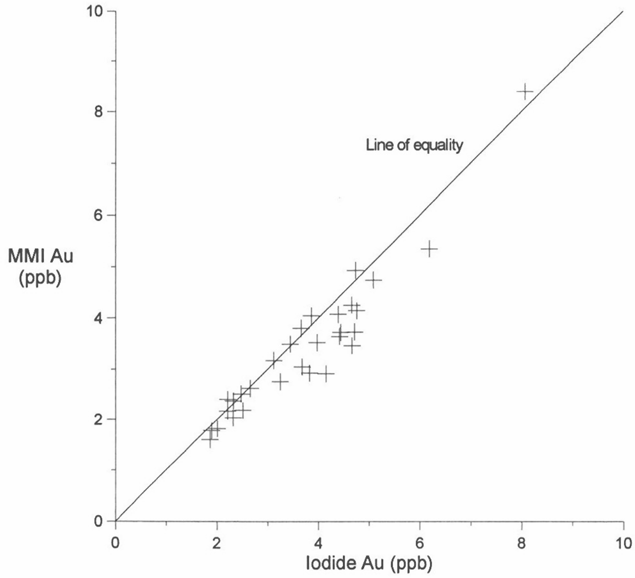

Figure 19: Comparison of iodide versus MMI extraction data for 0-0.1 m samples from the Mitchell palaeochannel, Higginsville.

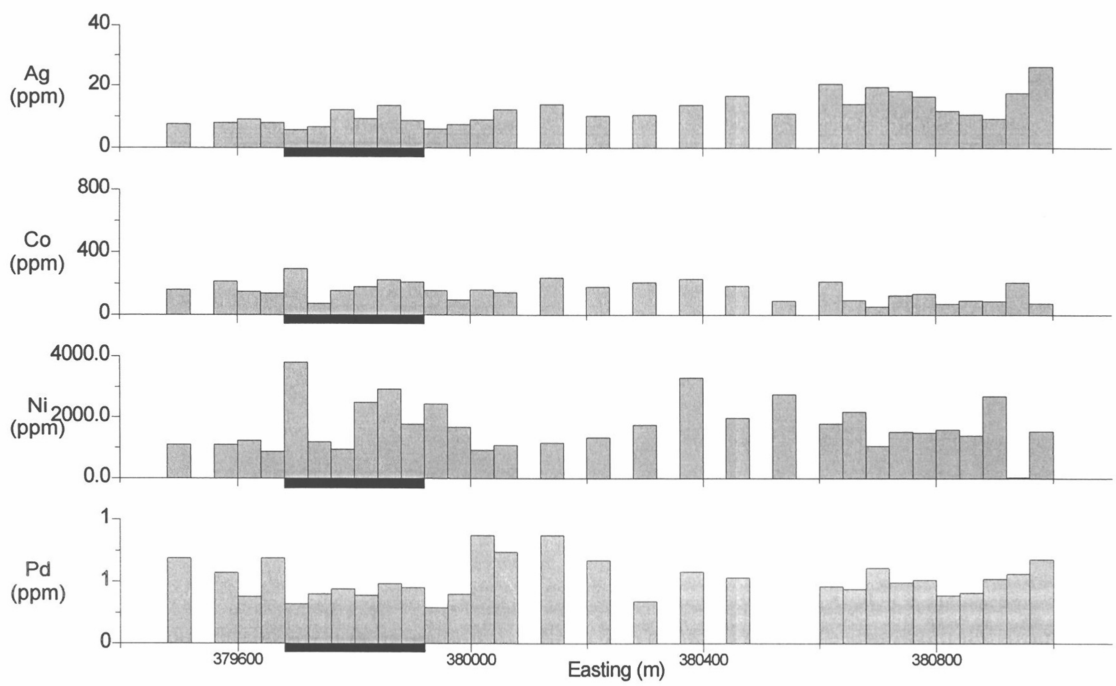

Figure 20: MMI-extractable distributions for selected elements for 0-0.1 m samples from the Mitchell palaeochannel, Higginsville. Black bar under Easting axis locates mineralization.

MMI extraction data (0-0.1 m, Mitchell traverse) for Ag, Co, Ni and Pd do not help to locate mineralization. Silver concentrations are higher in the eastern part of the traverse (erosional area, moderately weathered bedrock), where Au concentrations are also higher.

5.4 Ferruginous materials

Fifty individual, wet-sieved (>1 mm) ferruginous granules were selected at random from sample 09-4748 (Profile G) and broken using a geological hammer. Approximately half of the material was analysed for the INAA suite of elements. The nine ferruginous granules with the highest Au contents were mounted and polished for microscopic examination. The data indicate that ferruginous granules can be extremely enriched in Au; the maximum Au concentration was 51000 ppb, which compares with the total bulk soil Au content of 400 ppb (sample 09-4748). The Au contents of many granules were below detection (100 ppb); the elevated detection limit is due to the small sample size.

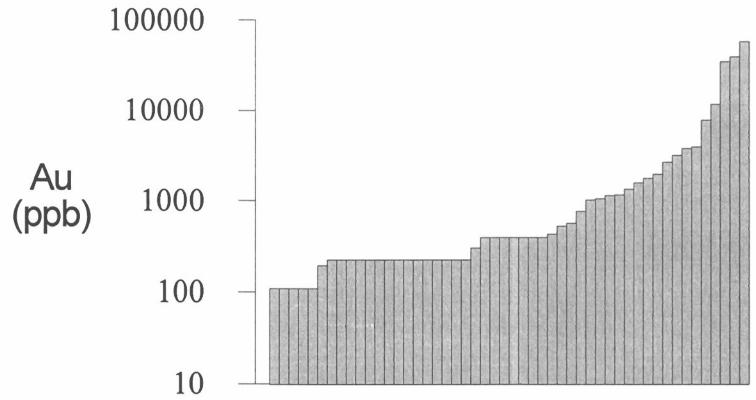

Figure 21: Histograms showing individual Au concentrations for 50 ferruginous granules randomly picked from soil profile G (Mitchell palaeochannel, Higginsville). The nine most Au-rich samples were examined microscopically.

Petrological investigations of 9 individual, Au-rich (>250 ppb) ferruginous granules (Figure 22) showed that the samples are pervasively ferruginized, with some having partly-preserved primary lithic fabrics. Gold grains up to 10 µm in size were observed, although no Ag was detected within them.

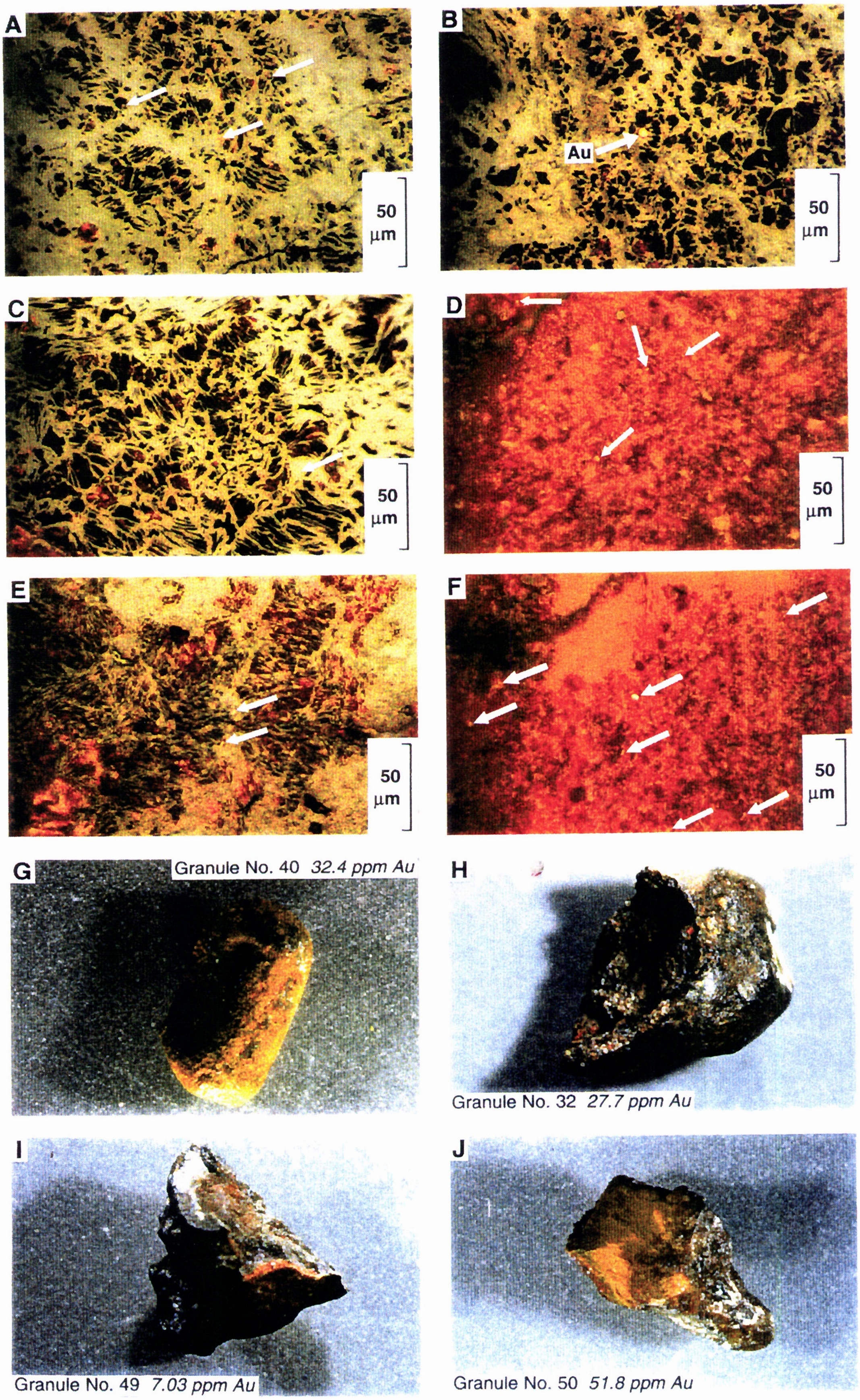

Figure 22: Photomicrographs (A-F) of Fe granule showing fabrics and Au grains (labelled with arrows); typical ferruginous granules (G-J) up to 4 mm in size with high Au concentrations.

Ferruginous material from 2-10 m separated out from drill hole material located over mineralization from Pluto and Mitchell did not have any detectable Au (<5 ppb) indicating that this material is not a useful indicator for underlying Au mineralization (Appendix A6.1).

5.5 SIZE FRACTION ANALYSIS

The results indicate:

(i) For 8 of the 9 samples, the highest Au and Ca are found in the finest size fraction;

(ii) There is a strong association between Au and Ca and a weaker one between Au and Mg;

(iii) The coarse size fraction for sample 09-4748 has a high Au concentration but low Ca and Mg concentrations which probably suggests an association between Au and Fe.

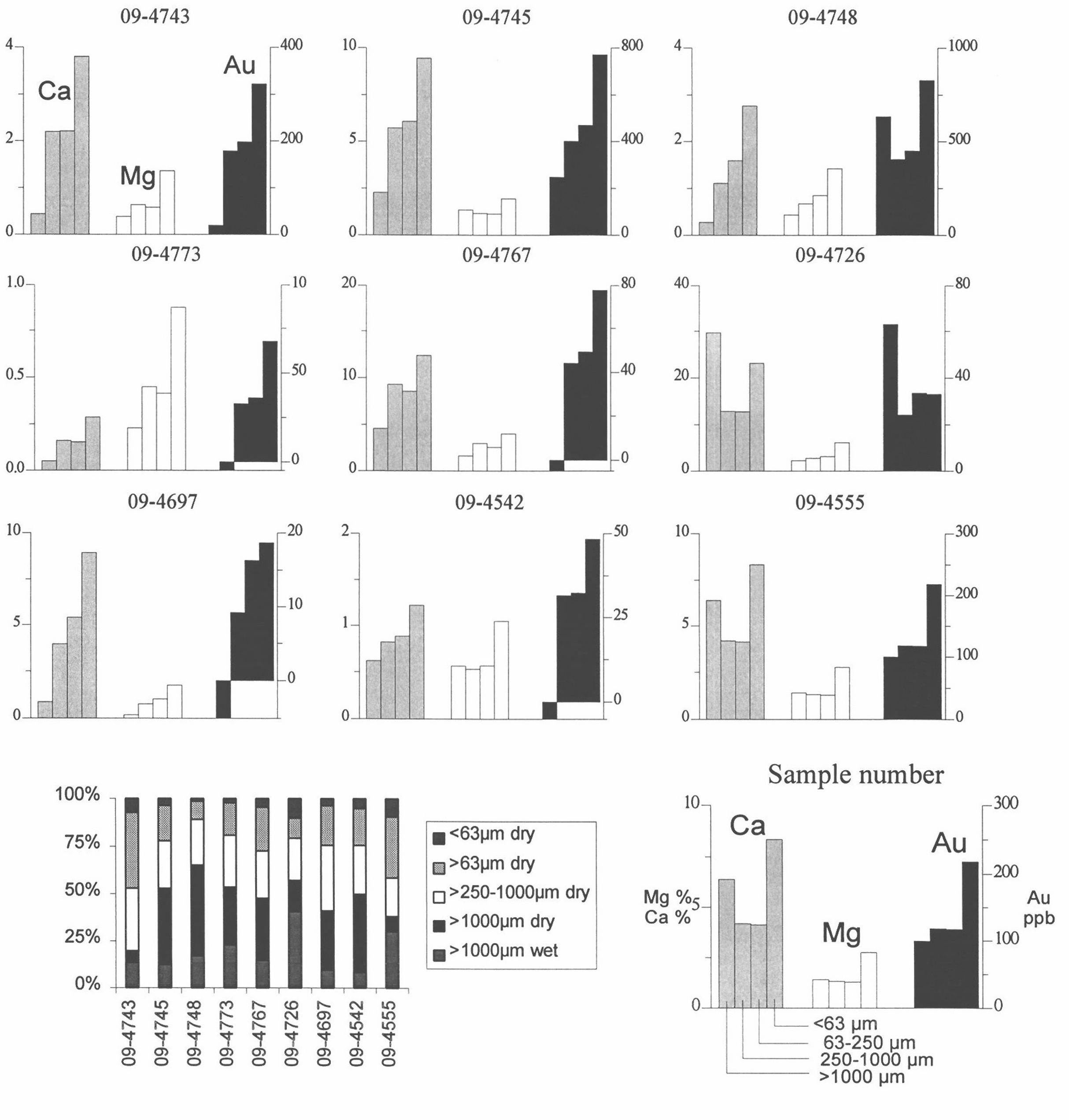

Figure 23: Gold , Ca and Mg analyses for 4 size fractions on 9 different samples.

5.6 Vegetation

One of the problems with biogeochemical sampling in arid areas of Australia, as compared with the temperate forests of Canada or the US where biogeochemical media are successfully used, is inconsistency of sample media. Bluebush was chosen for the survey as it had previously shown potential as a sample medium in other areas of the Yilgarn (Lintern *et al.*, 1996). Unfortunately, as a single representative species for the entire traverse at Pluto was absent, two different species (1 and 2) had to be used and quite different geochemical responses for Au and other elements were observed (Figure 24, Appendix A7.1). Gold concentrations in the vegetation appear to follow the concentration in the soil and are greatest in the western portion of the traverse (species 2). Gold concentrations are below detection over mineralization and in the eastern part of the traverse (species 1), so it is not possible to determine if the data are anomalous. However, results from elsewhere (Lintern *et al.*, 1996) suggest that if concentrations are below 2 ppb, as with most data here, they are not significant.

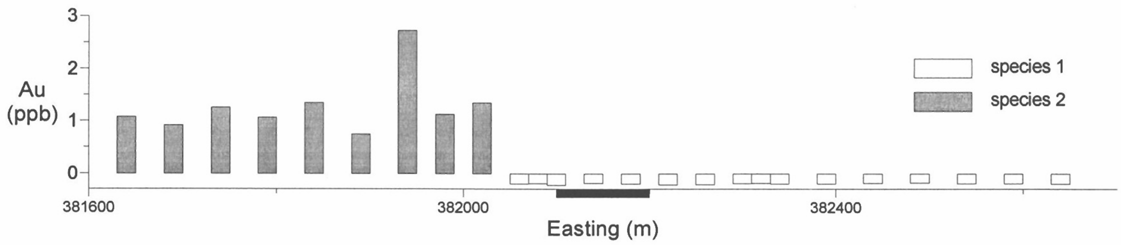

Figure 24: Gold concentrations for 2 different species of bluebush for Pluto traverse.

6. DISCUSSION

6.1 Introduction

The results indicate that a general association between Au and pedogenic carbonate is apparent at Higginsville. Similar observations of the Au-pedogenic carbonate association have been made in the Yilgarn Craton for several decades but were commonly explained as coincidental, occurring through *physical* entrapment. In some sampling programmes, carbonates were specifically avoided, for fear that they would dilute the geochemical response, as is generally the case for base metals. However, the *physico-chemical* association between Au and pedogenic carbonate was first demonstrated on material from the Bounty Au mine (Figure 25, Lintern, 1989). Subsequent developments have led to pedogenic carbonate being widely used as a sample media in the southern Yilgarn Craton and, more recently, elsewhere in Australia.

6.2 Earlier studies

The Bounty mine, 240 km SW of Kalgoorlie, represents a site where the pre-existing laterites have been eroded and soils are developed on colluvium and saprolite. Pedogenic carbonate has developed extensively within the clay-rich surficial material to depths of 1-2 m. Detailed sampling shows that the concentrations of Ca, Mg and Au are closely correlated. Their abundances generally increase steadily from the surface, reach a maximum in the top metre and then decline, with little present below two metres. The relationship is also evident in traverses across the mineralization and, where these extend into unmineralized areas, the Au/Ca+Mg ratio declines over a short distance. The results demonstrate that it is essential to sample the carbonate-rich horizon consistently during soil surveys (Lintern *et al.*, 1992).

Surficial ferruginous material at Bounty have little or no carbonate, but at many other sites, laterite may be infused with, and partly replaced by, carbonate. At Mulline, 140 km NW of Kalgoorlie, the regolith is mostly preserved and lateral dispersion of Au from primary mineralization has created a surficial halo characteristic of lateritic Au deposits. The lateritic residuum is undergoing extensive alteration and disintegration by precipitation of carbonate as coatings, veins, nodules, cements and indurated sheets (Lintern and Butt, 1991). Gold is present in both the Fe-rich and the Ca-rich components of the profile and its distribution reflects their relative proportions between Au and either Fe or Ca (Figure 25). The carbonate has diluted the abundances of elements in the laterite, such as Fe and trace elements (including Au) associated with it. For Au, however, the accumulation in the carbonate offsets the dilution, such that there is a net increase in Au abundance. Accordingly, there is no simple correlation between Au and either Fe or Ca.

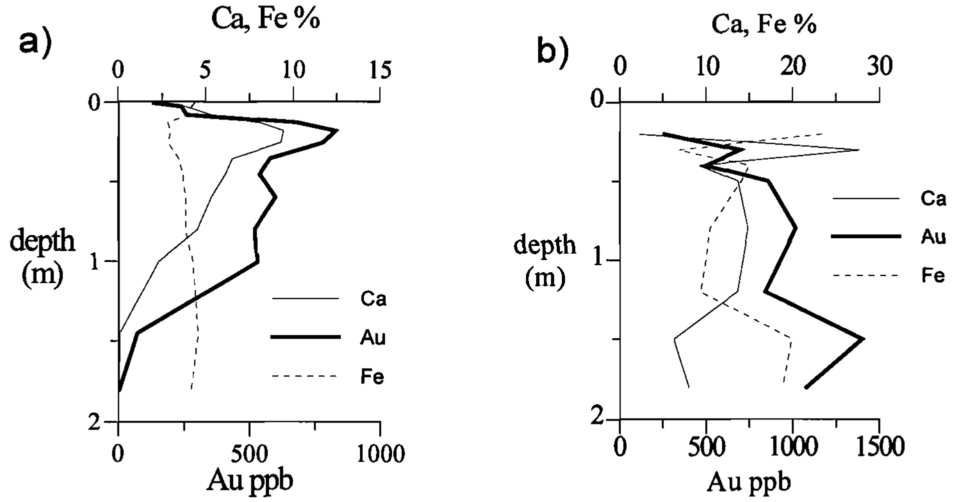

Figure 25: Typical Au, Ca and Fe concentrations at the a) Bounty and b) Mulline Au deposits, Yilgarn Craton (Lintern, 1989; Lintern and Butt, 1991).

6.3 ORIGIN OF THE GOLD-PEDOGENIC CARBONATE ASSOCIATION.

Dolomite and calcite form in the soil by the interaction of Ca^{2+}, Mg^{2+}, bicarbonate (HCO^{3-}) and water. Calcium and Mg are derived directly or indirectly from bedrock, groundwater, vegetation, dust or rainfall, and HCO^{3-} from CO_2 gas produced by root and microbial respiration. Carbon dioxide dissolves readily in water and dissociates to HCO^{3-} which, in turn, reacts with free Ca^{2+} in soil waters and will precipitate as calcite when saturation is reached, probably due to water being removed by evapo-transpiration. The reason for the dominant occurrence of pedogenic carbonates south of the Menzies Line is unclear, but is possibly related to the region having a mainly winter rainfall and, hence, a longer growing season and greater production of CO_2.

The Au distribution within soil profiles at Higginsville and elsewhere in the Yilgarn Craton is associated with that of Ca, so it is reasonable to assume that it is controlled by a similar process, *i.e.*, dissolved Au is precipitated by the removal of water from the soil. Adsorption of Au on carbonate surfaces from migrating soil water is improbable at the prevailing high pH, and would also result in a Au-enriched zone at the top or base of the carbonate horizon, which is not observed. Laboratory experiments have shown that the Au associated with the carbonate is very soluble. Data obtained during this investigation show that a similar relationship prevails in soils at Higginsville, in many of which over 25% of the Au in carbonate horizons is water soluble.

The involvement of vegetation in the re-cycling of Au and Ca at the surface is suggested by the presence of these elements in plant tissues, *although the magnitude of the role of vegetation in the* *entire process is probably only minor*. Both elements appear to be adsorbed via roots, enter the plant tissue, ultimately to be returned to the soil surface as litter. Gold is possibly mobilized in soil solution as an organic complex and deposited as such as an evaporite, with the carbonates.

6.4 ORIGIN OF THE GOLD-FERRUGINOUS GRANULE ASSOCIATION

The association of Au into the ferruginous granules probably occurred during the formation of the granules themselves. Many granules form from the breakdown of lateritic duricrust, Fe mottles or Fe-rich saprolite. Gold may be associated with such material by two main mechanisms:

(i) partial weathering of primary host rocks, which later become ferruginized. Encapsulated Au, *e.g.* in vein quartz or Fe oxides, would remain relatively protected against chemically mobilization;

(ii) Au chemically mobilized during humid periods and re-precipitated with contemporaneously precipitated Fe oxides.

As weathering proceeds, ferruginous saprolite, granules, nodules and pisoliths may dissolve or disintegrate, releasing Au grains which may themselves be subjected to weathering. With the onset of aridity, such pedogenically mobilized Au may precipitate with carbonates.

There may be a spatial relationship between the distribution of Au in the granules and the presence of high Au concentrations in carbonate. In some cases, there is less than a metre separating these two horizons (*e.g.* Profiles G and H) and processes such as capillarity, recycling by plants, bioturbation or diffusion may link them. In such profiles, some Au remains armoured against chemical weathering within the ferruginous granules. This acts as a reservoir to sustain the Au anomaly over a long period despite the Au in the carbonate being water soluble. *In effect, the granule behaves like a slow-release fertiliser pellet*. Eventually, however, all the Au in the granules may be released and become widely dispersed, so that the anomaly might eventually weaken and disappear. The strong association between Au in carbonate and Au-rich Fe granules may not always be present or apparent, since it depends on several factors including (i) susceptibility of the granules to weathering, (ii) susceptibility of the Au to be chemically mobilized and (iii) stability of the soil profile for a period of time to allow the Au-Ca relationship to develop over the granules.

7. SUMMARY

The apparent association between Au in some surficial soils and underlying Au mineralization is probably coincidental. The palaeochannels follow shears, presumably because the surface here was originally more easily eroded compared with adjacent rocks. Later under humid conditions, the channels were gradually in-filled by coarse then fine sediments. Later still, erosion of outcropping mineralization brought ferruginous granules (*e.g.*, from Vine) carried by sheet flow following the same general direction as the palaeodrainage. This is suggested by the following observations:

(i) A comparison of the spatial distribution between Au anomalies in the soil and underlying palaeochannel mineralization indicates that they do not overlap and therefore be unrelated. However, in some areas (*e.g.* Aphrodite and Graveyard), there may be a strong, coincident association (Figure 4).

(ii) The tenor of the Au anomalies in the soil and mineralization are not related. Gold anomalies appear to be strongest where the depth to mineralization is shallow. However, some extraordinary high concentrations (350-400 ppb) were recorded in Profile G where the depth to mineralization is about 25 m. Conversely, the strongest soil anomaly along the Pluto traverse was recorded in the west (30-40 ppb), where no mineralization has been recorded.

Similarly for Mitchell, the highest Au concentrations were recorded well to the east of mineralization (20-30 ppb).

(iii) Apparently "identical" ferruginous granules from the same horizon may be barren or, conversely, strongly enriched in Au. Chemically precipitated Au, derived from underlying mineralization would expected to be more evenly distributed.

(iv) The presence of Au mineralization in the "headwaters" of the Mitchell and Challenge-Swordsman catchments provides a feasible source for the downslope soil anomalies.

(v) Some of the water-soluble Au analyses show weak one or two point anomalies either over or adjacent to mineralization; further tests should be conducted on other traverses to determine the significance of this result.

(vii) The nature of the Au mineralization should be investigated since this may elucidate its genesis and sources. A study of Au grains from the base of the channel may provide information on whether they are primary or secondary.

(viii) The nature of the palaeochannel mineralization at Higginsville suggests that hydrogeochemical investigations may provide information on the mechanism of dispersion as well as providing an exploration method in its own right.

Evidence opposing Au in soil originating from the underlying mineralization includes:

(ii) If (ground)water is the medium by which Au moves to the surface, complexed Au would have to pass through several metres of sands and silts which are not favourable media for processes such as capillarity or diffusion because of the large voids.

(iii) Gold migrating upwards would either have to bypass, or pass through, many contrasting chemical traps, such as lignites and ferruginous mottles in different horizons of the transported overburden enroute to the surface. Plant roots are infrequently encountered below the first few metres of the surface.

8. EXPLORATION IMPLICATIONS

Specific targeting of the calcareous horizon has been demonstrated to maximize the probability of sampling the most consistently auriferous sample in all landscape regimes in the Kalgoorlie region. In relict and erosional regimes, such sampling may accurately define drilling targets. However, in depositional regimes, the results for Higginsville indicate that there is no direct link with mineralization. Here, although a soil carbonate anomaly discretely overlies buried mineralization, the data suggest that it is derived from detrital Fe granules in the soil.

Separate sampling of ferruginous granules may provide a local source of the Au found in the carbonate horizon. Gold in ferruginous granules usually indicates that Au is being shed from relict or erosional areas within the catchment, hence these areas are most prospective. Like carbonate ferruginous granules, they do not in themselves provide an indication of underlying palaeochannel mineralisation.

It is concluded that, in depositional areas examined in this study, sampling of calcareous material at best may indicate the potential of the area. It is suggested, therefore, that for such landscape regimes, wider sampling intervals should be used *i.e.* soil sampling is a regional tool, with a follow-up requirement that deep samples be collected including basal sands or ferruginous material in saprolite. Sampling of Fe granules or lag is a possible alternative, but the distribution of Au within them is more erratic (Carver *et al.*, 1987). The most cost-effective sampling procedure is by power auger drilling and compositing the cuttings through the carbonate-rich horizon. Surficial soil sampling or drilling and routinely sampling at a specified depth without regard to the sample type may be inappropriate because Au anomalies may be overlooked.

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10. REFERENCES

Anand, R.R. and Smith, R.E., 1992. Exploration Research News 6, CSIRO Australia, Division of Exploration Geoscience, 2-4.

Balme, B.E. and Churchill, D.M., 1959. Tertiary sediments at Coolgardie, Western Australia. Royal Society of Western Australia Journal 42: 37-43.

Bunting, J.A., van de Graff, W.J.E. and Jackson, M.J., 1974. Palaeodrainages and Cainozoic palaeogeography of the Eastern Goldfields, Gibson Desert and Great Victoria Desert: Western Australia. Geological Survey, Annual Report 1973, p 45-50.

Carver, R.N., Chenoweth, L.M., Mazzucchelli, R.H., Oates, C.J. and Robbins, T.W., 1987. "Lag" - a geochemical sampling medium for arid regions. Journal of Geochemical Exploration, 28, 183-199.

Clarke, J.D.A., 1993. Stratigraphy and evolution of the Lefroy and Cowan Palaeodrainages, Western Australia. Journal of the Royal Society of Western Australia, 76: 13-23.

Commander, D.P., Kern, A.M. and Smith, R.A., 1992. Hydrogeology of the Tertiary Palaeochannels in the Kalgoorlie Region (Roe Palaeodrainage). Record 1991/10. Geological Survey of Western Australia, Perth, Australia.

Devlin, S.P. and Crimeen, J.D., 1990. Lady Bountiful Extended gold deposit. In "Geology of the Mineral Deposits of Australia and Papua New Guinea" (Editor F.E. Hughes), pp 405-410 (The Australian Institute of Mining and Metallurgy: Melbourne).

Devlin, S.P., 1990. Grade distribution and grade control procedures, Great Lady gold deposit, Eastern Goldfields, Western Australia. Mine Geologists' Conference, Mount Isa, Queensland.

Fulwood, K.E., and Barwick, R.E., 1990. Mulga Rock Uranium Deposits, Officer Basin. In "Geology of the Mineral Deposits of Australia and Papua New Guinea" (Editor F.E. Hughes), pp 1621-1623 (The Australian Institute of Mining and Metallurgy: Melbourne).

Gibb Maitland, A., 1919. The Gold Deposits of Western Australia. In "The Mining Handbook". Geol. Surv. Memoir No. 1 Chapter II., Economic Geology. Part III., Section I..

Gray, D.J. and Lintern, M.J., 1993. Further aspects of the chemistry of gold in some Western Australian soils. (CSIRO/AMIRA P241: Weathering Processes). CSIRO Division of Exploration Geoscience Restricted Report 391R. 50pp.

Hart, M.K.W., 1989. Analysis for total iron, chromium, vanadium, and titanium in varying matrix geological samples by XRF, using pressed powder samples. Standards in X-ray analysis. Australian X-ray Analytical Association (WA Branch) Fifth State Conference proceedings, pp. 117-129.

Kern, A.M., 1996. Hydrogeology of the Widgiemooltha 1:250,000 Sheet. Explanatory Notes. Geological Survey of Western Australia, Department of Mines and Energy. 16 pp.

Kern, A.M. and Commander, D.P., 1993. Cainozoic stratigraphy in the Roe Palaeodrainage of the Kalgoorlie region, Western Australia. Western Australia Geoligical Survey, Report 34. Professional Papers, pp. 85-95.

Lintern, M.J., 1989. Study of the distribution of gold in soils at Mt. Hope, Western Australia. Restricted Report 24R. CSIRO Australia, Division of Exploration Geoscience, Perth, 17 pp. (Unpublished).

Lintern, M.J. and Butt, C.R.M., 1991. The distribution of gold and other elements in soils at Mulline, Western Australia. Restricted Report 159R. CSIRO Australia, Division of Exploration Geoscience, Perth, 58 pp. (Unpublished).

Lintern, M.J. and Scott, K.M., 1990. The distribution of gold and other elements in soils and vegetation at Panglo, Western Australia. Restricted Report 129R. CSIRO Australia, Division of Exploration Geoscience, Perth, 50 pp. (Unpublished).

Lintern, M.J., Downes, P.M. and Butt, C.R.M., 1992, In: Regolith Exploration Geochemistry in Tropical and Subtropical Terrains (C.R.M. Butt and H. Zeegers, Editors), Elsevier, Amsterdam, 351-355.

Lintern, M.J., Butt, C.R.M., and Scott, K.M., 1996. Gold in vegetation and soil - three case studies from the goldfields of southern Western Australia. Journal of Geochemical Exploration (in press).

Norrish, K and Chappell, B.W., 1977. X-Ray fluorescence spectrometry. In J.Zussman (Ed): Physical methods in determinative mineralogy. Academic Press, London, pp. 201-272.

Smyth, E.L. and Button, A., 1989. Gold exploration in the Tertiary palaeodrainage systems of Western Australia. In "Gold forum on technology and practices", World Gold '89, Reno, Nevada, 1989, pp 13-22.

Whincup, P., McDonald, D. and Duke, H., 1989. In situ Leaching of Western Australian Palaeochannel Gold. In "Gold forum on technology and practices", World Gold '89, Reno, Nevada, 1989, pp 261-269.

APPENDICES

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Table A1.1: Profile A (382340E 6481000N); colours in Munsell notation.

Depth (m)	Description
0-0.1	Reddish brown (5 YR 4/6). Sandy clay with much surface ferruginous material, cobbles and gravels. Trace of carbonate present. Minor colour: Light yellow orange (7.5 YR 8/6).
0.1-0.2	Dark reddish brown. (5 YR 3/6). Clay with rootlets and ferruginous material. Carbonate present. Minor colour: Orange (5 YR 7/6).
0.2-0.4	Dark reddish brown. (2.5 YR 3/6). Clay with rootlets and ferruginous material. Carbonate present.
0.4-0.6	Dark reddish brown. (5 YR 3/6). Wet heavy red clay, some ferruginous material, ?white gypsum.
0.6-0.8	Reddish brown. (5 YR 4/6). Heavy red clay, Khaki and grey mottles. Trace of carbonate present. Minor colour: Light grey (5 Y 8/2).
0.8-1.0	Reddish brown. (5 YR 4/6). Heavy red clay with grey mottles. Minor colour: Pale yellow (5 Y 8/3).
1.0-1.2	Reddish brown. (5 YR 4/6). Heavy red clay with grey mottles. Minor colour: Pale yellow (5 Y 8/3).
1.2-1.4	Reddish brown. (5 YR 4/6). Heavy red clay with grey mottles. Minor colour: Light yellow (7.5 Y 7/3).
1.4-1.6	Reddish brown. (5 YR 4/6). Heavy red clay with grey mottles. Minor colour: Light yellow (7.5 Y 7/3).
1.6-1.8	Light yellow (7.5 Y 7/3). Heavy red clay with grey mottles. Minor colour: Reddish brown. (5 YR 4/6).
1.8-2.0	Light yellow (7.5 Y 7/3). Heavy red clay with grey mottles. Minor colour: Reddish brown. (5 YR 4/6).

Table A1.2: Profile B (382200E 6481000N); colours in Munsell notation.

Depth (m)	Description
0-0.1	Reddish brown (5 YR 4/8). Sandy clay with rootlets and ferruginous material.
0.1-0.2	Dark reddish brown (5 YR 3/6). Clay with some sand and ferruginous material. Trace of carbonate present. Minor colour: Reddish brown (5 YR 4/6).
0.2-0.3	Reddish brown (.5 YR 4/8). Clay with roots and ferruginous material. Carbonate present. Minor colour: Bright reddish brown (5 YR 5/8).
0.3-0.5	Bright reddish brown (5 YR 5/6) Red clay with roots, rootlets and ferruginous gravels. Carbonate present. Minor colour: Orange (5 YR 7/6).
0.5-0.7	Reddish brown (5 YR 4/6) Heavy red clay with rootlets and ferruginous gravels. Carbonate present. Minor colour: Orange (5 YR 7/6).
0.7-0.9	Reddish brown (2.5 YR 4/6). Heavy red clay with rootlets and ferruginous gravels. Trace of carbonate present.
0.9-1.1	Reddish brown (2.5 YR 4/6). Heavy red clay with rootlets and ferruginous gravels.
1.1-1.3	Reddish brown (2.5 YR 4/6). Heavy red clay with rootlets and ferruginous gravels and large ferruginous cobbles.
1.3-1.5	Reddish brown (2.5 YR 4/6). Heavy red clay with rootlets and ferruginous gravels and some ferruginous materials.
1.5-1.7	Reddish brown (2.5 YR 4/6). Heavy red clay and some mottling. Minor colour: Pale yellow (2.5 Y 8/3).
1.7-1.9	Reddish brown (2.5 YR 4/6). Heavy red clay ferruginous materials up to 5cm and grey mottling. Minor colour: Pale yellow (2.5 Y 8/3).
1.9-2.1	Reddish brown (2.5 YR 4/6). Heavy red clay ferruginous materials up to 2cm and grey mottling. Minor colour: Pale yellow (2.5 Y 8/3).

Table A1.3: Profile C (382150E 6481000N); colours in Munsell notation.

Depth (m)	Description
0-0.1	Bright reddish brown (5 YR 5/6). Sandy clay with ferruginous gravels and rootlets. Carbonate present.
0.1-0.2	Brown (7.5 YR 4/4). Red calcareous clay with ferruginous material and rootlets. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.2-0.4	Reddish brown (5 YR 4/6). Red clay with ferruginous material and roots. Carbonate present.
0.4-0.6	Reddish brown (5 YR 4/6). Heavy red clay with roots. Carbonate present.
0.6-0.8	Reddish brown (5 YR 4/6). Heavy red clay with ferruginous material and roots.
0.8-1.0	Reddish brown (5 YR 4/8). Heavy red clay with roots.
1.0-1.2	Reddish brown (5 YR 4/8). Heavy red clay with micro-mottling.
1.2-1.4	Reddish brown (5 YR 4/8). Heavy red clay with micro-mottling. Minor colour: Light yellow (5 YR 7/3).
1.4-1.6	Reddish brown (5 YR 4/8). Heavy red clay with mottling. Minor colour: Light yellow (5 YR 7/3).
1.6-1.8	Reddish brown (5 YR 4/8). Heavy red clay with mottling. Minor colour: Light grey (5 YR 8/2).
1.8-2.0	Reddish brown (5 YR 4/8) and Light grey (5 YR 8/2). Heavy red clay with mottling.
2.0-2.2	Reddish brown (5 YR 4/8) and Light grey (5 YR 8/2). Heavy red clay with mottling.

Table A1.4: Profile D (382070E 6481000N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Reddish brown (5 YR 4/6). Sandy clay with large amounts of ferruginous granules. Carbonate present.
0.1-0.2	Reddish brown (5 YR 4/6). Sandy clay with rootlets and large amounts of ferruginous granules. Carbonate present.
0.2-0.4	Reddish brown (5 YR 4/6). Red clay with ferruginous fragments and gypsum crystals. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
0.4-0.6	Reddish brown (5 YR 4/6). Red clay with ferruginous fragments and gypsum crystals. Carbonate present. Minor colour: Orange (5 YR 6/8).
0.6-0.8	Reddish brown (5 YR 4/6). Red clay with ferruginous granules and gypsum crystals. . Minor colour: Bright reddish brown (5 YR 5/6).
0.8-1.0	Bright reddish brown (5 YR 5/6). Red clay with many ferruginous gravels.
1.0-1.2	Brown (7.5 YR 4/6). Prismatic clay with many ferruginous granules with micro-mottling.
1.2-1.4	Brown (10 YR 4/6). Similar clay with many ferruginous gravels with mottling. Minor colour: Pale yellow (5 Y 8/3).
1.4-1.6	Brown (7.5 YR 4/6), Yellow (5 Y 8/5). Mottled, predominantly grey on collection and some brown mottles, with rootlets and many ferruginous granules.
1.6-1.8	Light yellow (5 Y 7/3). Mottled, predominantly grey on collection and some brown mottles, with rootlets and many ferruginous granules. Minor colour: Reddish brown (5 YR 4/6).
1.8-2.0	Bright reddish brown (2.5 YR 5/6). Mottled, predominantly grey on collection and some brown mottles, with rootlets and many ferruginous granules. Minor colour: Light yellow (5 Y 7/3).

Table A1.5: Profile E (381740E 6481000N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Bright brown (7.5 YR 5/8). Sandy clay with carbonate nodules (up to 5cm), many rootlets and Ferruginous materials. Carbonate present.
0.1-0.2	Bright brown (7.5 YR 5/6). Sandy clay with roots, many carbonate nodules (up to 5cm) and Ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 6/6).
0.2-0.4	Bright brown (7.5 YR 5/6). Sandy clay with roots, many carbonate nodules (up to 5cm) and Ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 6/6).
0.4-0.6	Bright brown (7.5 YR 5/6). Sandy clay with roots, many carbonate nodules (up to 5cm) and Ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.6-0.8	Bright brown (7.5 YR 5/6). Sandy clay with many carbonate nodules (up to 5cm) and Ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.8-1.0	Bright brown (7.5 YR 5/6). Sandy clay with many carbonate nodules (up to 5cm) and Ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
1.0-1.2	Orange (7.5 YR 6/6). Heavy red clay with carbonate nodules and many ferruginous material. Carbonate present. Minor colours: Orange (7.5 YR 7/6), Brown (7.5 YR 4/6).
1.2-1.4	Orange (7.5 YR 6/6). Heavy red clay with carbonate nodules and many ferruginous material. Carbonate present. Minor colours: Orange (7.5 YR 7/6), Brown (7.5 YR 4/6).
1.4-1.6	Orange (7.5 YR 6/6). Heavy red clay with carbonate nodules and many ferruginous material. Carbonate present. Minor colours: Reddish brown (5 YR 4/8), Yellow orange (7.5 YR 8/8).
1.6-1.8	Orange (7.5 YR 6/6). Heavy red clay with soft carbonate concretions, ferruginous granules, dolomite(?). Carbonate present. Minor colours: Reddish brown (5 YR 4/8) Yellow orange(7.5 YR 8/8).
1.8-2.0	Reddish brown (5 YR 4/8). Heavy red clay with soft carbonate concretions, ferruginous granules, dolomite(?). Carbonate present. Minor colours: Light yellow orange (7.5 YR 8/6).
2.0-2.2	Orange (7.5 YR 6/6). Heavy red clay with soft carbonate concretions, ferruginous granules, dolomite(?). Carbonate present. Minor colours: Orange (5 YR 6/6) Orange(5 YR 7/6).
2.2-2.4	Orange (7.5 YR 6/6). Heavy red clay with soft carbonate concretions, ferruginous granules, dolomite(?). Carbonate present. Minor colours: Orange (5 YR 7/6) Reddish brown (5 YR 4/8).

Table A1.6: Profile F (379654E 6484268N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Brown (7.5 YR 4/6). Sandy clay with carbonate nodules and ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 6/6).
0.1-0.2	Bright brown (7.5 YR 5/6). Sandy clay with carbonate nodules and ferruginous materials. Carbonate present. Minor colour: Orange (7.5 YR 6/6).
0.2-0.4	Brown (7.5 YR 4/6). Sandy clay with ferruginous granules. Carbonate present. Minor colour: Orange (7.5 YR 6/6).
0.4-0.6	Bright brown (7.5 YR 4/6). Soft carbonate concretions and Ferruginous granules. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.6-0.8	Bright reddish brown (5 YR 5/6). Heavy red clay with carbonate concretions, ferruginous granules and rootlets. Carbonate present. Minor colour: Orange (7.5 YR 6/6).
0.8-1.0	Reddish brown (5 YR 4/6). Heavy red clay with carbonate concretions, ferruginous granules and rootlets. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
1.0-1.2	Reddish brown (5 YR 4/6). Heavy red clay with ferruginous granules and few carbonate concretions. Trace of carbonate present. Minor colour: Orange (5 YR 7/8).
1.2-1.4	Bright reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules, rootlets and few carbonate concretions.
1.4-1.6	Bright reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules and few carbonate concretions.
1.6-1.8	Bright reddish brown (5 YR 3/6). Heavy red clay with ferruginous nodules.
1.8-2.0	Bright reddish brown (5 YR 3/6). Heavy red clay with ferruginous nodules.

Table A1.7: Profile G (379260E 6484500N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Brown (7.5 YR 4/6). Red sandy clay with much soft carbonates, ferruginous granules and many roots. Carbonate present. Minor colour: Bright brown (7.5 YR 5/6).
0.1-0.2	Brown (7.5 YR 4/6). Sandy clay with carbonate nodules and ferruginous granules. Carbonate present. Minor colour: Bright brown (7.5 YR 5/6).
0.2-0.4	Brown (7.5 YR 4/4). Clay with soft carbonate concretions and ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/6).
0.4-0.6	Dull brown (7.5 YR 5/4) Clay with soft carbonate concretions and ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
0.6-0.8	Dull orange (5 YR 7/4). Calcareous clay with many ferruginous granules. Main carbonate horizon just beneath the ferruginous granule stone line. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
0.8-1.0	Reddish brown (5 YR 4/6). Heavy red clay, less calcareous, with many ferruginous granules. Carbonate present.
1.0-1.2	Reddish brown (5 YR 4/6). Heavy red clay, less calcareous, with many ferruginous granules. Carbonate present.
1.2-1.4	Reddish brown (5 YR 4/8). Heavy red clay, less calcareous with lithorelics. Trace of carbonate present.
1.4-1.6	Reddish brown (5 YR 4/6). Heavy red clay, with many ferruginous granules. Minor colour: Light yellow orange (7.5 YR 8/4).
1.6-1.8	Reddish brown (5 YR 4/6). Heavy red clay, with many ferruginous granules. Minor colour: Pale yellow (5 YR 8/3).
1.8-2.0	Reddish brown (5 YR 4/6). Heavy red clay, with many ferruginous granules. Minor colour: Pale yellow (5 YR 8/3).

Table A1.8: Profile H (378340E 6484600N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Bright brown (7.5 YR 5/6). Sandy clay with carbonate nodules, ferruginous fragments and many rootlets. Carbonate present. Minor colour: Dull brown (7.5 YR 5/4).
0.1-0.2	Bright brown (7.5 YR 5/6). Sandy clay with carbonate nodules, ferruginous fragments and many rootlets. Carbonate present. Minor colour: Dull orange (7.5 YR 7/4).
0.2-0.4	Dull orange (7.5 YR 6/4). Loamy calcareous clay with ferruginous granules. Carbonate present. Minor colour: Dull orange (7.5 YR 7/4).
0.4-0.6	Dull brown (7.5 YR 5/4) Loamy calcareous clay with ferruginous granules. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.6-0.8	Brown (7.5 YR 4/6). Clay with carbonate concretions and ferruginous granules. The principal carbonate horizon with ferruginous granule stone line just beneath. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.8-1.0	Dark reddish brown (5 YR 3/6). Heavy red clay, , with ferruginous granules.
1.0-1.2	Reddish brown (5 YR 4/6). Heavy red clay, with ferruginous granules and roots. Minor colour: Orange (7.5 YR 7/6).
1.2-1.4	Reddish brown (5 YR 4/6). Heavy red clay, with ferruginous granules and fine rootlets.
1.4-1.6	Reddish brown (5 YR 4/6). Heavy red clay, with ferruginous granules and fine rootlets.
1.6-1.8	Reddish brown (5 YR 4/6). Heavy red clay, with ferruginous granules, fine rootlets and micro-mottling. Minor colour: Light yellow (5 YR 7/3).
1.8-2.0	Reddish brown (5 YR 4/6). Heavy red clay, with more mottling. Minor colours: Light yellow (5 YR 7/3), Light grey (10 YR 8/2).

Table A1.9: Profile I (378305E 6484610N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Bright brown (7.5 YR 5/6). Sandy clay with ferruginous granules, rootlets and some carbonate nodules to 1cm. Carbonate present.
0.1-0.2	Dull brown (7.5 YR 5/4). Sandy clay with ferruginous granules and carbonate nodules. Carbonate present. Minor colour: Dull orange (7.5 YR 7/4).
0.2-0.4	Dull orange (7.5 YR 6/4). Calcareous sandy clay with ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
0.4-0.6	Dull orange (7.5 YR 6/4). Red clay with carbonate concretions and ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
0.6-0.8	Dull orange (7.5 YR 7/4). Red clay with carbonate concretions and ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
0.8-1.0	Dull orange (7.5 YR 6/4). Red clay with carbonate concretions and ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
1.0-1.2	Dull orange (7.5 YR 6/4). Red clay with carbonate concretions and ferruginous granules. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
1.2-1.3	Reddish brown (5 YR 4/8). End of calcareous horizon. Carbonate present. Minor colour: Light yellow orange (7.5 YR 8/4).
1.3-1.35	Reddish brown (5 YR 4/8). Ferruginous fragment stone line. Minor colour: Orange (5 YR 6/6).
1.35-1.55	Reddish brown (5 YR 4/6). Heavy red clay with ferruginous granules. Minor colour: Light yellow orange (7.5 YR 8/4).
1.55-1.75	Reddish brown (5 YR 4/6). Heavy red clay with some mottling and stark white powdery concretions. Minor colour: Orange (5 YR 7/6).
1.75-1.95	Dull reddish brown (2.5 YR 5/4). Heavy red clay with grey mottling and some stark white powdery concretions. Minor colour: Dull orange (5 YR 7/4).

Table A1.10: Profile J (378305E 648461N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Bright brown (7.5 YR 5/6). Sandy clay with ferruginous granules and rootlets. Possible contamination from overburden. Carbonate present.
0.1-0.2	Brown (7.5 YR 4/6). Sandy clay with carbonate nodules, ferruginous granules and rootlets. Carbonate present.
0.2-0.4	Brown (7.5 YR 4/6). Red clay with ferruginous granules and rootlets. Carbonate present. Minor colour: Orange (7.5 YR 7/6).
0.4-0.6	Reddish brown (5 YR 4/6). Heavy red clay with ferruginous granules and rootlets. Carbonate present.
0.6-0.8	Reddish brown (5 YR 4/6). Heavy red clay with ferruginous granules and rootlets. Carbonate present.
0.8-1.0	Reddish brown (2.5 YR 4/6). Heavy red clay with ferruginous granules and rootlets. Carbonate present.
1.0-1.2	Dark reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules and rootlets. Trace of carbonate present.
1.2-1.4	Dark reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules and rootlets. Trace of carbonate present.
1.4-1.6	Dark reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules and rootlets.
1.6.1.8	Dark reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules and rootlets.
1.8-2.0	Dark reddish brown (5 YR 3/6). Heavy red clay with ferruginous granules and rootlets.

Table A1.11: Profile K (378332E 6485166N); colours in Munsell notation.

Depth (m)	Description
0.0-0.1	Dull reddish brown (5 YR 4/4).
0.1-0.2	Dark reddish brown (5 YR 3/6).
0.2-0.3	Dull reddish brown (5 YR 4/4).
0.3-0.4	Dull reddish brown (5 YR 4/4).
0.4-0.5	Dull reddish brown (5 YR 4/4).
0.5-0.6	Dull reddish brown (5 YR 4/4). Minor colour: Light yellow orange (7.5 YR 8/4).
0.6-0.7	Dull reddish brown (5 YR 4/4). Minor colour: Dull orange (5 YR 6/4), Light yellow orange (7.5 YR 8/4).
0.7-0.8	Dull reddish brown (5 YR 5/4). Minor colour: Light yellow orange (7.5 YR 8/4).
0.8-0.9	Dull reddish brown (5 YR 4/4). Minor colour: Light yellow orange (7.5 YR 8/4).
0.9-1.0	Dull reddish brown (5 YR 4/4). Minor colour: Dull reddish brown (5 YR 5/4), Light yellow orange (7.5 YR 8/4).
1.0-1.1	Reddish brown (5YR 4/6). Minor colour: Light yellow orange (7.5 YR 8/4).
1.1-1.2	Reddish brown (5YR 4/6). Minor colour: Light yellow orange (7.5 YR 8/4).
1.2-1.3	Reddish brown (5YR 4/6). Minor colour: Light yellow orange (7.5 YR 8/4).
1.3-1.4	Reddish brown (5YR 4/6). Minor colour: Light yellow orange (7.5 YR 8/4).
1.4-1.5	Reddish brown (5YR 4/6). Minor colour: Light yellow orange (7.5 YR 8/4).
1.5-1.6	Reddish brown (5YR 4/6). Minor colour: Light yellow orange (7.5 YR 8/4).

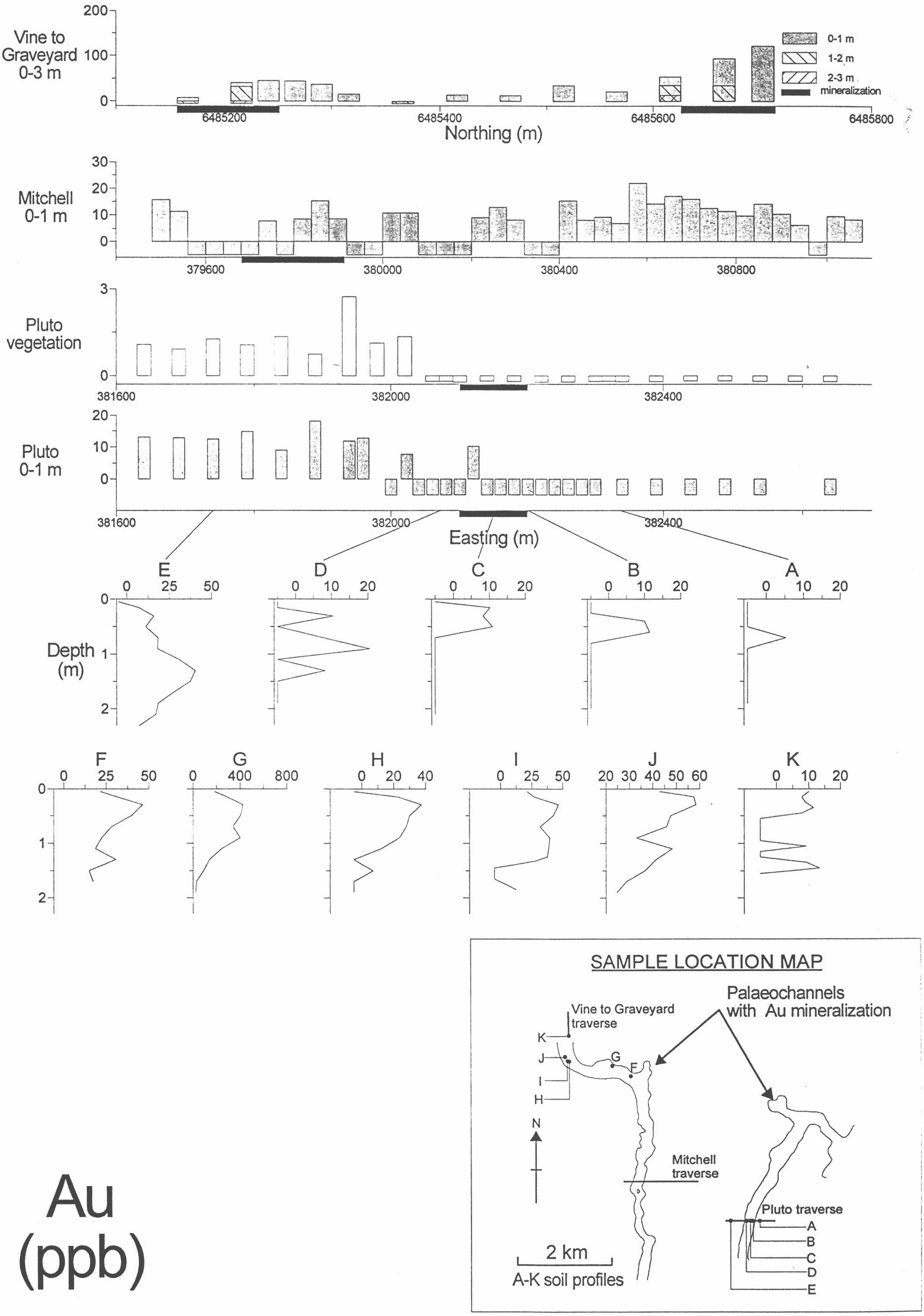


Figure A2.1 Composite geochemical data for profile samples for Au

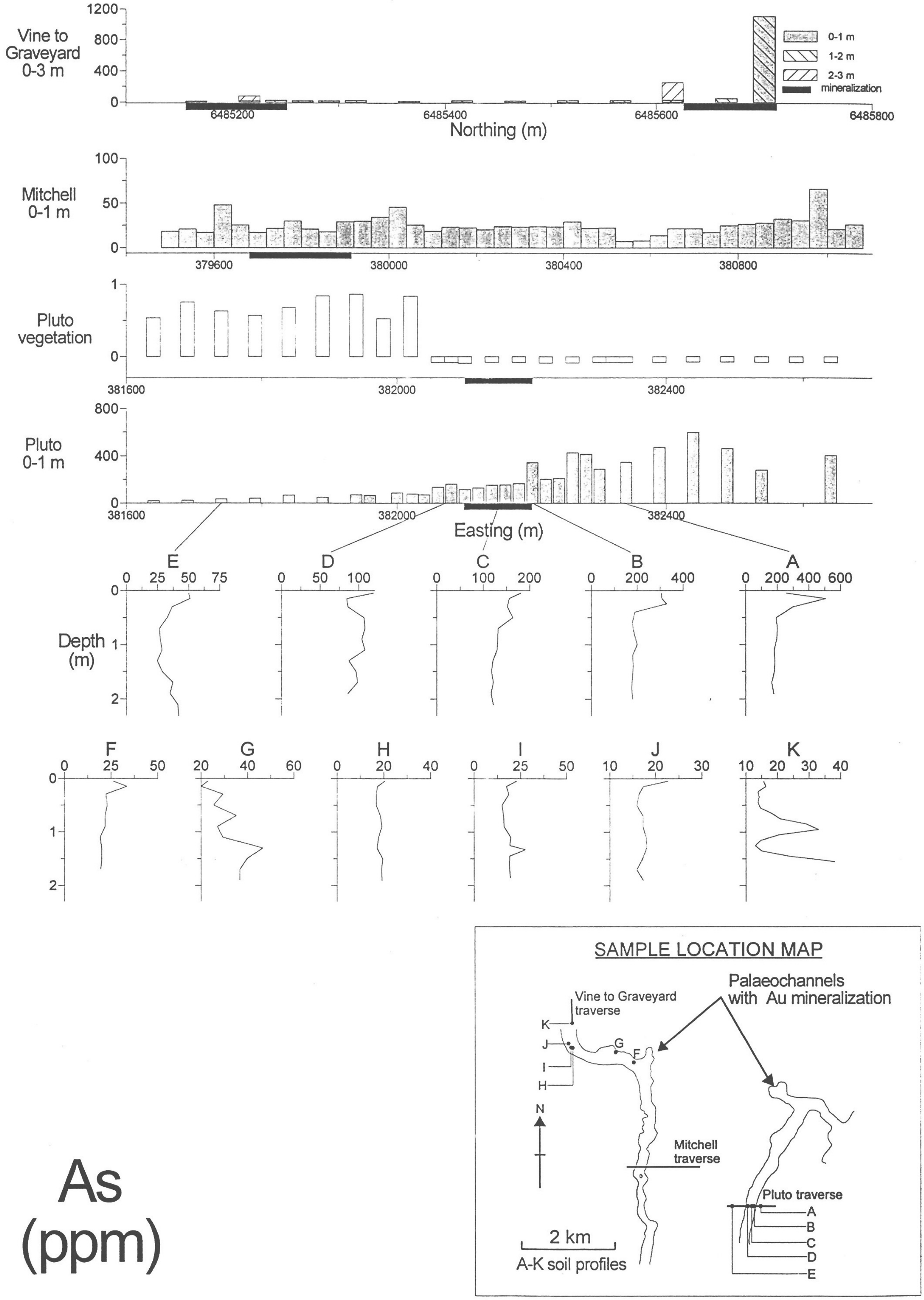


Figure A2.2: Composite geochemical data for profile samples for As

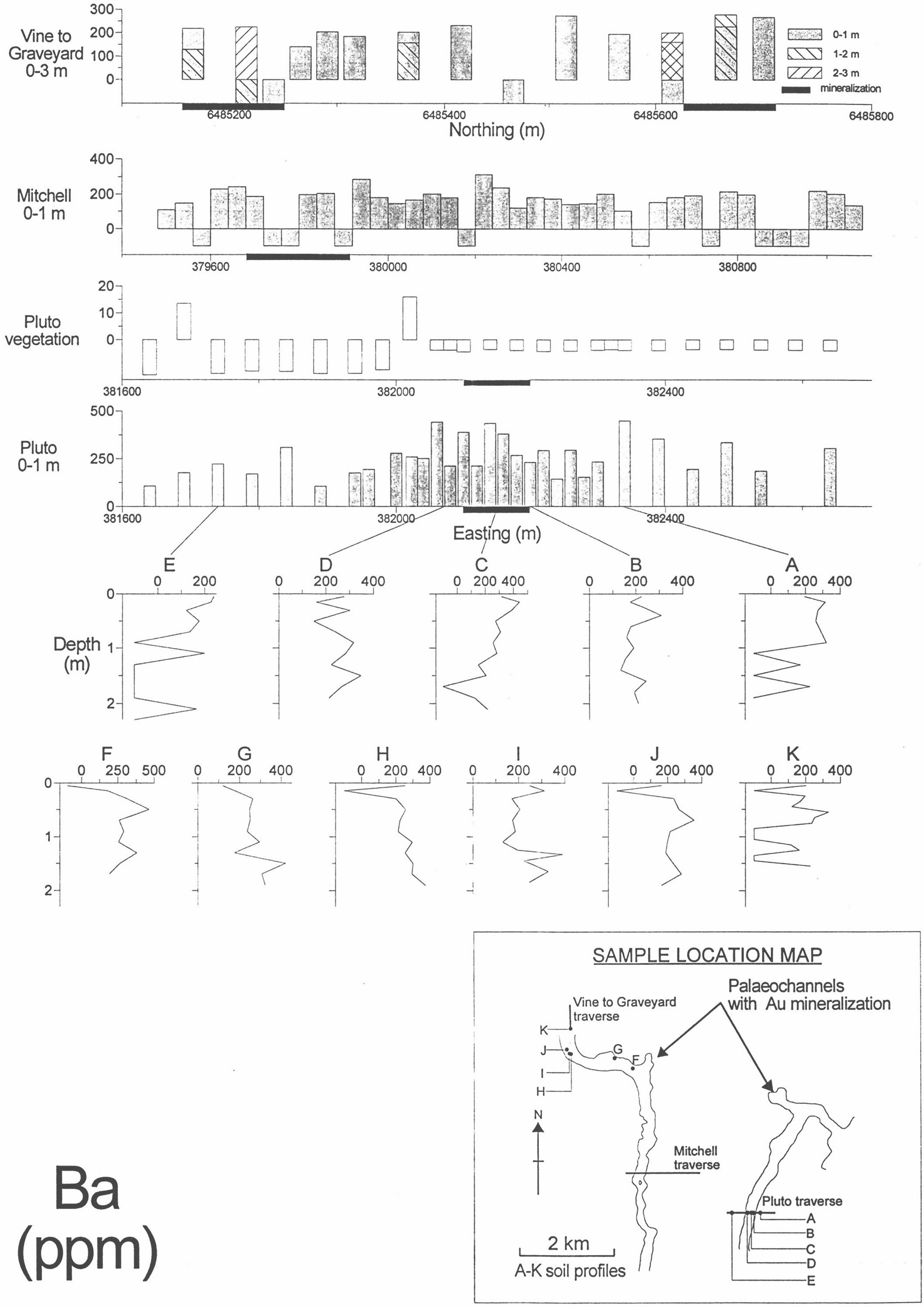


Figure A2.3: Composite gechemical data for profile samples for Ba

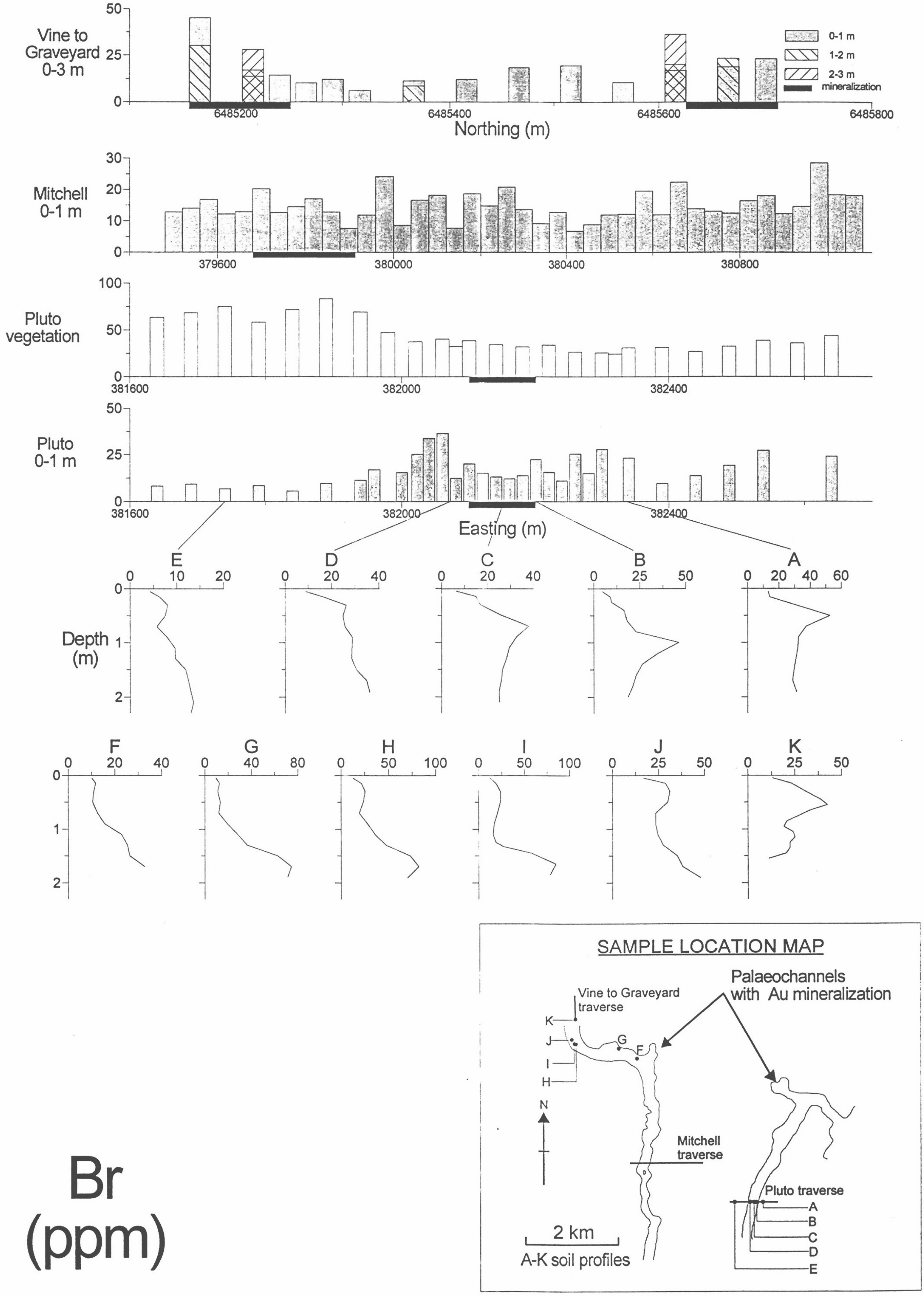


Figure A2.4 : Composite geochemical data for profile samples for Br

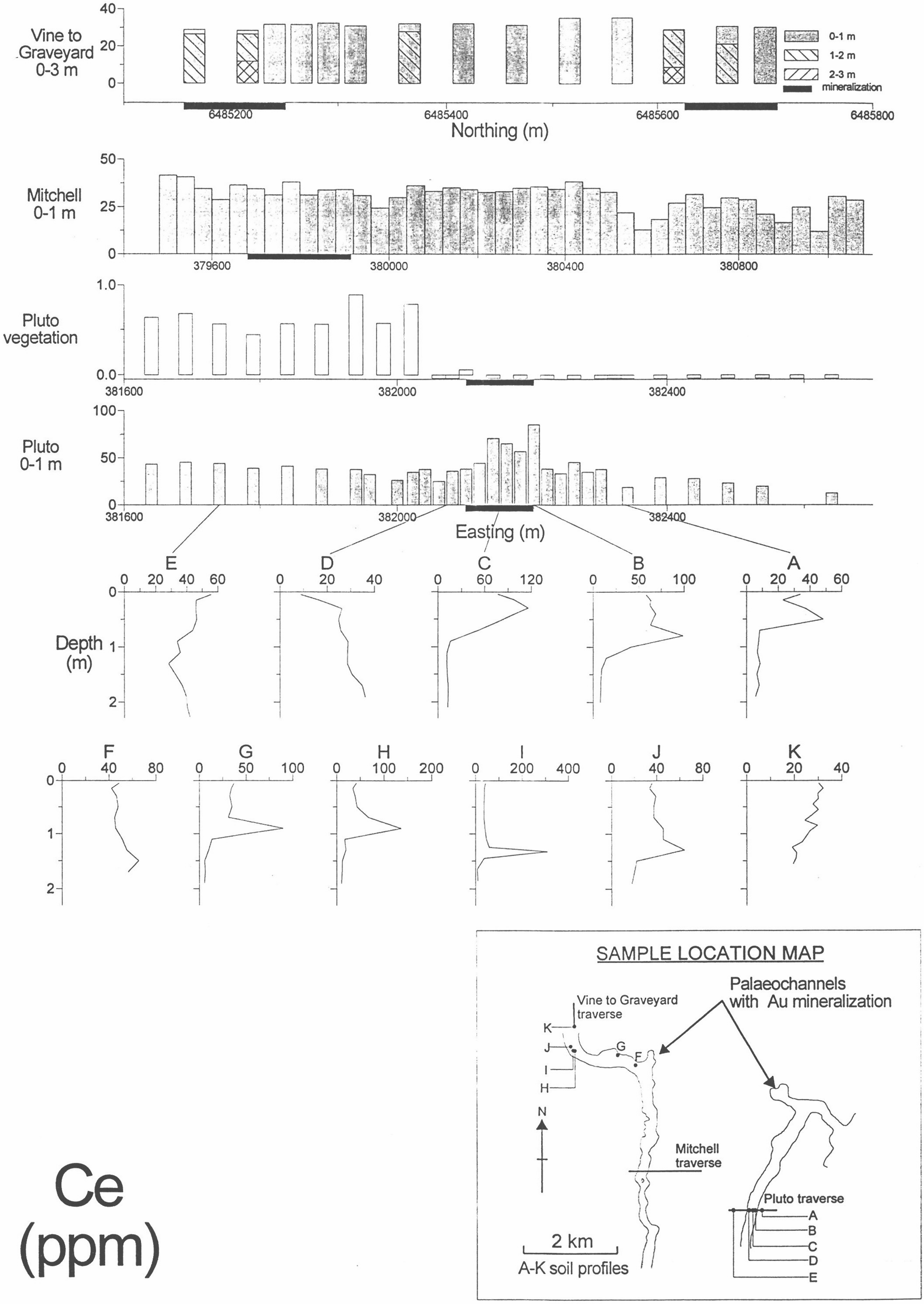


Figure A2.5 : Composite geochemical data for profile samples for Ce

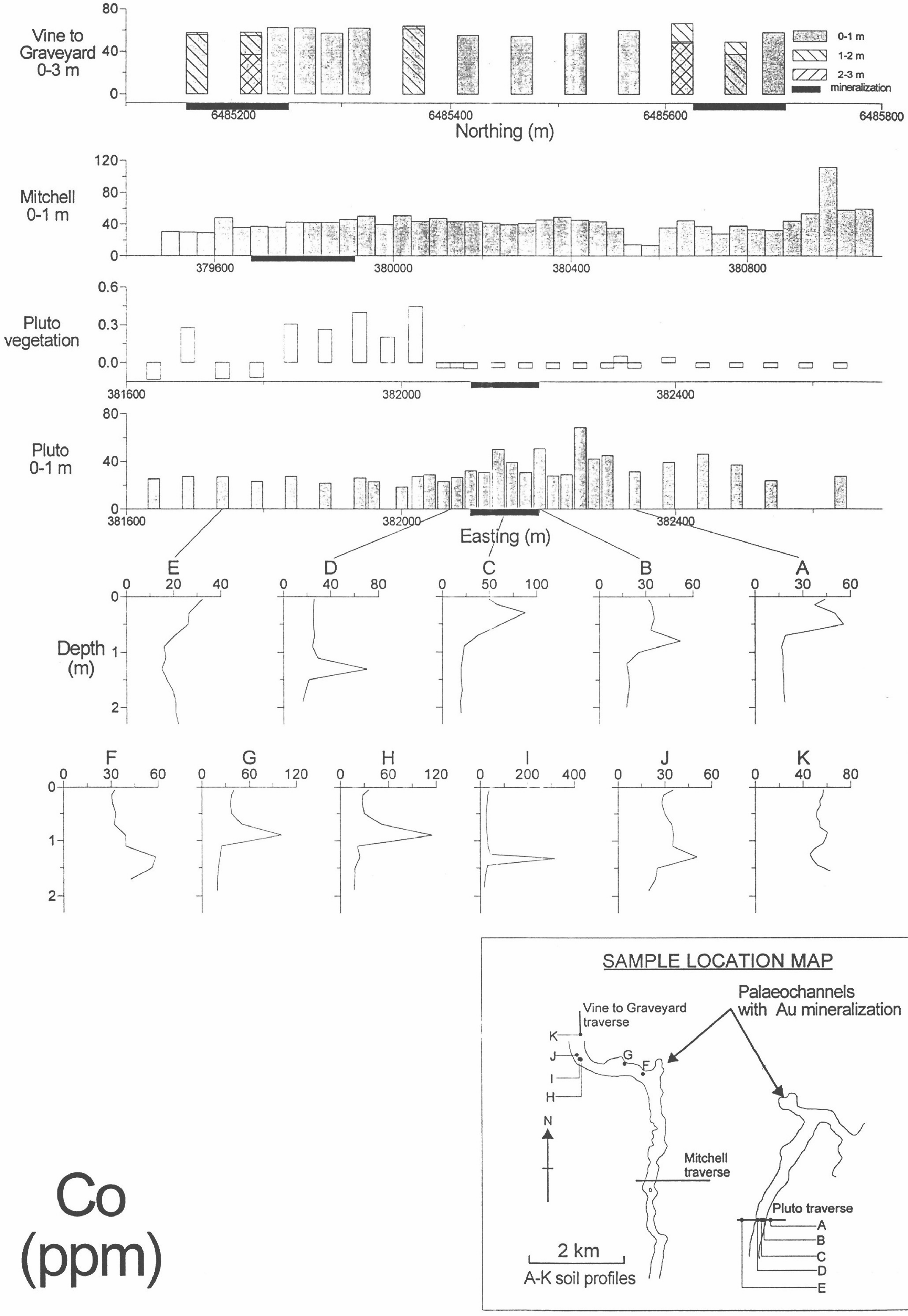


Figure A2.6 : Composite geochemical data for profile samples for Co

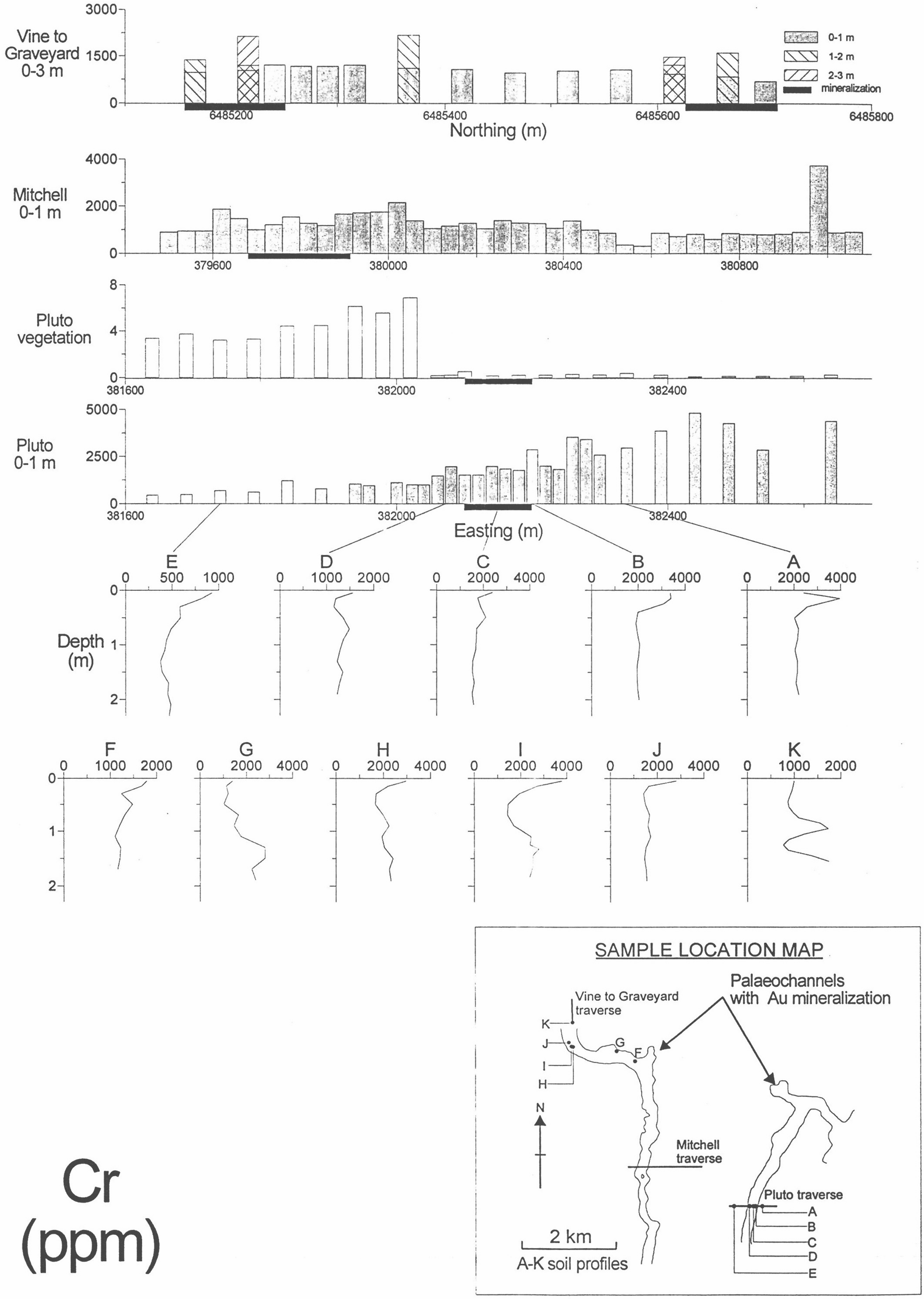


Figure A2.7 : Composite geochemical data for profile samples for Cr

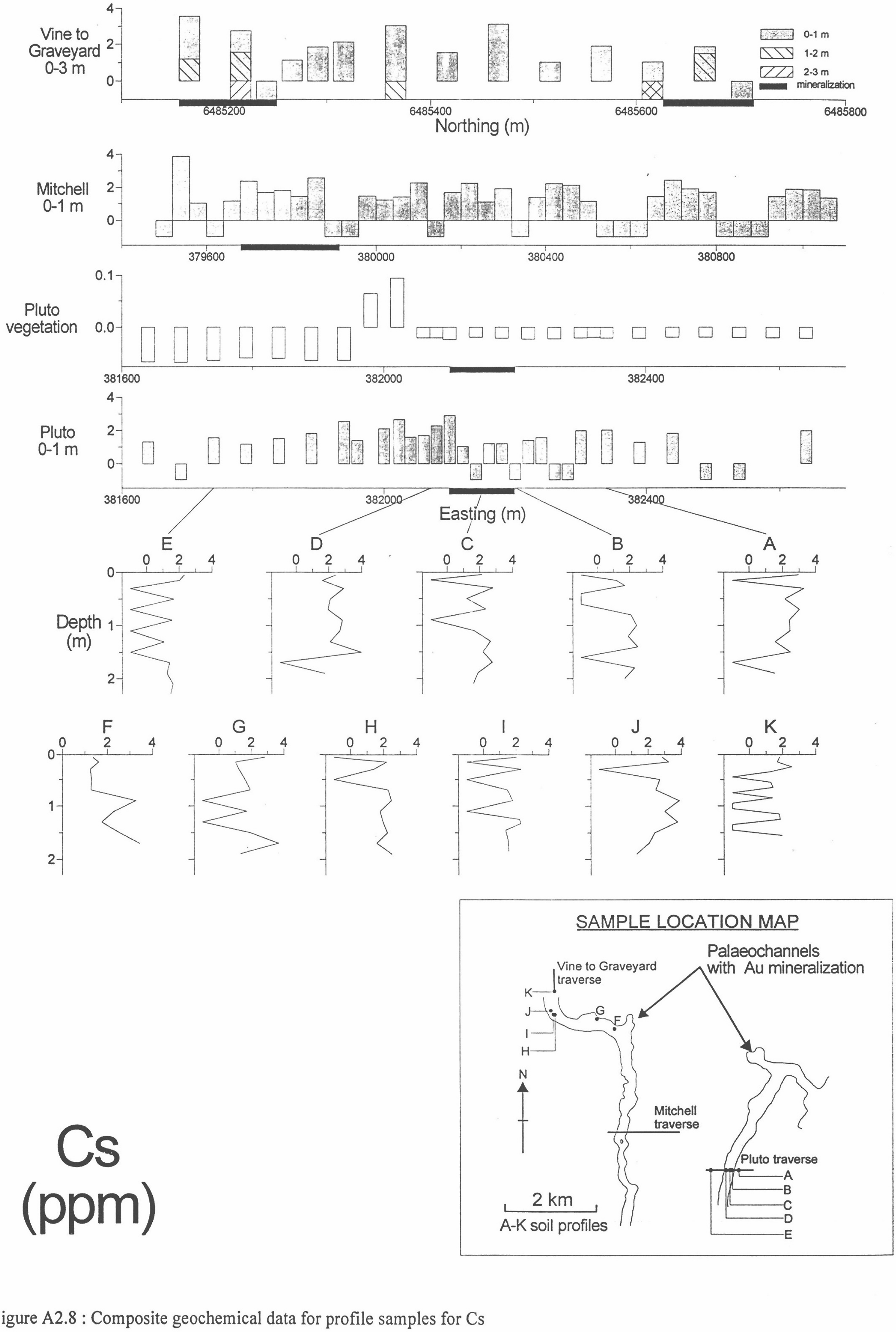


Figure A2.8 : Composite geochemical data for profile samples for Cs

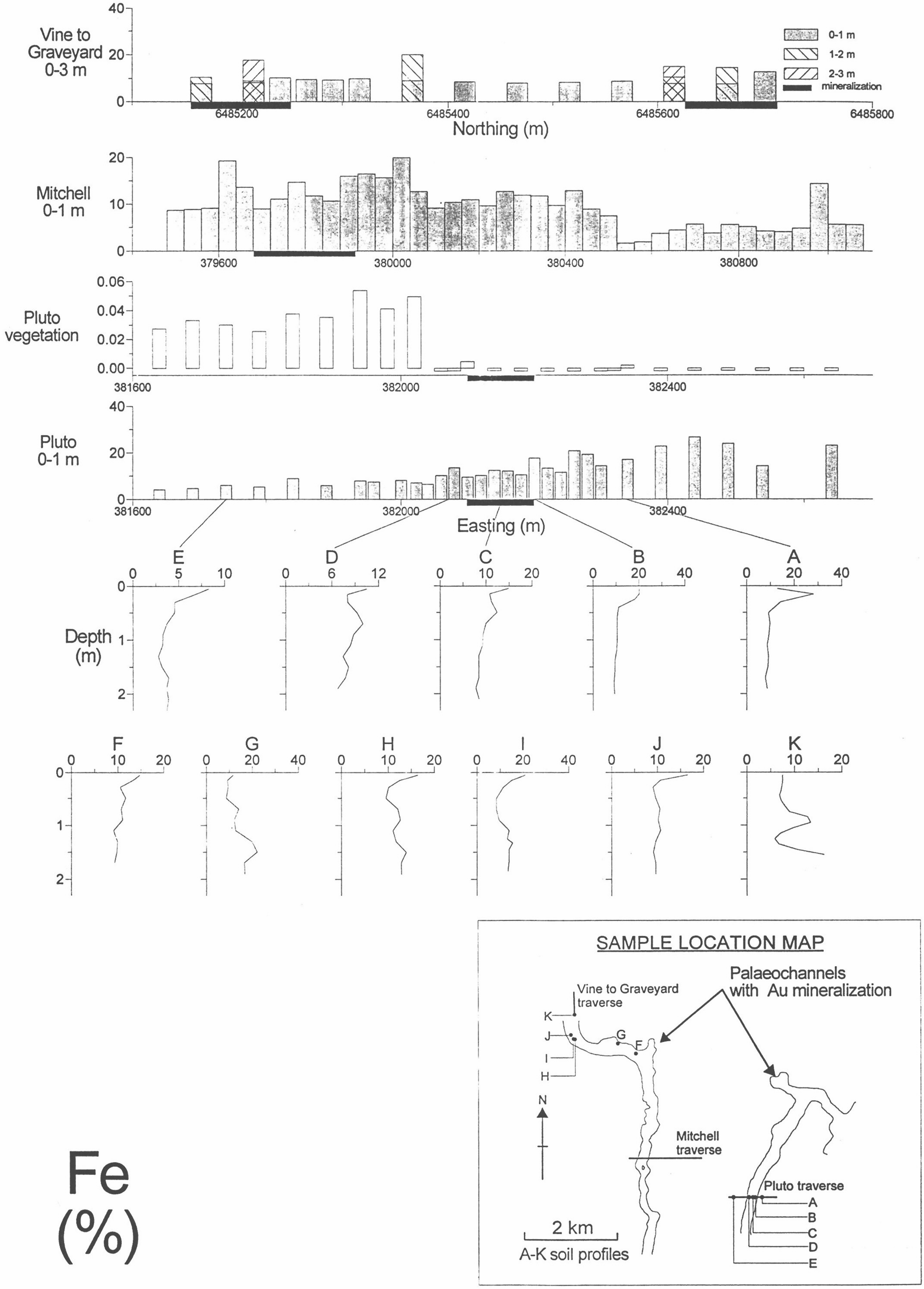


Figure A2.9 : Composite geochemical data for profile samples for Fe

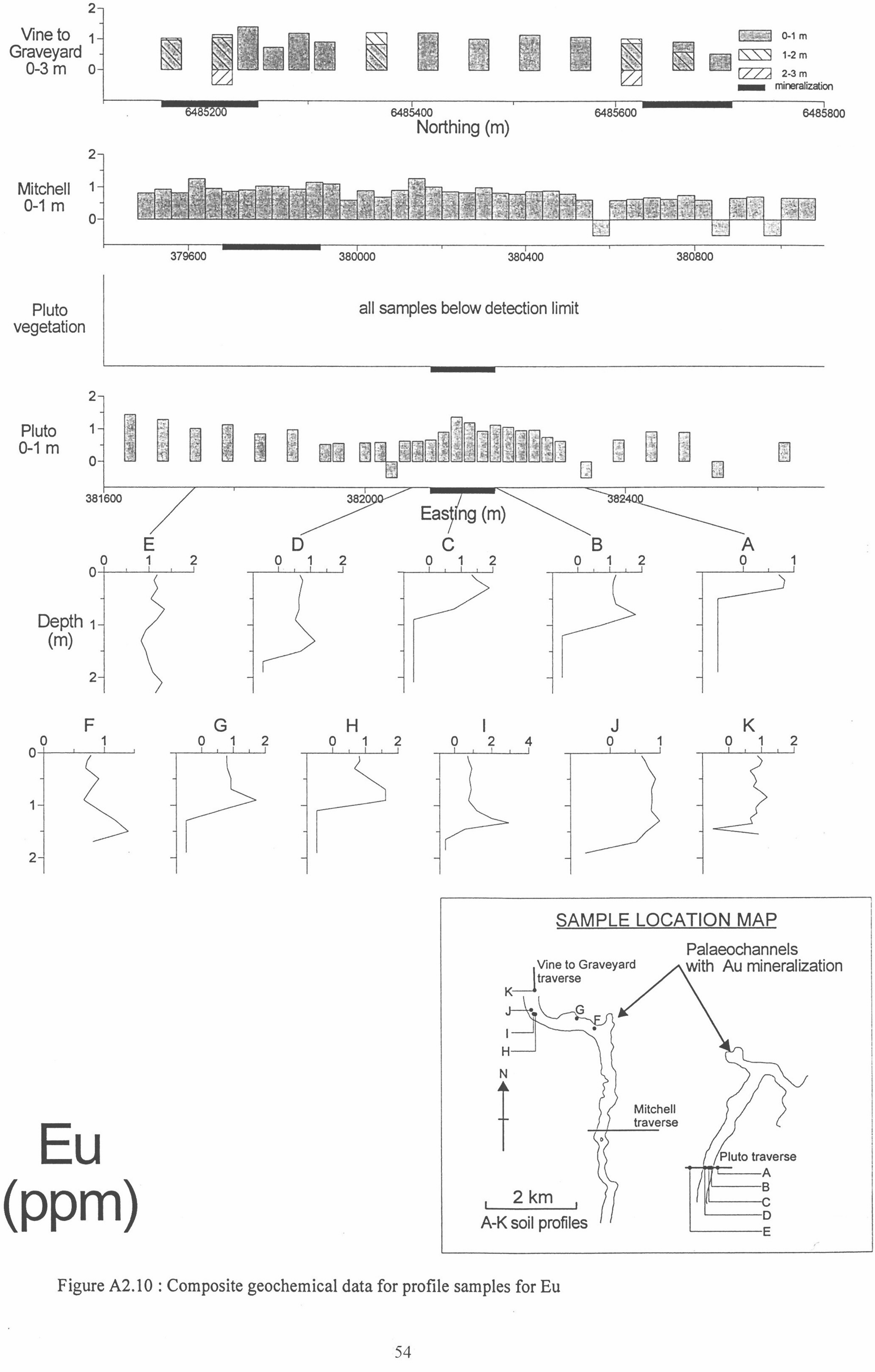


Figure A2.10 : Composite geochemical data for profile samples for Eu

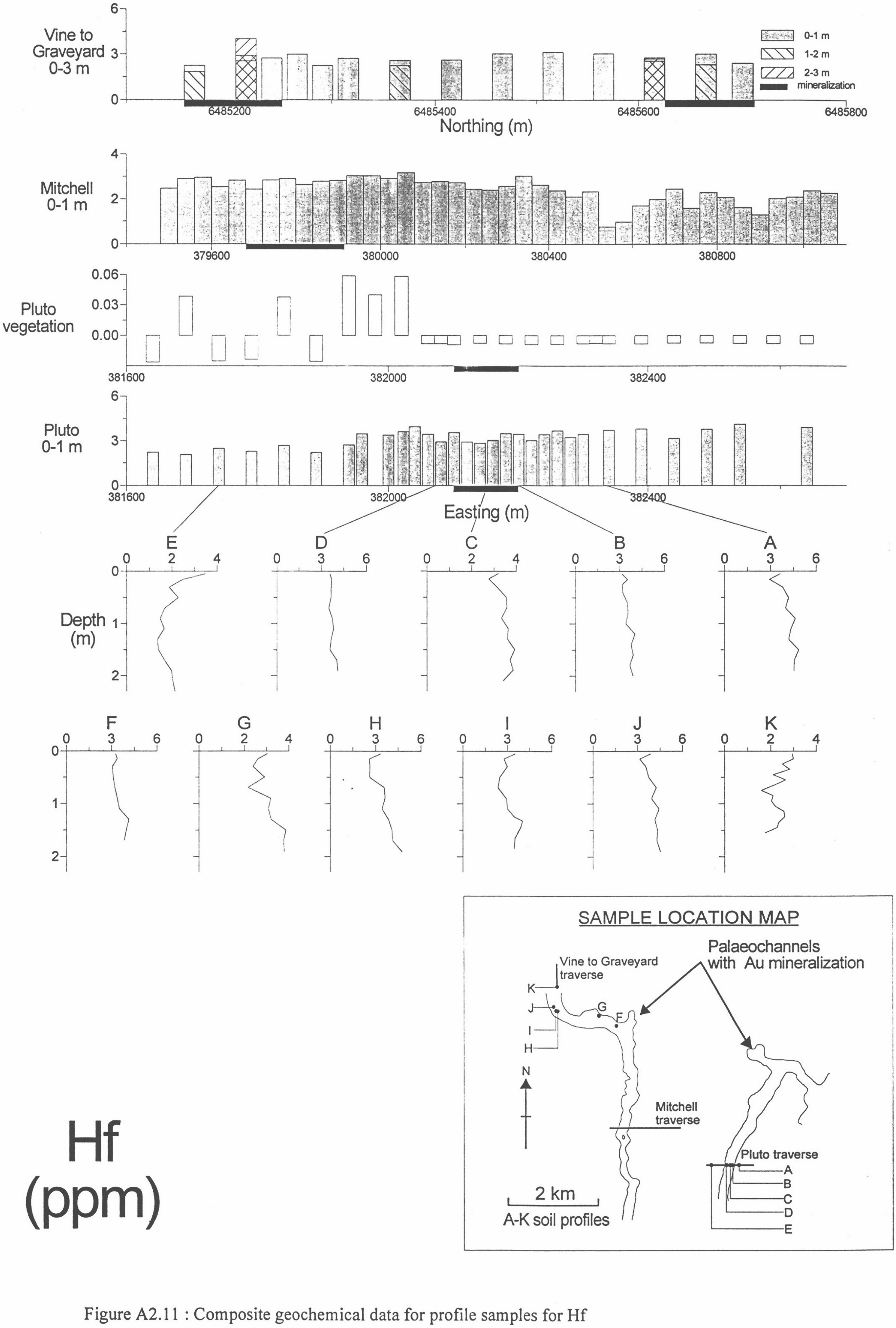


Figure A2.11 : Composite geochemical data for profile samples for Hf

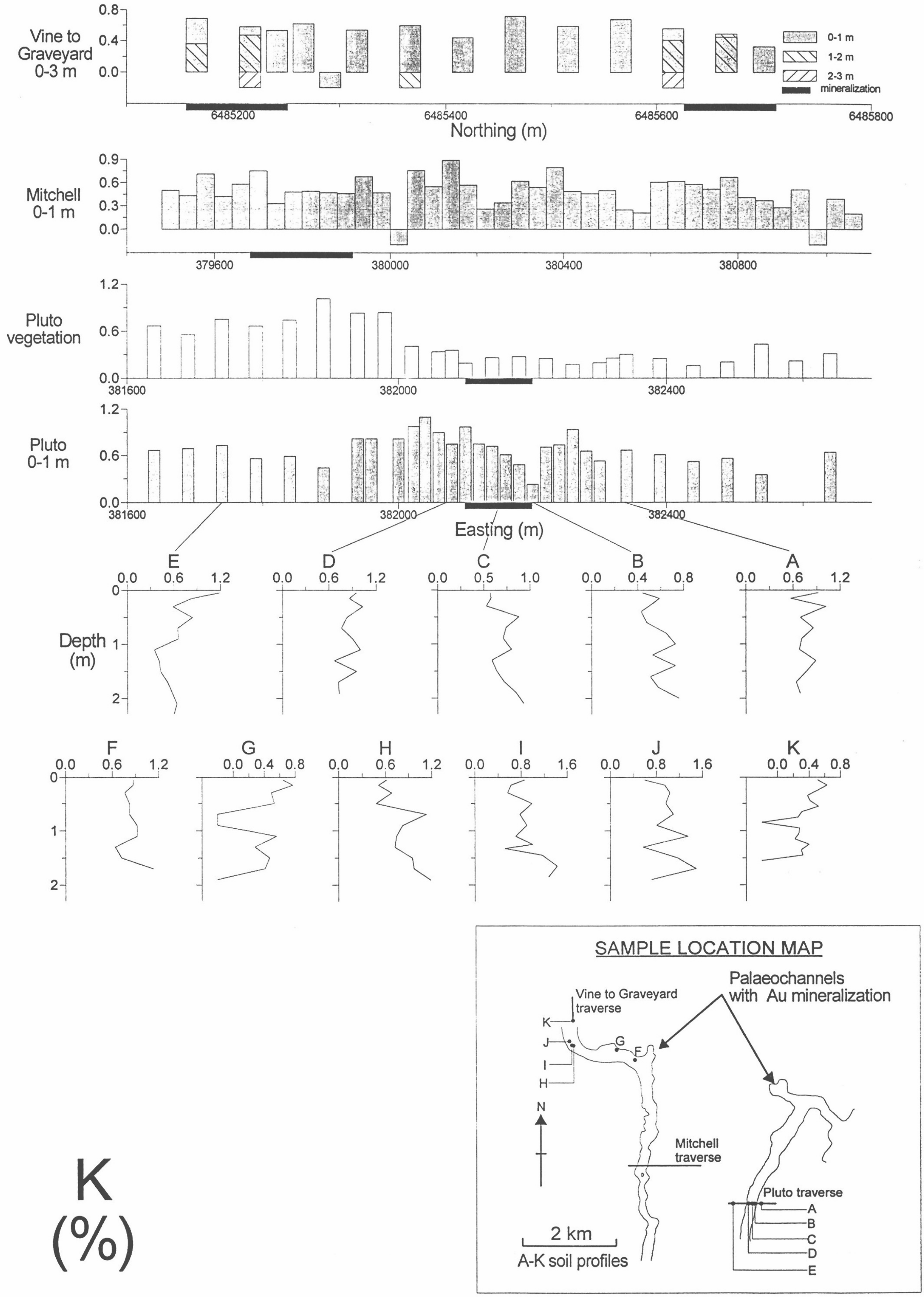


Figure A2.12 : omposite geochemical data for profile samples for K

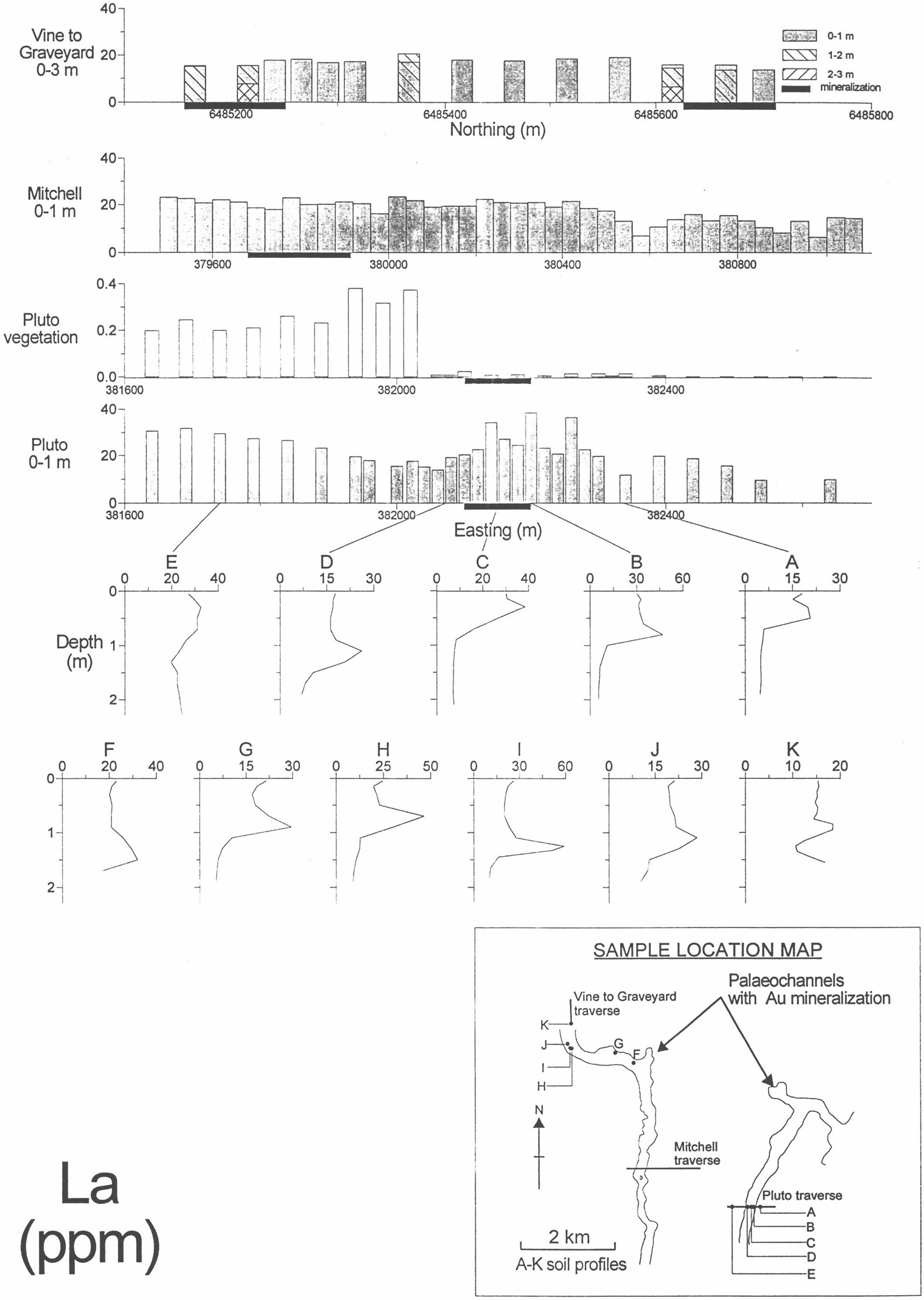


Figure A2.13 : Composite geochemical data for profile samples for La

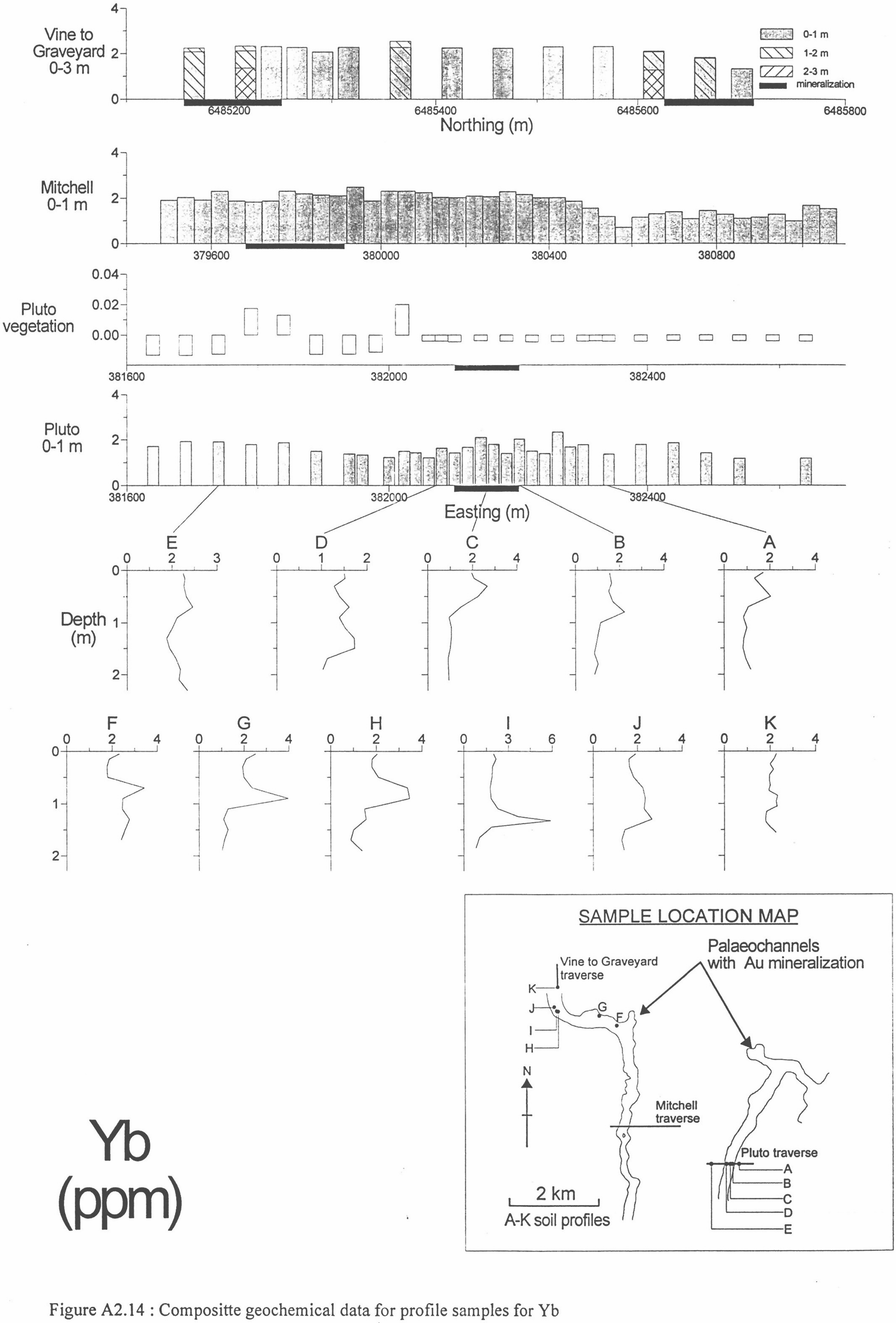
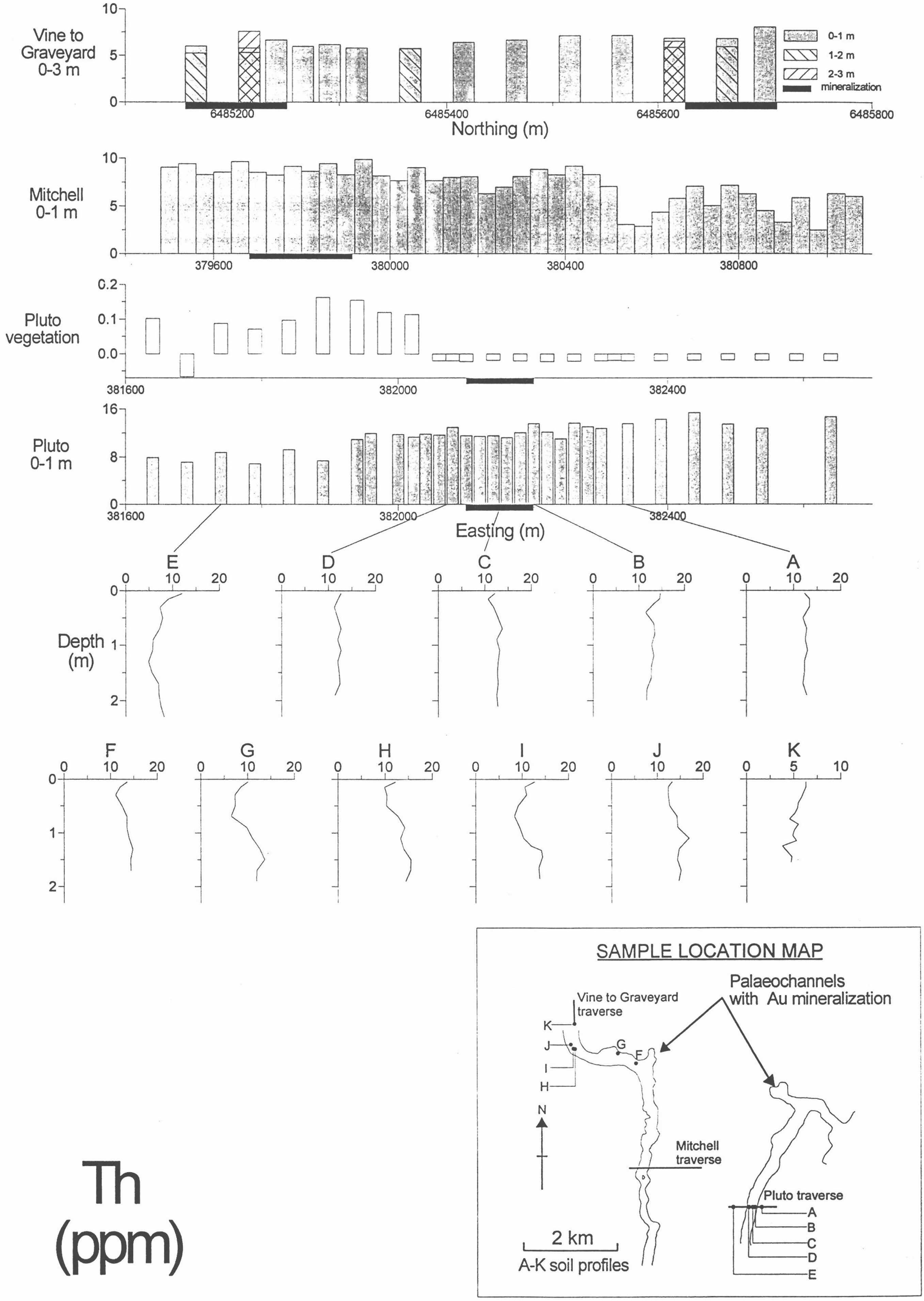


Figure A2.14 : Compositte geochemical data for profile samples for Yb



Figuer A2.15 : Composite geochemical data for profile samples for Th

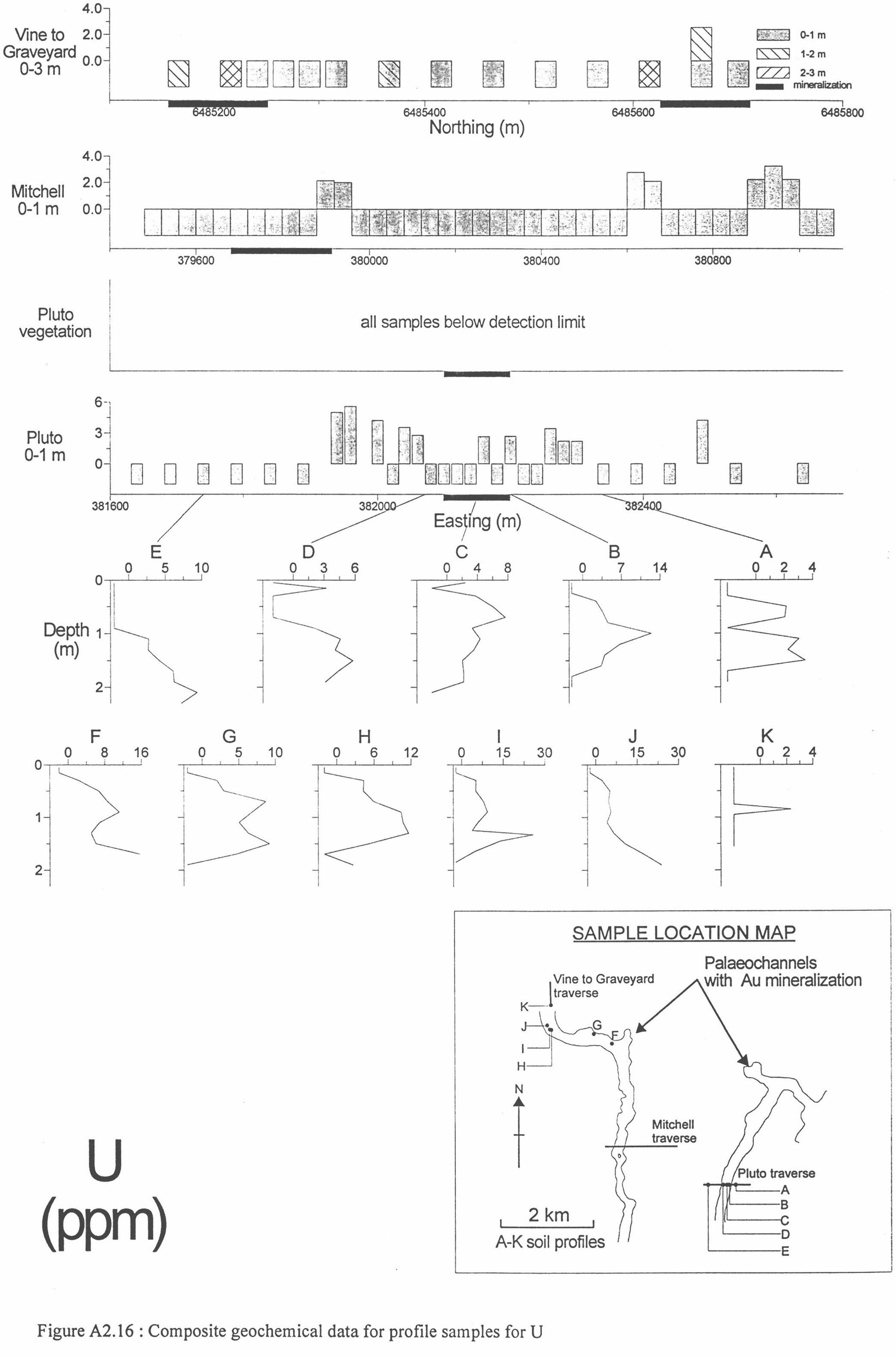


Figure A2.16 : Composite geochemical data for profile samples for U

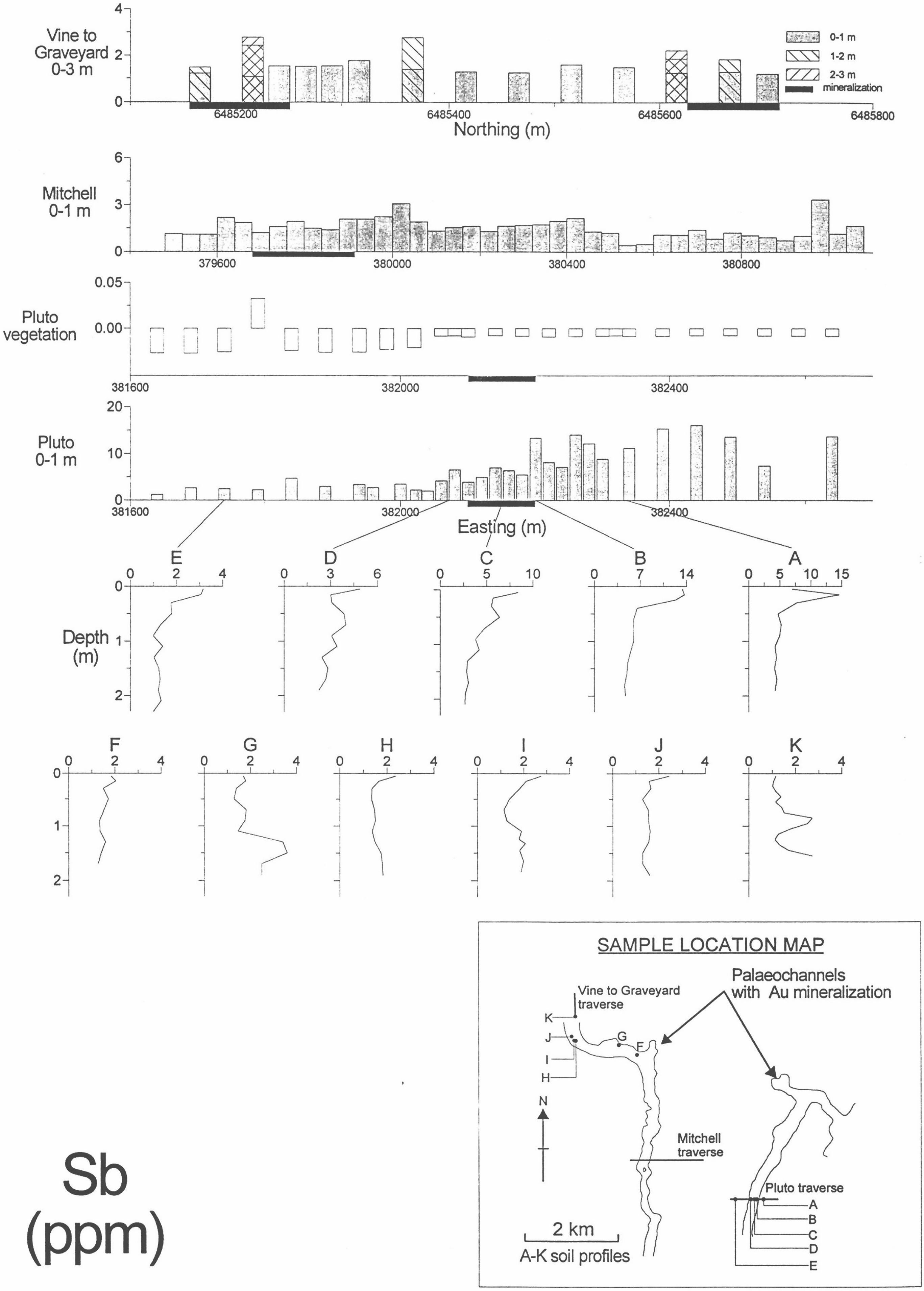


Figure A2.17 : Composite geochemical data for profile samples for Sb

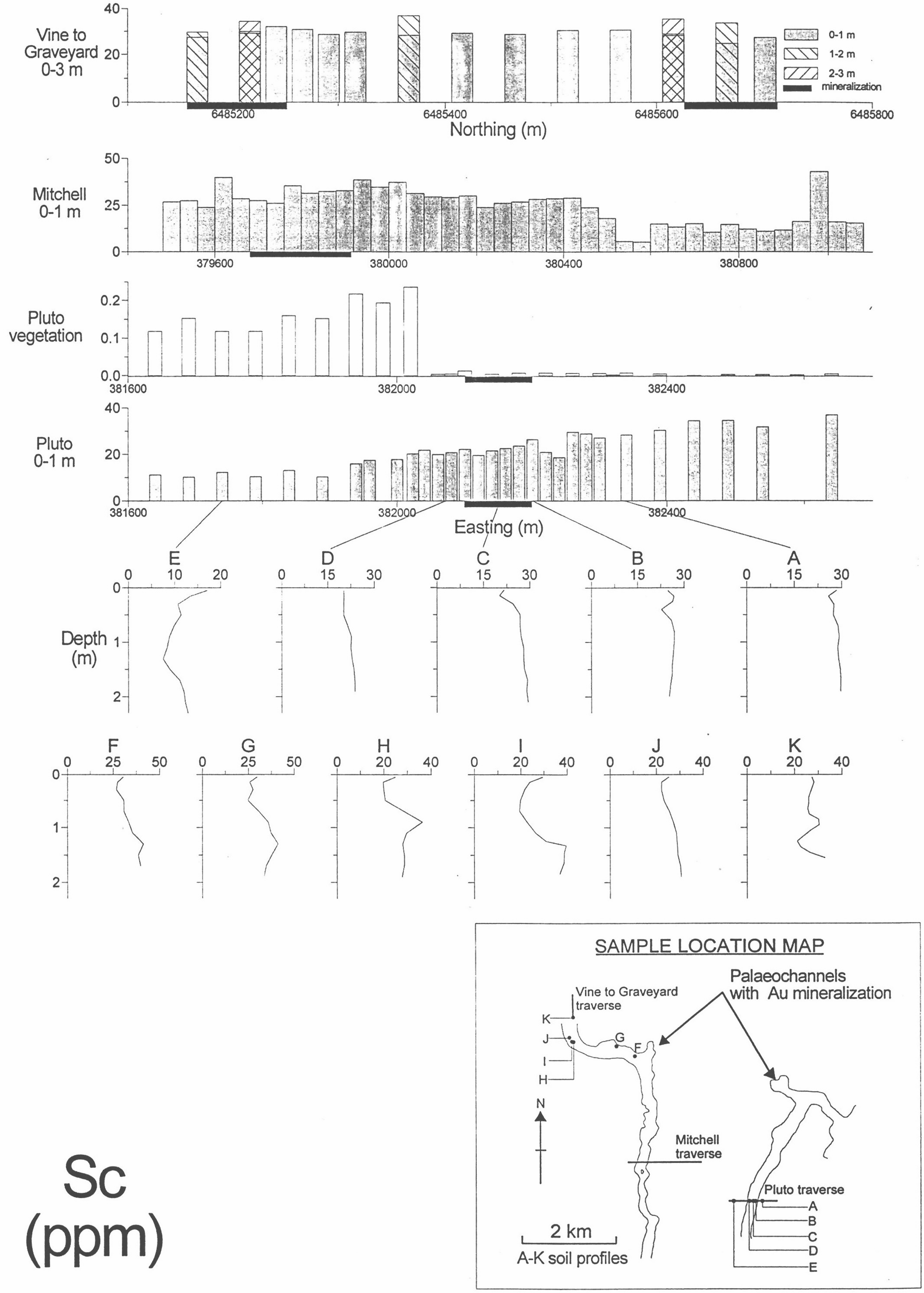


Figure A2.18 : Composite geochemical data for profile samples for Sc

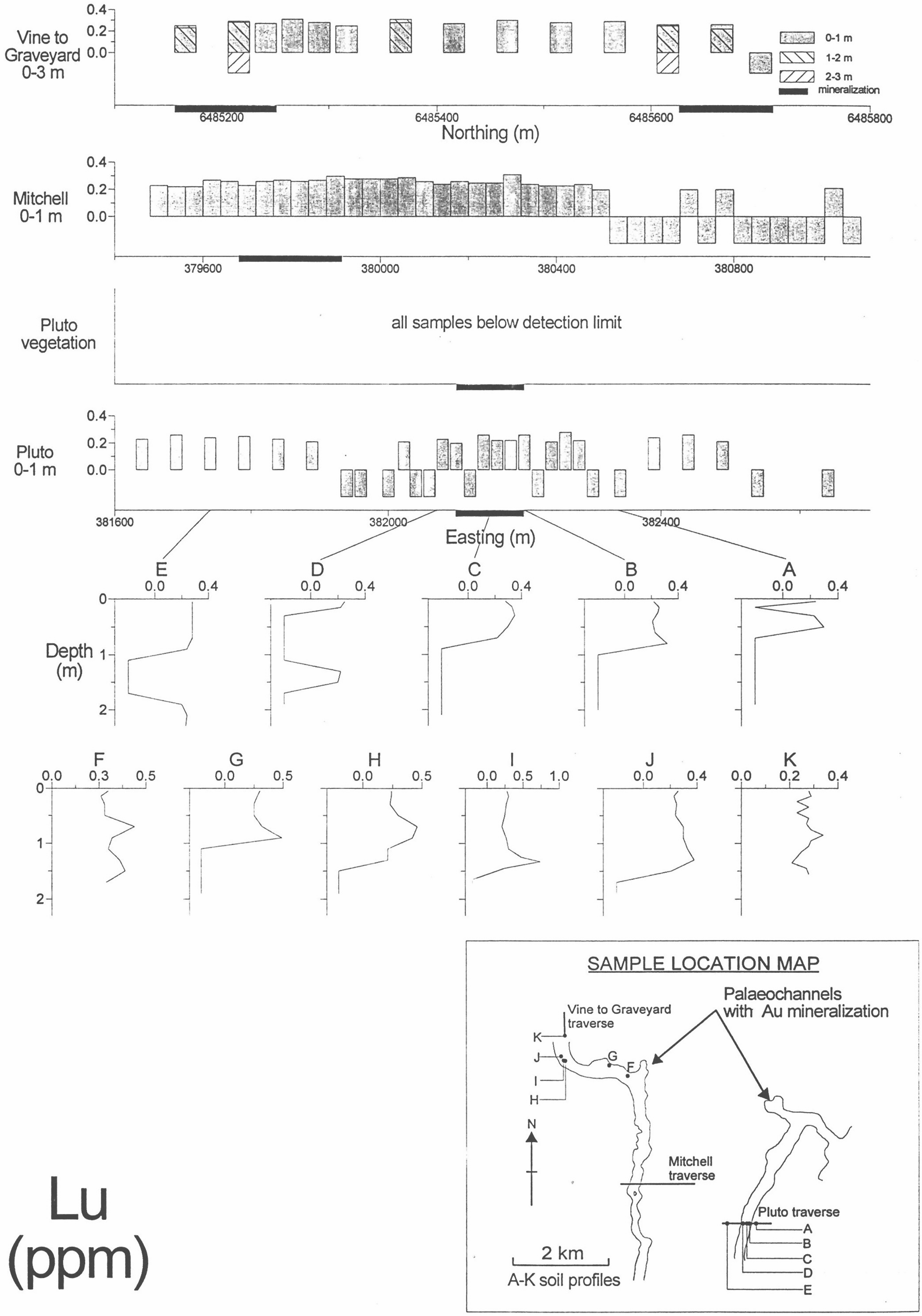


Figure A2.19 : Composite geochemical data for profile samples for Lu

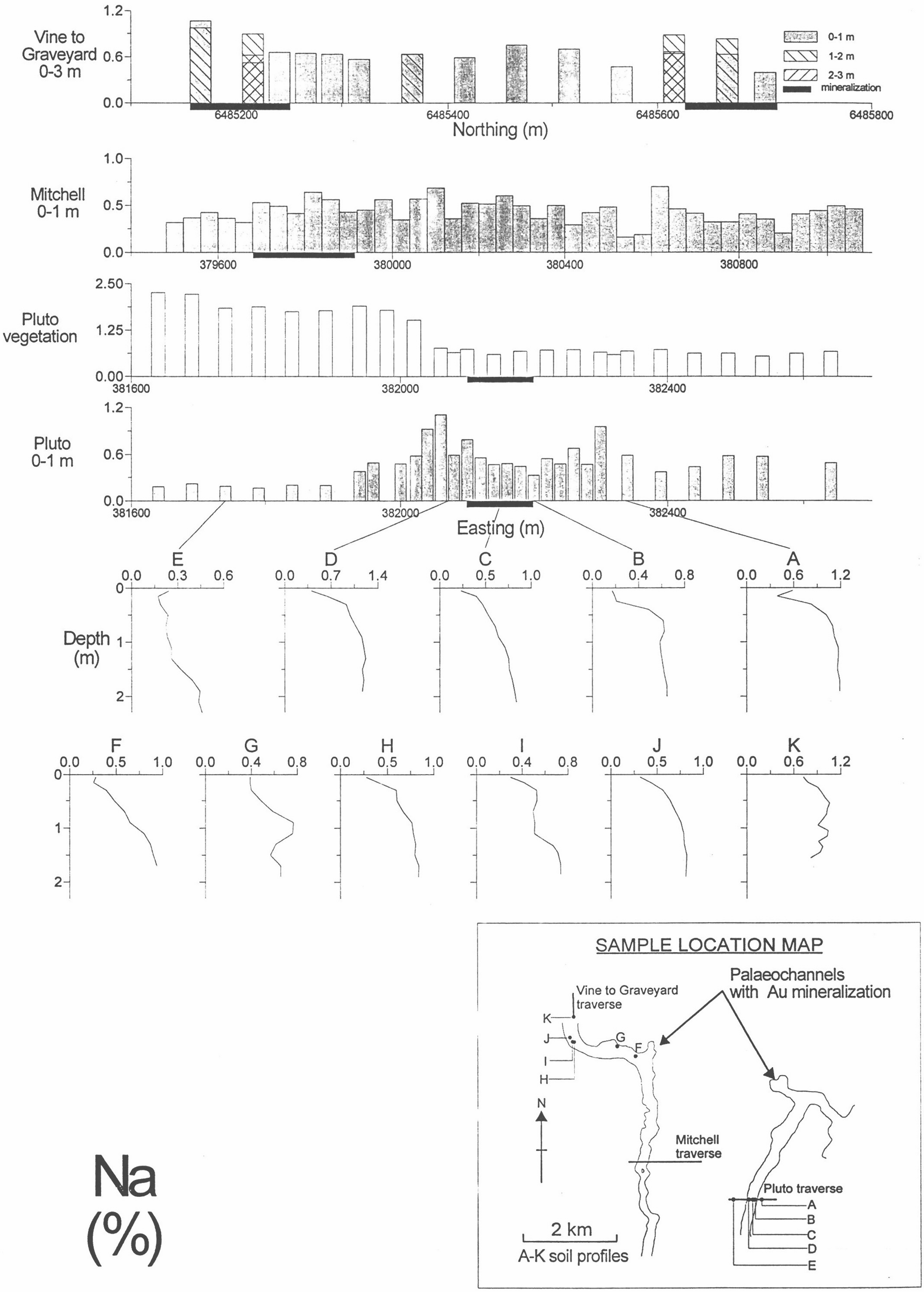


Figure A2.20 : Composite geochemical data for profile samples for Na

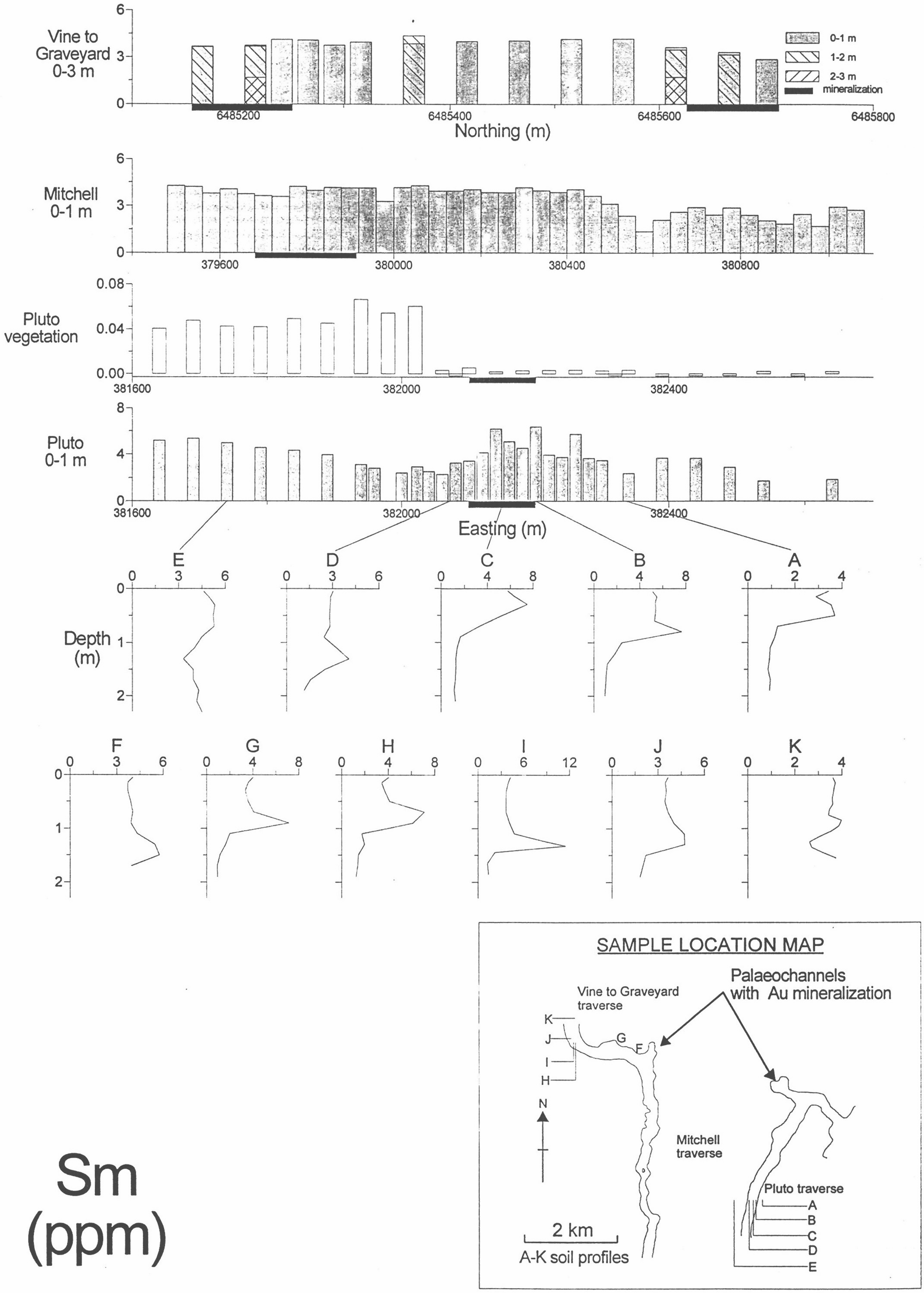


Figure A2.21 : Composite geochemical data for profile samples for Sm

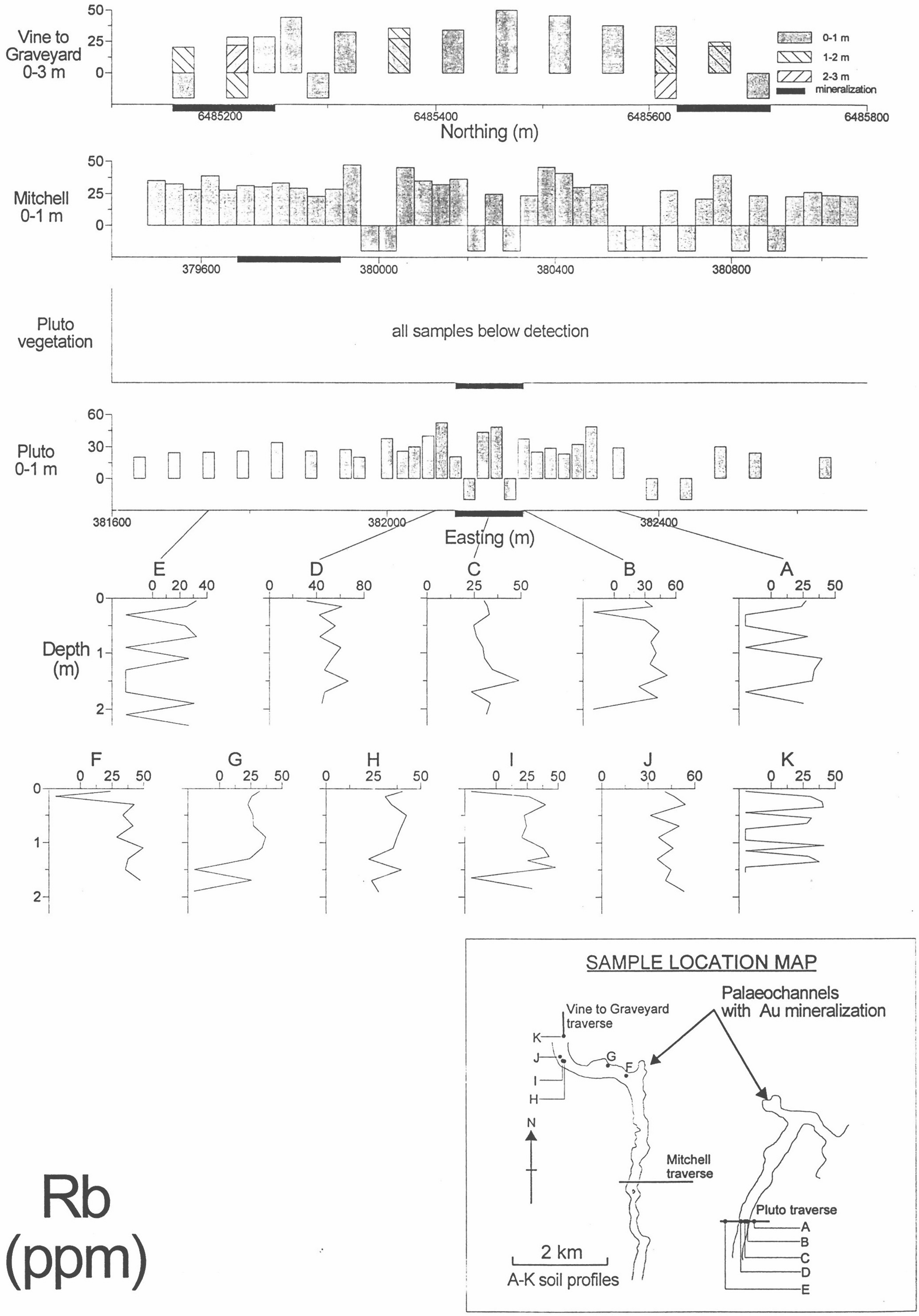


Figure A2.22 : Composite geochemical data for profile samples for Rb

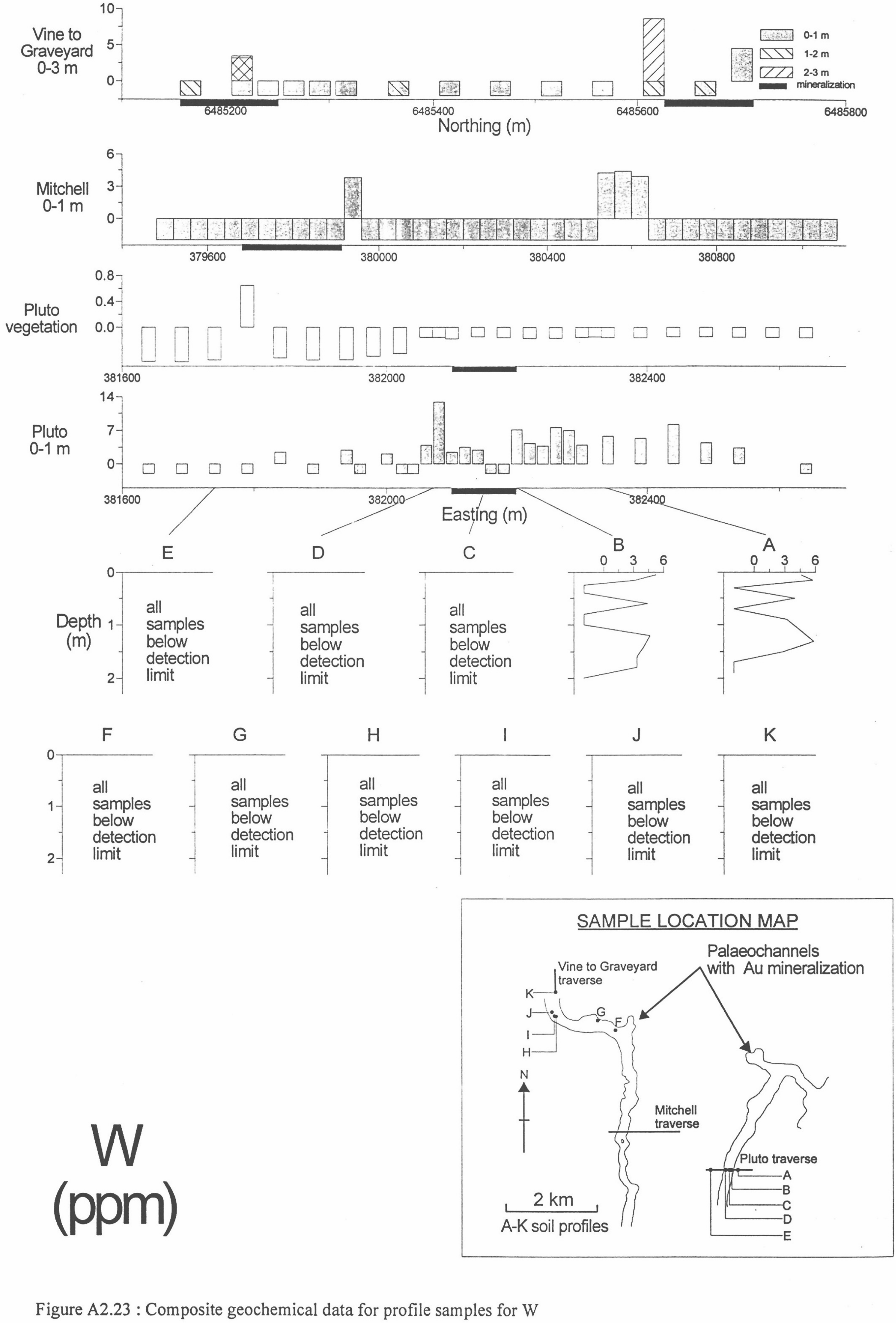


Figure A2.23 : Composite geochemical data for profile samples for W

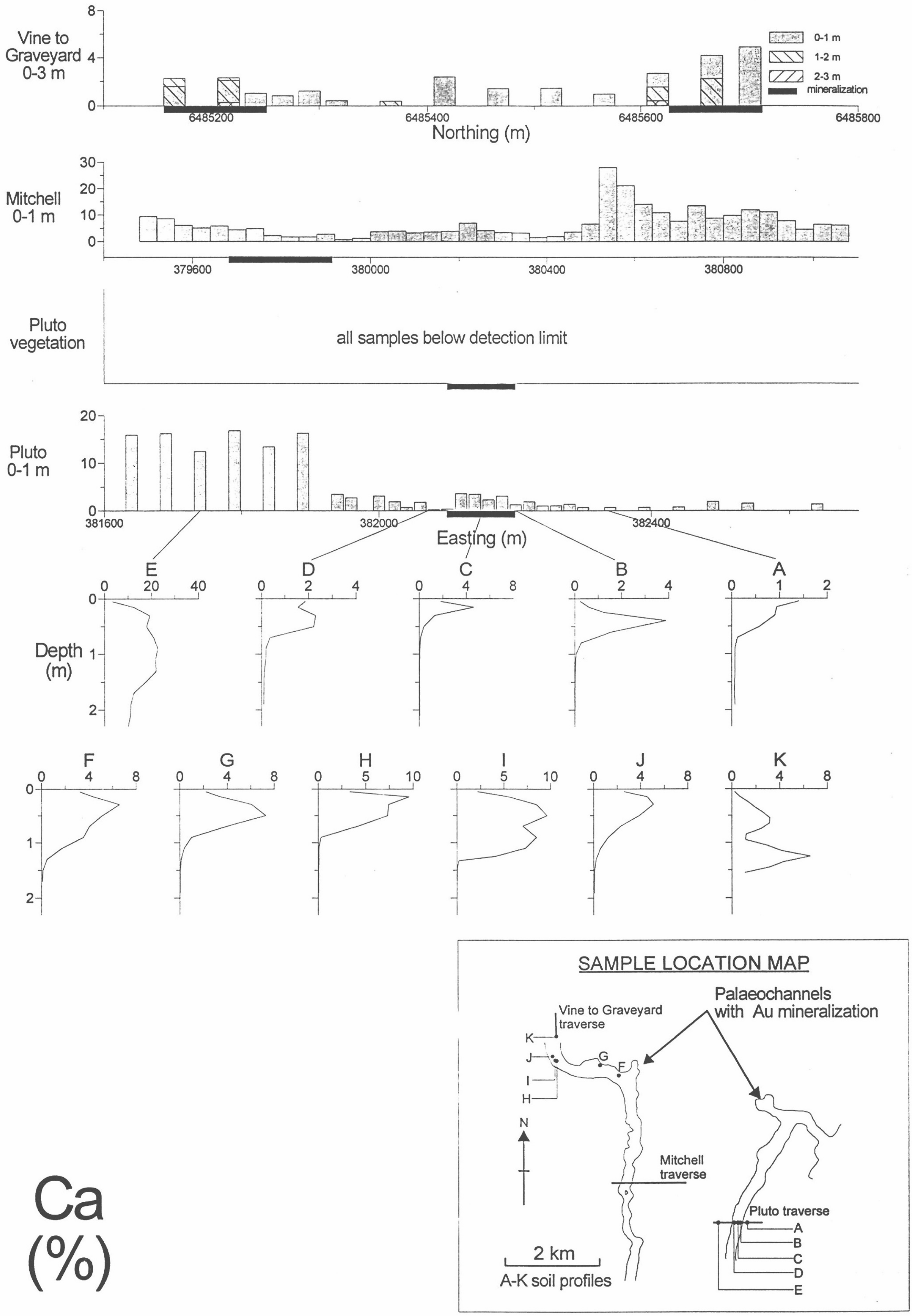


Figure A2.24 : Composite geochemical data from profile samples for Ca

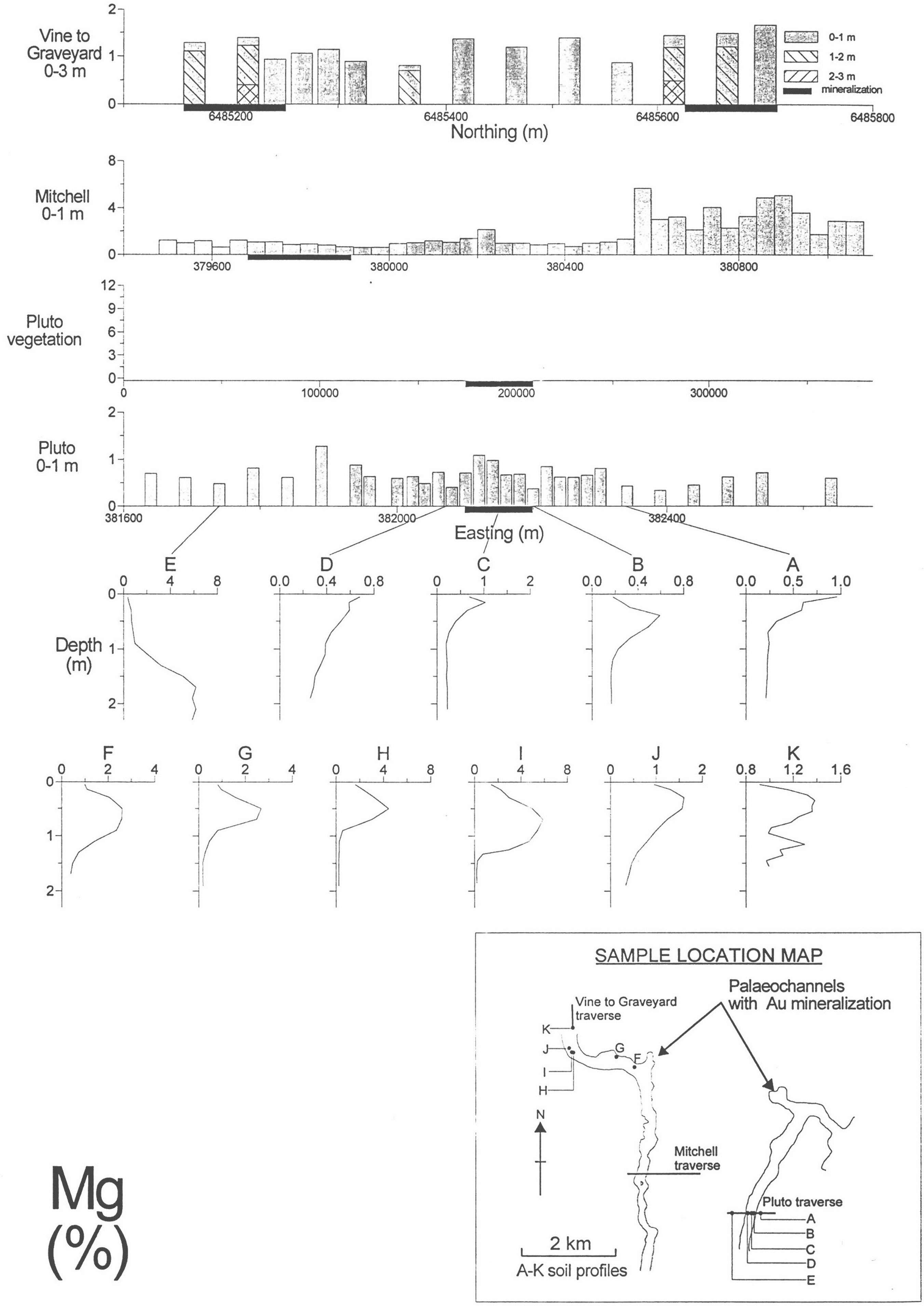
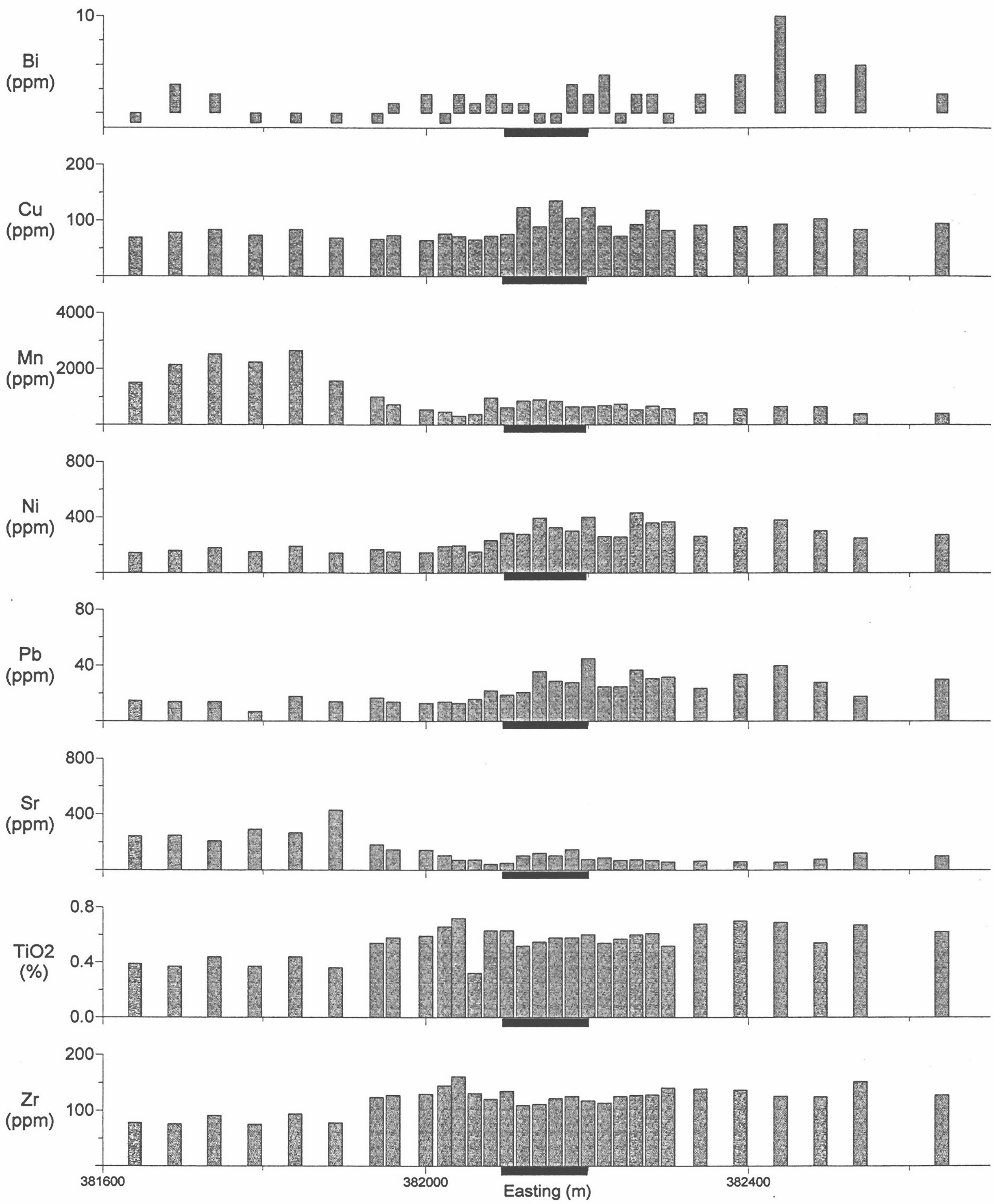


Figure A2.25 : Composite geochemical data for profile samples for Mg



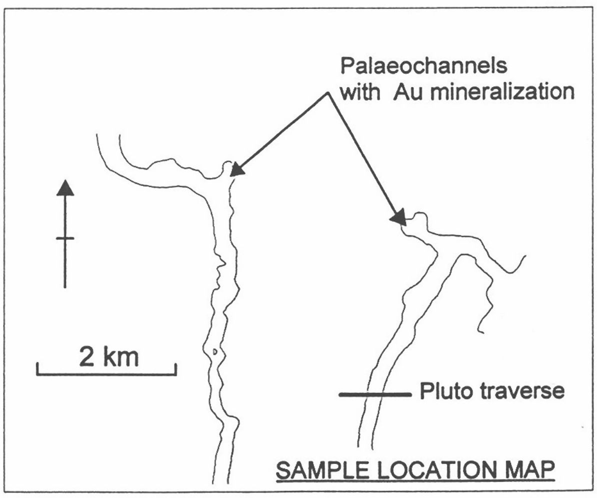


Figure A2.26: Composite geochemical data for Pluto (0-1m) for selected elements

Table A3.1: Tabulated geochemical data from the regolith

Sample	Easting	Northing	location	av depth	Au	Au	Au	Au	Ag	As	Ba	Br	Ca
	(m)	(m)		(m)	INAA	water	iodide	cyanide	INAA	INAA	INAA	INAA	AAS
					ppb	ppb	ppb	ppb	ppm	ppm	ppm	ppm	%
09-4502	382020	6481000	pluto 1a	0.50	<5	na	na	na	<5	66	127	40	0.85
09-4503	382020	6481000	pluto 1a	1.50	8	na	na	na	<5	56	190	42	0.35
09-4504	382021	6481000	pluto 1b	0.50	<5	na	na	na	<5	75	273	25	1.67
09-4505	382022	6481000	pluto 1c	0.50	7	na	na	na	<5	87	343	23	2.62
09-4506	382023	6481000	pluto 1d	0.50	8	1.7	2.1	1.9	<5	78	261	25	1.99
09-4507	382040	6481000	pluto 2	0.50	<5	2.0	1.4	2.0	<5	72	252	34	0.70
09-4508	382060	6481000	pluto 3	0.50	<5	2.5	1.4	1.0	<5	136	442	37	1.83
09-4509	382080	6481000	pluto 4	0.50	<5	2.1	0.4	0.1	<5	163	212	12	0.23
09-4510	382080	6481000	pluto 4	1.50	<5	1.9	0.8	0.4	<5	143	291	17	0.36
09-4511	382100	6481000	pluto 5	0.50	<5	2.9	1.6	0.9	<5	117	390	20	0.39
09-4512	382120	6481000	pluto 6	0.50	10	3.6	2.8	1.8	<5	131	212	15	3.68
09-4513	382140	6481000	pluto 7	0.50	<5	2.9	3.4	0.9	<5	154	436	13	3.50
09-4514	382160	6481000	pluto 8	0.50	<5	2.7	2.9	0.8	<5	155	381	12	2.30
09-4515	382180	6481000	pluto 9	0.50	<5	2.3	2.8	1.0	<5	166	269	14	3.14
09-4516	382200	6481000	pluto 10	0.50	<5	2.3	2.2	1.0	<5	346	231	23	1.29
09-4517	382220	6481000	pluto 11	0.50	<5	1.3	5.0	0.9	<5	203	296	16	1.99
09-4518	382240	6481000	pluto 12	0.50	<5	1.5	2.3	0.8	<5	210	144	11	1.08
09-4519	382260	6481000	pluto 13	0.50	<5	3.4	2.3	0.9	<5	427	298	25	1.14
09-4520	382280	6481000	pluto 14	0.50	<5	2.3	1.7	0.5	<5	414	155	15	1.46
09-4521	382300	6481000	pluto 15	0.50	<5	2.1	1.0	0.7	<5	290	234	28	0.73
09-4522	382340	6481000	pluto 16	0.50	<5	1.4	0.8	0.5	<5	348	449	23	0.70
09-4523	382390	6481000	pluto 17	0.50	<5	1.7	0.8	0.7	<5	472	356	10	0.72
09-4524	382440	6481000	pluto 18	0.50	<5	1.5	0.8	0.4	<5	598	194	14	0.79
09-4525	382490	6481000	pluto 19	0.50	<5	2.1	0.7	0.4	<5	461	337	19	1.91
09-4526	382540	6481000	pluto 20	0.50	<5	1.0	2.0	0.8	<5	282	185	27	1.57
09-4527	382640	6481000	pluto 21	0.50	<5	1.3	0.6	0.7	<5	405	307	24	1.36
09-4528	382000	6481000	pluto 22	0.50	<5	1.6	4.1	1.1	<5	88	281	16	3.18
09-4529	381960	6481000	pluto 23	0.50	13	2.0	4.6	1.6	<5	67	194	17	2.78
09-4530	381940	6481000	pluto 24	0.50	12	3.1	4.2	1.6	<5	72	176	12	3.54
09-4531	381890	6481000	pluto 25	0.50	18	2.3	6.6	2.8	<5	51	107	10	16.33
09-4532	381840	6481000	pluto 26	0.50	9	2.3	5.1	1.3	<5	69	311	6	13.42
09-4533	381790	6481000	pluto 27	0.50	15	2.0	3.9	1.0	<5	42	170	9	16.85
09-4534	381740	6481000	pluto 28	0.50	13	1.8	3.7	1.2	<5	36	223	7	12.44
09-4535	381690	6481000	pluto 29	0.50	13	1.2	3.2	0.8	<5	26	177	9	16.22
09-4536	381640	6481000	pluto 30	0.50	13	2.1	5.1	1.5	<5	21	108	8	15.91
09-4537	378332	6485166	g/yard N	0.50	8	4.1	1.1	0.5	<5	15	218	45	1.59
09-4538	378332	6485166	g/yard N	1.50	<5	2.2	4.3	0.6	<5	23	129	30	2.27
09-4539	378331	6485216	g/yard N	0.50	40	5.9	24.1	8.0	<5	17	<100	14	2.10
09-4540	378331	6485216	g/yard N	1.50	32	5.2	20.8	3.7	<5	22	<100	17	2.32
09-4541	378331	6485216	g/yard N	2.50	<5	2.0	5.6	1.7	<5	79	225	28	0.29
09-4542	378330	6485266	g/yard N	0.50	44	6.6	24.5	7.3	<5	20	140	10	0.82
09-4543	378328	6485316	g/yard N	0.50	16	3.3	7.7	2.1	<5	24	185	6	0.43
09-4544	378327	6485366	g/yard N	0.50	<5	1.0	2.3	1.0	<5	19	203	12	0.39
09-4545	378327	6485366	g/yard N	1.50	<5	1.3	1.4	0.6	<5	43	157	9	0.39
09-4546	378326	6485416	g/yard N	0.50	14	3.6	7.0	1.9	<5	23	232	12	2.39
09-4547	378325	6485466	g/yard N	0.50	13	7.9	5.6	1.8	<5	22	<100	18	1.41
09-4548	378324	6485516	g/yard N	0.50	35	5.1	19.3	7.9	<5	24	274	20	1.46
09-4549	378322	6485566	g/yard N	0.50	22	4.0	10.2	4.1	<5	30	195	11	0.96
09-4550	378321	6485616	g/yard N	0.50	54	8.3	29.7	10.1	<5	31	<100	17	2.69
09-4551	378321	6485616	g/yard N	1.50	35	4.5	19.2	3.1	<5	49	161	20	1.54
09-4552	378321	6485616	g/yard N	2.50	13	1.5	4.3	1.5	<5	254	201	37	0.41
09-4553	378320	6485666	g/yard N	0.50	94	11.5	62.0	14.6	<5	50	227	19	4.19
09-4554	378320	6485666	g/yard N	1.50	35	4.8	25.7	3.2	<5	69	279	24	2.23
09-4555	378319	6485701	g/yard N	0.50	122	18.6	68.0	30.0	<5	1110	268	23	4.89
09-4556	378329	6485291	g/yard N	0.50	37	9.8	27.2	5.1	<5	20	204	12	1.21
09-4557	378330	6485241	g/yard N	0.50	45	4.4	26.2	8.0	<5	26	<100	15	1.03
09-4558	379500	6481880	SH16901	0.50	16	1.5	5.0	1.2	<5	18	109	13	9.37
09-4559	379540	6481880	SH16902	0.50	11	na	na	na	<5	21	147	14	8.54
09-4560	379580	6481880	SH16903	0.50	<5	1.3	5.0	1.3	<5	17	<100	17	6.11

Table A3.1: Tabulated geochemical data from the regolith

09-4561	379620	6481880	SH16904	0.50	<5	1.3	2.8	0.9	<5	48	229	12	5.13
09-4562	379660	6481880	SH16905	0.50	<5	1.7	4.6	0.9	<5	25	243	13	5.84
09-4563	379700	6481880	SH16906	0.50	<5	1.8	3.3	1.6	<5	17	187	20	4.42
09-4564	379740	6481880	SH16907	0.50	8	1.9	3.0	1.3	<5	21	<100	13	4.91
09-4565	379780	6481880	SH16908	0.50	<5	3.4	2.9	1.0	<5	30	<100	15	2.25
09-4566	379820	6481880	SH16909	0.50	9	3.7	3.6	0.8	<5	21	197	17	1.79
09-4567	379860	6481880	SH16910	0.50	15	2.9	5.8	1.3	<5	18	205	13	1.76
09-4568	379900	6481880	SH16911	0.50	9	2.0	3.9	1.1	<5	29	<100	8	2.81
09-4569	379940	6481880	SH16912	0.50	<5	1.2	2.7	1.4	<5	30	287	12	0.77
09-4570	379980	6481880	SH16913	0.50	<5	1.4	2.3	0.9	<5	34	181	24	1.31
09-4571	380020	6481880	SH16914	0.50	11	0.8	3.1	0.8	<5	46	146	9	3.81
09-4572	380060	6481880	SH16915	0.50	11	2.1	4.6	1.2	<5	26	167	17	4.06
09-4573	380100	6481880	SH16916	0.50	<5	na	na	na	<5	18	202	18	3.37
09-4574	380140	6481880	SH16917	0.50	<5	3.2	3.1	1.4	<5	23	180	8	3.68
09-4575	380180	6481880	SH16918	0.50	<5	na	na	na	<5	22	<100	19	3.90
09-4576	380220	6481880	SH16919	0.50	9	2.2	5.2	1.4	<5	20	313	15	6.98
09-4577	380300	6481880	SH16921	0.50	8	1.5	3.3	1.0	<5	23	121	14	3.47
09-4578	380380	6481880	SH16923	0.50	<5	2.3	3.1	0.8	<5	23	174	13	1.67
09-4579	380460	6481880	SH16925	0.50	8	2.6	3.9	1.5	<5	22	146	9	3.68
09-4580	380540	6481880	SH16927	0.50	7	0.4	0.6	0.6	<5	7	104	12	28.10
09-4581	380620	6481880	SH16929	0.50	14	3.1	4.3	2.1	<5	14	154	12	14.10
09-4582	380700	6481880	SH16931	0.50	16	3.0	8.3	2.6	<5	21	193	14	7.59
09-4583	380780	6481880	SH16933	0.50	11	1.5	4.4	2.5	<5	25	216	13	8.77
09-4584	380860	6481880	SH16935	0.50	14	1.3	3.5	2.3	<5	27	<100	18	11.92
09-4585	380940	6481880	SH16937	0.50	6	1.5	3.2	2.2	<5	30	<100	15	7.84
09-4586	381020	6481880	SH16939	0.50	10	1.2	2.3	1.9	<5	21	203	18	6.50
09-4587	381060	6481880	SH16940	0.50	8	na	na	na	<5	26	137	18	6.28
09-4588	380980	6481880	SH16938	0.50	<5	na	na	na	<5	66	221	29	4.63
09-4589	380900	6481880	SH16936	0.50	10	1.7	2.7	1.6	<5	32	<100	12	11.20
09-4590	380820	6481880	SH16934	0.50	10	0.9	3.6	2.7	<5	26	197	16	9.80
09-4591	380740	6481880	SH16932	0.50	13	3.0	5.7	2.4	<5	17	<100	13	13.45
09-4592	380660	6481880	SH16930	0.50	17	2.0	5.4	3.7	<5	21	183	23	10.90
09-4593	380580	6481880	SH16928	0.50	22	na	na	na	<5	8	<100	20	21.15
09-4594	380580	6481880	SH16928	0.01	10	na	na	na	<5	5	<100	15	27.32
09-4595	380500	6481880	SH16926	0.50	9	na	na	na	<5	22	202	12	6.64
09-4596	380420	6481880	SH16924	0.50	16	na	na	na	<5	29	141	7	2.00
09-4597	380340	6481880	SH16922	0.50	<5	na	na	na	<5	23	182	9	3.28
09-4598	380260	6481880	SH16920	0.50	13	na	na	na	<5	24	238	21	4.16
09-4599	382340	6481000	Profile A	0.05	<5	na	na	na	<5	256	194	13	1.41
09-4600	382340	6481000	Profile A	0.15	<5	na	na	na	<5	505	315	14	0.95
09-4601	382340	6481000	Profile A	0.30	<5	na	na	na	<5	299	273	31	0.90
09-4602	382340	6481000	Profile A	0.50	<5	na	na	na	<5	193	261	53	0.58
09-4603	382340	6481000	Profile A	0.70	5	na	na	na	<5	202	292	38	0.13
09-4604	382340	6481000	Profile A	0.90	<5	na	na	na	<5	198	321	33	0.07
09-4605	382340	6481000	Profile A	1.10	<5	na	na	na	<5	181	<100	32	0.07
09-4606	382340	6481000	Profile A	1.30	<5	na	na	na	<5	185	171	31	0.08
09-4607	382340	6481000	Profile A	1.50	<5	na	na	na	<5	183	<100	30	0.07
09-4608	382340	6481000	Profile A	1.70	<5	na	na	na	<5	165	226	29	0.07
09-4609	382340	6481000	Profile A	1.90	<5	na	na	na	<5	179	<100	31	0.07
09-4610	382200	6481000	Profile B	0.05	<5	na	na	na	<5	306	226	5	0.24
09-4611	382200	6481000	Profile B	0.15	<5	na	na	na	<5	309	175	9	0.61
09-4612	382200	6481000	Profile B	0.25	<5	na	na	na	<5	329	235	10	1.27
09-4613	378332	6485166	Profile K	0.05	10	na	na	na	<5	16	202	13	0.24
09-4614	378332	6485166	Profile K	0.15	8	na	na	na	<5	16	<100	23	0.70
09-4615	378332	6485166	Profile K	0.25	9	na	na	na	<5	14	198	28	1.36
09-4616	378332	6485166	Profile K	0.35	12	na	na	na	<5	14	169	33	1.90
09-4617	378332	6485166	Profile K	0.45	8	na	na	na	<5	14	120	39	2.63
09-4618	378332	6485166	Profile K	0.55	<5	na	na	na	<5	15	332	42	3.18
09-4619	378332	6485166	Profile K	0.65	<5	na	na	na	<5	18	252	33	3.14
09-4620	378332	6485166	Profile K	0.75	<5	na	na	na	<5	21	237	27	2.43
09-4621	378332	6485166	Profile K	0.85	<5	na	na	na	<5	29	<100	21	1.21
09-4622	378332	6485166	Profile K	0.95	<5	na	na	na	<5	33	<100	19	1.13

Table A3.1: Tabulated geochemical data from the regolith

09-4623	378332	6485166	Profile K	1.05	9	na	na	na	<5	21	<100	24	2.92
09-4624	378332	6485166	Profile K	1.15	<5	na	na	na	<5	15	116	25	4.14
09-4625	378332	6485166	Profile K	1.25	<5	na	na	na	<5	13	163	23	6.56
09-4626	378332	6485166	Profile K	1.35	10	na	na	na	<5	15	<100	23	4.36
09-4627	378332	6485166	Profile K	1.45	13	na	na	na	<5	24	<100	21	3.16
09-4628	378332	6485166	Profile K	1.55	<5	na	na	na	<5	38	226	11	1.11
09-4687	382200	6481000	Profile B	0.40	10	na	na	na	<5	190	309	17	3.87
09-4688	382200	6481000	Profile B	0.60	12	na	na	na	<5	179	178	18	1.57
09-4689	382200	6481000	Profile B	0.80	<5	na	na	na	<5	188	160	23	0.28
09-4690	382200	6481000	Profile B	1.00	<5	na	na	na	<5	201	192	46	0.07
09-4691	382200	6481000	Profile B	1.20	<5	na	na	na	<5	181	155	35	0.04
09-4692	382200	6481000	Profile B	1.40	<5	na	na	na	<5	183	134	26	0.02
09-4693	382200	6481000	Profile B	1.60	<5	na	na	na	<5	180	245	23	0.02
09-4694	382200	6481000	Profile B	1.80	<5	na	na	na	<5	176	194	21	0.02
09-4695	382200	6481000	Profile B	2.00	<5	na	na	na	<5	181	212	19	0.02
09-4696	382150	6481000	Profile C	0.05	<5	na	na	na	<5	181	314	6	1.81
09-4697	382150	6481000	Profile C	0.15	10	na	na	na	<5	156	444	15	4.64
09-4698	382150	6481000	Profile C	0.30	8	na	na	na	<5	152	389	17	1.31
09-4699	382150	6481000	Profile C	0.50	11	na	na	na	<5	164	273	26	0.39
09-4700	382150	6481000	Profile C	0.70	<5	na	na	na	<5	132	310	38	0.11
09-4701	382150	6481000	Profile C	0.90	<5	na	na	na	<5	131	256	33	0.06
09-4702	382150	6481000	Profile C	1.10	<5	na	na	na	<5	130	284	30	0.04
09-4703	382150	6481000	Profile C	1.30	<5	na	na	na	<5	121	151	28	0.04
09-4704	382150	6481000	Profile C	1.50	<5	na	na	na	<5	118	207	27	0.03
09-4705	382150	6481000	Profile C	1.70	<5	na	na	na	<5	122	<100	26	0.03
09-4706	382150	6481000	Profile C	1.90	<5	na	na	na	<5	117	125	25	0.03
09-4707	382150	6481000	Profile C	2.10	<5	na	na	na	<5	122	216	25	0.04
09-4708	382070	6481000	Profile D	0.05	<5	na	na	na	<5	119	276	9	1.87
09-4709	382070	6481000	Profile D	0.15	<5	na	na	na	<5	85	160	17	1.56
09-4710	382070	6481000	Profile D	0.30	11	na	na	na	<5	86	301	26	2.29
09-4711	382070	6481000	Profile D	0.50	<5	na	na	na	<5	107	148	25	2.22
09-4712	382070	6481000	Profile D	0.70	8	na	na	na	<5	108	242	26	0.36
09-4713	382070	6481000	Profile D	0.90	21	na	na	na	<5	104	317	29	0.20
09-4714	382070	6481000	Profile D	1.10	<5	na	na	na	<5	108	284	29	0.18
09-4715	382070	6481000	Profile D	1.30	8	na	na	na	<5	87	223	29	0.13
09-4716	382070	6481000	Profile D	1.50	<5	na	na	na	<5	97	348	31	0.11
09-4717	382070	6481000	Profile D	1.70	<5	na	na	na	<5	99	267	35	0.10
09-4718	382070	6481000	Profile D	1.90	<5	na	na	na	<5	86	214	36	0.10
09-4719	381740	6481000	Profile E	0.05	<5	na	na	na	<5	50	239	4	3.05
09-4720	381740	6481000	Profile E	0.15	7	na	na	na	<5	51	228	6	12.54
09-4721	381740	6481000	Profile E	0.30	16	na	na	na	<5	37	121	8	19.26
09-4722	381740	6481000	Profile E	0.50	11	na	na	na	<5	33	177	8	17.90
09-4723	381740	6481000	Profile E	0.70	18	na	na	na	<5	27	136	6	21.01
09-4724	381740	6481000	Profile E	0.90	18	na	na	na	<5	27	<100	8	22.71
09-4725	381740	6481000	Profile E	1.10	31	na	na	na	<5	29	200	10	21.76
09-4726	381740	6481000	Profile E	1.30	40	na	na	na	<5	25	<100	10	22.07
09-4727	381740	6481000	Profile E	1.50	37	na	na	na	<5	29	<100	12	17.46
09-4728	381740	6481000	Profile E	1.70	28	na	na	na	<5	37	<100	13	12.38
09-4729	381740	6481000	Profile E	1.90	18	na	na	na	<5	35	<100	13	11.15
09-4730	381740	6481000	Profile E	2.10	17	na	na	na	<5	41	165	14	11.02
09-4731	381740	6481000	Profile E	2.30	7	na	na	na	<5	42	<100	13	10.06
09-4732	379654	6484268	Profile F	0.05	22	na	na	na	<5	26	<100	10	3.22
09-4733	379654	6484268	Profile F	0.15	31	na	na	na	<5	34	179	12	4.39
09-4734	379654	6484268	Profile F	0.30	46	na	na	na	<5	22	313	11	6.57
09-4735	379654	6484268	Profile F	0.50	40	na	na	na	<5	23	465	10	5.12
09-4736	379654	6484268	Profile F	0.70	28	na	na	na	<5	22	258	13	4.04
09-4737	379654	6484268	Profile F	0.90	22	na	na	na	<5	22	290	16	3.52
09-4738	379654	6484268	Profile F	1.10	19	na	na	na	<5	19	254	23	1.72
09-4739	379654	6484268	Profile F	1.30	31	na	na	na	<5	20	379	25	0.46
09-4740	379654	6484268	Profile F	1.50	15	na	na	na	<5	20	264	26	0.11
09-4741	379654	6484268	Profile F	1.70	17	na	na	na	<5	19	192	33	0.07
09-4742	379654	6484268	Profile F	1.90	12	na	na	na	<5	25	285	46	0.06

Table A3.1: Tabulated geochemical data from the regolith

09-4743	379260	6484500	Profile G	0.05	183	na	na	na	<5	23	118	9	2.19
09-4744	379320	6484500	Profile G	0.15	287	na	na	na	<5	20	177	13	3.43
09-4745	379320	6484500	Profile G	0.30	425	na	na	na	<5	29	264	11	6.05
09-4746	379320	6484500	Profile G	0.50	403	na	na	na	<5	25	248	13	7.28
09-4747	379320	6484500	Profile G	0.70	340	na	na	na	<5	35	251	12	4.04
09-4748	379320	6484500	Profile G	0.90	402	na	na	na	<5	27	237	19	0.99
09-4749	379320	6484500	Profile G	1.10	243	na	na	na	<5	29	296	28	0.37
09-4750	379320	6484500	Profile G	1.30	139	na	na	na	<5	47	175	36	0.12
09-4751	379320	6484500	Profile G	1.50	90	na	na	na	<5	40	421	63	0.05
09-4752	379320	6484500	Profile G	1.70	29	na	na	na	<5	37	307	75	0.03
09-4753	379320	6484500	Profile G	1.90	23	na	na	na	<5	37	323	71	0.03
09-4754	378340	6484600	Profile H	0.05	<5	na	na	na	<5	20	253	13	3.30
09-4755	378430	6484600	Profile H	0.15	23	na	na	na	<5	17	<100	22	9.58
09-4756	378430	6484600	Profile H	0.30	38	na	na	na	<5	17	200	25	7.42
09-4757	378430	6484600	Profile H	0.50	30	na	na	na	<5	17	258	24	7.32
09-4758	378430	6484600	Profile H	0.70	28	na	na	na	<5	19	224	19	4.20
09-4759	378430	6484600	Profile H	0.90	24	na	na	na	<5	19	213	28	0.31
09-4760	378430	6484600	Profile H	1.10	12	na	na	na	<5	18	296	36	0.06
09-4761	378430	6484600	Profile H	1.30	<5	na	na	na	<5	17	254	48	0.07
09-4762	378430	6484600	Profile H	1.50	7	na	na	na	<5	20	301	73	0.05
09-4763	378430	6484600	Profile H	1.70	<5	na	na	na	<5	19	294	82	0.05
09-4764	378430	6484600	Profile H	1.90	<5	na	na	na	<5	19	372	70	0.04
09-4765	378305	6484610	Profile I	0.05	21	na	na	na	<5	23	246	13	2.18
09-4766	378375	6484610	Profile I	0.15	27	na	na	na	<5	18	312	19	5.51
09-4767	378375	6484610	Profile I	0.30	47	na	na	na	<5	19	172	24	8.53
09-4768	378375	6484610	Profile I	0.50	42	na	na	na	<5	15	206	24	9.64
09-4769	378375	6484610	Profile I	0.70	32	na	na	na	<5	16	174	21	7.02
09-4770	378375	6484610	Profile I	0.90	40	na	na	na	<5	16	187	17	8.52
09-4771	378375	6484610	Profile I	1.10	39	na	na	na	<5	20	132	16	7.33
09-4772	378375	6484610	Profile I	1.25	38	na	na	na	<5	19	197	19	4.10
09-4773	378375	6484610	Profile I	1.33	28	na	na	na	<5	28	391	28	0.24
09-4774	378375	6484610	Profile I	1.45	<5	na	na	na	<5	19	222	58	0.07
09-4775	378375	6484610	Profile I	1.65	<5	na	na	na	<5	19	329	85	0.04
09-4776	378375	6484610	Profile I	1.85	12	na	na	na	<5	20	247	79	0.03
09-4777	378250	6484700	Profile J	0.05	43	na	na	na	<5	23	164	17	2.58
09-4778	378250	6484700	Profile J	0.15	58	na	na	na	<5	17	<100	29	4.57
09-4779	378250	6484700	Profile J	0.30	58	na	na	na	<5	16	236	31	5.11
09-4780	378250	6484700	Profile J	0.50	48	na	na	na	<5	16	266	30	3.92
09-4781	378250	6484700	Profile J	0.70	46	na	na	na	<5	17	355	24	2.34
09-4782	378250	6484700	Profile J	0.90	33	na	na	na	<5	17	215	23	1.28
09-4783	378250	6484700	Profile J	1.10	48	na	na	na	<5	18	199	25	0.60
09-4784	378250	6484700	Profile J	1.30	41	na	na	na	<5	18	189	28	0.24
09-4785	378250	6484700	Profile J	1.50	37	na	na	na	<5	17	233	35	0.09
09-4786	378250	6484700	Profile J	1.70	29	na	na	na	<5	16	280	38	0.07
09-4787	378250	6484700	Profile J	1.90	25	na	na	na	<5	17	166	48	0.06

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Ce	Co	Cr	Cs	Cu	Eu	Fe	Hf	Ir	K	La	Lu	Mg	Mn	Mo	Na	Ni
	INAA	INAA	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	INAA	INAA	AAS	XRF	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	ppm	%	ppm	ppm	%	ppm
09-4502	41	34	962	2.7	na	0.8	6	4	<20	1.18	18.5	0.21	0.48	na	<10	0.63	na
09-4503	18	17	940	2.9	na	<0.5	6	4	<20	1.09	10.7	<0.2	0.29	na	<5	0.79	na
09-4504	33	24	977	1.8	na	0.63	7	4	<20	0.93	16.6	<0.2	0.52	na	<5	0.49	na
09-4505	33	24	1090	2.8	na	<0.5	8	4	<20	0.85	16.4	0.21	0.65	na	<5	0.44	na
09-4506	35	28	1010	2.7	77	0.6	7	4	<20	0.98	17.6	0.21	0.64	470	<5	0.58	193
09-4507	38	29	1000	1.6	72	<0.5	6	4	<20	1.1	15.2	<0.2	0.49	324	<5	0.93	198
09-4508	25	23	1480	1.7	66	0.64	10	3	<20	0.9	14	<0.2	0.73	387	<5	1.11	154
09-4509	36	27	1970	2.3	73	0.63	14	3	<20	0.75	19.1	0.23	0.41	981	<5	0.59	236
09-4510	31	24	1830	1.7	65	<0.5	13	3	<20	0.64	18	<0.2	0.38	693	<5	0.77	198
09-4511	38	32	1530	2.9	76	0.67	10	4	<20	0.97	20.3	0.2	0.71	628	<5	0.79	290
09-4512	45	31	1520	1.0	124	0.91	10	3	<20	0.75	22.5	<0.2	1.09	873	<5	0.56	283
09-4513	71	50	1980	<1.0	90	1.37	13	3	<20	0.72	34.2	0.26	0.98	912	<5	0.47	397
09-4514	65	39	1840	1.2	136	1.2	12	3	<20	0.61	27.1	0.22	0.67	867	<5	0.48	329
09-4515	57	31	1770	1.2	105	0.94	11	3	<20	0.48	24.4	0.22	0.68	660	<5	0.45	305
09-4516	85	51	2870	<1.0	124	1.13	18	3	<20	0.23	38.4	0.26	0.37	651	<5	0.33	405
09-4517	39	28	2000	1.4	91	1.07	13	3	<20	0.71	23.1	<0.2	0.85	702	<5	0.55	267
09-4518	34	29	1820	1.6	73	0.97	12	3	<20	0.74	20.6	0.21	0.63	757	<5	0.48	264
09-4519	46	69	3550	<1.0	94	0.98	21	4	<20	0.94	36.5	0.28	0.62	548	<5	0.68	435
09-4520	35	42	3430	<1.0	119	0.76	19	3	<20	0.66	22.5	0.22	0.67	678	<5	0.47	362
09-4521	38	45	2590	2.0	83	0.64	14	3	<20	0.53	19.7	<0.2	0.81	589	<5	0.96	370
09-4522	19	32	2970	2.0	93	<0.5	17	4	<20	0.67	11.8	<0.2	0.44	435	<5	0.59	268
09-4523	29	39	3870	1.3	90	0.67	23	4	<20	0.61	19.7	0.24	0.34	577	<5	0.37	327
09-4524	28	46	4810	1.8	94	0.92	27	3	<20	0.52	18.6	0.26	0.45	655	<5	0.44	382
09-4525	23	37	4260	<1.0	103	0.9	24	4	<20	0.56	15.6	0.21	0.63	650	<5	0.58	304
09-4526	20	24	2860	<1.0	84	<0.5	14	4	<20	0.35	9.56	<0.2	0.72	391	<5	0.57	253
09-4527	13	28	4380	2.0	95	0.59	23	4	<20	0.64	9.77	<0.2	0.60	405	<5	0.49	279
09-4528	26	19	1130	2.1	65	0.59	8	3	<20	0.82	15.6	<0.2	0.60	554	<5	0.48	148
09-4529	33	23	957	1.4	74	0.57	7	3	<20	0.82	17.9	<0.2	0.64	726	<10	0.50	154
09-4530	38	26	1050	2.5	67	0.53	8	3	<20	0.82	19.5	<0.2	0.89	1016	<10	0.38	171
09-4531	38	22	792	1.8	69	0.98	6	2	<20	0.44	23.1	0.21	1.28	1591	<5	0.20	145
09-4532	41	27	1210	1.5	84	0.85	9	3	<20	0.59	26.5	0.23	0.62	2657	<5	0.20	194
09-4533	39	23	619	1.2	74	1.13	5	2	<20	0.56	27.3	0.25	0.82	2248	<5	0.17	154
09-4534	44	27	699	1.6	84	1.02	6	3	<20	0.73	29.5	0.24	0.48	2543	<5	0.19	184
09-4535	45	28	493	<1.0	79	1.29	5	2	<20	0.69	31.8	0.26	0.61	2163	<5	0.22	162
09-4536	43	25	455	1.3	70	1.44	4	2	<20	0.67	30.7	0.23	0.70	1523	<5	0.19	144
09-4537	29	56	968	3.6	na	0.97	8	2	<20	0.69	15.6	0.23	1.29	na	<5	1.07	na
09-4538	27	58	1370	1.2	na	1.03	11	2	<20	0.36	15.2	0.25	1.11	na	<5	0.98	na
09-4539	29	55	1030	2.8	na	1.15	8	3	<20	0.58	15.6	0.28	1.40	na	<5	0.52	na
09-4540	27	58	1190	1.6	na	1.05	9	3	<20	0.47	15.6	0.29	1.23	na	<5	0.90	na
09-4541	12	37	2130	<1.0	na	<0.5	18	4	<20	<0.2	7.65	<0.2	0.41	na	<5	0.62	na
09-4542	32	62	1160	1.2	na	0.74	10	3	<20	0.62	18.2	0.31	1.07	na	<5	0.65	na
09-4543	31	62	1200	2.1	na	0.92	10	3	<20	0.54	17.3	0.25	0.91	na	<5	0.57	na
09-4544	32	62	1110	3.0	na	0.85	9	3	<20	0.6	17.1	0.28	0.82	na	<5	0.63	na
09-4545	28	64	2180	<1.0	na	1.23	20	2	<20	<0.2	20.6	0.31	0.71	na	<5	0.64	na
09-4546	32	55	1070	1.6	na	1.22	9	3	<20	0.44	18	0.27	1.38	na	<5	0.59	na
09-4547	31	54	955	3.1	na	1.02	8	3	<20	0.72	17.6	0.3	1.20	na	<5	0.75	na
09-4548	36	58	1020	1.0	na	1.16	8	3	<20	0.59	18.5	0.28	1.40	na	<5	0.70	na
09-4549	36	60	1060	1.9	na	1.09	9	3	<20	0.68	19.1	0.29	0.88	na	<5	0.47	na
09-4550	29	49	925	1.0	na	0.88	8	3	<20	0.56	16	0.25	1.46	na	<5	0.64	na
09-4551	29	66	1210	<1.0	na	1.03	11	3	<20	0.41	14.6	0.26	1.20	na	<5	0.88	na
09-4552	9	48	1470	<1.0	na	<0.5	15	3	<20	<0.2	6.56	<0.2	0.50	na	<5	0.66	na
09-4553	31	38	834	1.9	na	0.93	8	3	<20	0.45	15.9	0.26	1.50	na	<5	0.63	na
09-4554	21	49	1610	1.5	na	0.6	15	2	<20	0.49	13.7	0.22	1.21	na	<5	0.83	na
09-4555	31	58	677	<1.0	na	0.54	13	2	<20	0.33	13.9	<0.2	1.68	na	<5	0.39	na
09-4556	33	57	1160	1.9	na	1.2	9	2	<20	<0.2	16.8	0.28	1.15	na	<5	0.63	na
09-4557	32	63	1200	<1.0	na	1.4	10	3	<20	0.53	17.8	0.27	0.94	na	<5	0.66	na
09-4558	42	31	905	<1.0	na	0.81	9	2	<20	0.5	23.1	0.23	1.26	na	<5	0.32	na
09-4559	41	30	949	3.9	na	0.93	9	3	<20	0.43	22.6	0.22	1.02	na	<5	0.37	na
09-4560	35	29	941	1.1	na	0.82	9	3	<20	0.71	20.7	0.22	1.20	na	<5	0.42	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Ce	Co	Cr	Cs	Cu	Eu	Fe	Hf	Ir	K	La	Lu	Mg	Mn	Mo	Na	Ni
	INAA	INAA	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	INAA	INAA	AAS	XRF	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	ppm	%	ppm	ppm	%	ppm
09-4561	29	48	1870	<1.0	na	1.26	19	3	<20	0.42	22.1	0.27	0.67	na	<5	0.36	na
09-4562	37	36	1470	1.2	na	0.96	14	3	<20	0.58	21.1	0.26	1.24	na	<5	0.32	na
09-4563	35	37	995	2.4	na	0.87	9	2	<20	0.75	18.7	0.23	1.09	na	<5	0.53	na
09-4564	31	36	1210	1.7	na	0.91	11	3	<20	0.33	18	0.26	1.10	na	<5	0.49	na
09-4565	38	42	1540	1.8	na	1.04	15	3	<20	0.48	22.9	0.27	0.87	na	<5	0.41	na
09-4566	31	42	1270	1.5	na	1.03	12	3	<20	0.49	20	0.26	0.93	na	<5	0.64	na
09-4567	34	42	1180	2.6	na	0.94	11	3	<20	0.47	20.2	0.27	0.83	na	<5	0.57	na
09-4568	34	46	1670	<1.0	na	1.16	16	3	<20	0.46	21.2	0.3	0.70	na	<5	0.43	na
09-4569	31	50	1730	<1.0	na	1.11	17	3	<20	0.68	20.5	0.28	0.64	na	<5	0.45	na
09-4570	24	40	1760	1.5	na	0.61	16	3	<20	0.47	16.2	0.28	0.66	na	<5	0.57	na
09-4571	30	51	2160	1.2	na	0.9	20	3	<20	<0.2	23.4	0.28	0.97	na	<5	0.35	na
09-4572	36	44	1390	1.4	na	0.7	13	3	<20	0.76	21.8	0.29	1.06	na	<5	0.57	na
09-4573	33	48	1060	2.3	na	0.91	9	3	<20	0.55	19	0.26	1.23	na	<5	0.69	na
09-4574	35	43	1170	<1.0	na	1.28	10	3	<20	0.89	19.5	0.24	1.08	na	<5	0.36	na
09-4575	34	43	1280	1.7	na	1.02	11	3	<20	0.57	19.5	0.26	1.41	na	<5	0.52	na
09-4576	33	41	1050	2.3	na	0.87	10	2	<20	0.26	22.3	0.25	2.15	na	<5	0.52	na
09-4577	35	41	1290	1.9	na	1	12	3	<20	0.62	20.7	0.31	1.01	na	<5	0.50	na
09-4578	35	49	1080	1.4	na	0.8	10	3	<20	0.8	19.1	0.23	0.97	na	<5	0.50	na
09-4579	35	43	1010	2.2	na	0.9	9	2	<20	0.46	18.5	0.24	1.00	na	<5	0.42	na
09-4580	22	14	388	<1.0	na	0.62	2	1	<20	0.25	13.1	<0.2	1.36	na	<5	0.16	na
09-4581	19	36	877	<1.0	na	0.6	4	2	<20	0.61	10.7	<0.2	3.03	na	<5	0.70	na
09-4582	32	37	830	2.4	na	0.68	6	2	<20	0.58	15.8	0.2	2.14	na	<5	0.41	na
09-4583	30	38	858	1.7	na	0.75	6	2	<20	0.67	15.4	0.2	2.28	na	<5	0.32	na
09-4584	21	32	815	<1.0	na	<0.5	4	2	<20	0.37	10.4	<0.2	4.90	na	<5	0.35	na
09-4585	25	54	919	1.5	na	0.71	5	2	<20	0.51	13.1	<0.2	3.59	na	<5	0.41	na
09-4586	31	58	899	1.9	na	0.67	6	2	<20	0.39	14.7	0.21	2.90	na	<5	0.50	na
09-4587	29	60	934	1.4	na	0.67	6	2	<20	0.2	14.3	<0.2	2.88	na	<5	0.46	na
09-4588	12	112	3750	1.9	na	<0.5	14	2	<20	<0.2	6.55	<0.2	1.77	na	<5	0.44	na
09-4589	17	44	834	<1.0	na	0.66	4	1	<20	0.28	8.23	<0.2	5.08	na	<5	0.20	na
09-4590	29	33	826	<1.0	na	0.61	5	2	<20	0.41	13.2	<0.2	3.27	na	<5	0.41	na
09-4591	25	28	618	1.9	na	0.63	4	2	<20	0.52	13.2	<0.2	4.06	na	<5	0.32	na
09-4592	27	45	729	1.5	na	0.64	4	2	<20	0.62	13.7	<0.2	3.25	na	<5	0.46	na
09-4593	13	14	327	<1.0	na	<0.5	2	1	<20	0.21	7.07	<0.2	5.70	na	<5	0.19	na
09-4594	12	11	228	<1.0	na	<0.5	1	1	<20	<0.2	5.88	<0.2	4.33	na	<5	0.11	na
09-4595	33	35	876	1.2	na	0.8	7	2	<20	0.5	17.4	0.2	1.11	na	<5	0.48	na
09-4596	38	45	1390	2.2	na	0.88	13	2	<20	0.49	21.5	0.23	0.72	na	<5	0.29	na
09-4597	36	46	1270	<1.0	na	0.83	12	3	<20	0.54	21	0.24	0.86	na	<5	0.36	na
09-4598	33	39	1400	1.1	na	0.84	13	2	<20	0.34	21	0.25	1.00	na	<5	0.61	na
09-4599	34	44	2400	3.0	na	0.7	13	4	<20	0.92	18.1	0.24	0.96	na	<5	0.59	na
09-4600	23	38	3970	<1.0	na	0.82	28	3	<20	0.57	15.2	<0.2	0.61	na	<5	0.39	na
09-4601	37	50	2560	3.3	na	0.79	14	4	<20	1.02	19.9	0.23	0.59	na	<5	0.83	na
09-4602	48	56	2030	2.1	na	<0.5	9	4	<20	0.69	20.6	0.3	0.33	na	<5	1.02	na
09-4603	8	19	2200	3.0	na	<0.5	10	4	<20	0.86	6.03	<0.2	0.23	na	<5	1.10	na
09-4604	8	17	2150	2.4	na	<0.5	9	5	<20	0.71	5.67	<0.2	0.24	na	<5	1.12	na
09-4605	7	18	2050	2.5	na	<0.5	9	4	<20	0.68	5.16	<0.2	0.23	na	<5	1.17	na
09-4606	9	18	2150	1.6	na	<0.5	9	4	<20	0.89	4.99	<0.2	0.22	na	<5	1.17	na
09-4607	7	18	2140	2.5	na	<0.5	9	5	<20	0.77	5.09	<0.2	0.22	na	<5	1.16	na
09-4608	8	18	2090	<1.0	na	<0.5	8	5	<20	0.64	5.1	<0.2	0.22	na	<5	1.19	na
09-4609	6	19	2210	1.5	na	<0.5	9	5	<20	0.69	4.81	<0.2	0.21	na	<5	1.19	na
09-4610	59	32	3370	<1.0	na	1.2	20	3	<20	0.44	30.3	0.22	0.18	na	<5	0.17	na
09-4611	64	34	3400	1.2	na	1.13	20	4	<20	0.59	33	0.26	0.26	na	<5	0.20	na
09-4612	63	35	3090	1.7	na	1.1	18	3	<20	0.53	31.4	0.25	0.33	na	<5	0.21	na
09-4613	30	57	1000	1.8	na	0.87	8	3	<20	0.51	15.3	0.28	0.92	na	<5	0.72	na
09-4614	32	57	979	1.7	na	1.03	8	3	<20	0.63	15.5	0.29	1.15	na	<5	0.78	na
09-4615	30	54	952	2.6	na	0.94	7	3	<20	0.51	15.1	0.23	1.32	na	<5	0.91	na
09-4616	30	54	909	1.3	na	0.65	7	3	<20	0.38	15.2	0.28	1.39	na	<5	0.96	na
09-4617	28	52	868	<1.0	na	0.78	7	2	<20	0.41	14.7	0.23	1.36	na	<5	1.00	na
09-4618	30	51	892	1.3	na	0.85	7	3	<20	0.52	15.3	0.28	1.36	na	<5	1.06	na
09-4619	28	54	976	1.4	na	0.75	8	2	<20	0.31	15.1	0.27	1.25	na	<5	1.03	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Ce	Co	Cr	Cs	Cu	Eu	Fe	Hf	Ir	K	La	Lu	Mg	Mn	Mo	Na	Ni
	INAA	INAA	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	INAA	INAA	AAS	XRF	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	ppm	%	ppm	ppm	%	ppm
09-4620	24	54	1100	<1.0	na	1	9	2	<20	0.26	14.4	0.29	1.18	na	<5	1.02	na
09-4621	30	61	1550	1.4	na	1.18	13	2	<20	0.2	18.5	0.34	1.02	na	<5	0.97	na
09-4622	27	59	1730	<1.0	na	0.95	13	2	<20	0.28	18.4	0.29	0.99	na	<5	0.91	na
09-4623	25	57	1220	<1.0	na	0.82	10	2	<20	0.27	15.5	0.28	1.14	na	<5	1.04	na
09-4624	23	49	891	1.8	na	0.86	7	3	<20	0.22	12.5	0.25	1.30	na	<5	1.03	na
09-4625	19	46	771	1.9	na	0.65	6	3	<20	0.4	10.6	0.23	1.09	na	<5	0.92	na
09-4626	21	48	879	<1.0	na	0.72	7	2	<20	0.3	11	0.21	1.11	na	<5	0.97	na
09-4627	21	52	1380	<1.0	na	<0.5	11	2	<20	0.32	13.7	0.27	0.97	na	<5	0.94	na
09-4628	20	62	1740	2.0	na	0.9	16	2	<20	<0.2	16.7	0.28	0.99	na	<5	0.82	na
09-4687	69	36	2000	<1.0	na	1.1	11	3	<20	0.43	32.1	0.21	0.59	na	<5	0.49	na
09-4688	63	33	1910	<1.0	na	1.19	11	4	<20	0.48	34.4	0.23	0.49	na	<5	0.62	na
09-4689	99	52	1980	2.1	na	1.8	11	4	<20	0.65	47	0.32	0.33	na	<5	0.63	na
09-4690	42	26	2070	2.4	na	0.74	11	3	<20	0.73	11	<0.2	0.23	na	<20	0.59	na
09-4691	15	18	2030	1.9	na	<0.5	10	4	<20	0.53	8.42	<0.2	0.18	na	<10	0.60	na
09-4692	9	19	1960	2.5	na	<0.5	10	4	<20	0.73	6.25	<0.2	0.17	na	<5	0.61	na
09-4693	8	19	1970	<1.0	na	<0.5	10	4	<20	0.51	6.06	<0.2	0.17	na	<5	0.63	na
09-4694	8	18	1980	2.3	na	<0.5	9	4	<20	0.58	5.44	<0.2	0.17	na	<5	0.65	na
09-4695	8	18	2050	1.7	na	<0.5	9	4	<20	0.76	5.36	<0.2	0.17	na	<5	0.65	na
09-4696	77	50	2390	2.1	na	1.33	15	3	<20	0.57	30.2	0.28	0.69	na	<5	0.23	na
09-4697	98	58	1760	<1.0	na	1.49	11	3	<20	0.58	30.7	0.33	1.03	na	<5	0.40	na
09-4698	116	88	1880	2.8	na	1.89	11	3	<20	0.53	38.5	0.35	0.65	na	<5	0.47	na
09-4699	85	64	2110	1.2	na	1.33	12	4	<20	0.88	27.1	0.3	0.40	na	<10	0.53	na
09-4700	52	38	1720	2.4	na	0.77	10	4	<20	0.74	16.2	0.22	0.26	na	<10	0.61	na
09-4701	16	23	1700	<1.0	na	<0.5	9	3	<20	0.71	8.39	<0.2	0.20	na	<5	0.64	na
09-4702	12	21	1670	1.6	na	<0.5	9	4	<20	0.8	7.73	<0.2	0.20	na	<5	0.72	na
09-4703	11	20	1550	2.7	na	<0.5	8	4	<20	0.59	7.31	<0.2	0.21	na	<5	0.76	na
09-4704	12	20	1530	2.2	na	<0.5	8	4	<20	0.64	7.25	<0.2	0.20	na	<5	0.76	na
09-4705	13	21	1610	2.8	na	<0.5	9	4	<20	0.72	7.12	<0.2	0.21	na	<5	0.80	na
09-4706	13	19	1520	1.9	na	<0.5	8	4	<20	0.85	7.03	<0.2	0.22	na	<5	0.82	na
09-4707	12	20	1580	1.6	na	<0.5	9	3	<20	0.93	7.44	<0.2	0.22	na	<5	0.84	na
09-4708	36	26	1560	2.4	na	0.67	11	4	<20	0.95	17.8	0.25	0.68	na	<5	0.40	na
09-4709	37	26	1200	1.6	na	0.76	8	4	<20	0.86	17.1	0.22	0.59	na	<5	0.65	na
09-4710	37	25	1160	2.9	na	0.7	8	4	<20	1.03	17	<0.2	0.59	na	<5	0.93	na
09-4711	35	25	1360	2.1	na	0.63	9	4	<20	0.83	16.2	<0.2	0.52	na	<5	0.99	na
09-4712	34	26	1490	2.0	na	0.64	10	4	<20	0.76	16.2	<0.2	0.44	na	<5	1.07	na
09-4713	30	25	1360	2.8	na	0.52	9	4	<20	0.9	18	<0.2	0.39	na	<5	1.16	na
09-4714	26	29	1290	2.7	na	0.81	8	4	<20	1	26.1	<0.2	0.39	na	<5	1.19	na
09-4715	71	70	1230	2.1	na	1.14	7	4	<20	0.67	20.8	0.22	0.35	na	<5	1.22	na
09-4716	36	22	1350	4.0	na	0.69	8	4	<20	0.95	10.7	0.2	0.30	na	<10	1.17	na
09-4717	12	19	1280	<1.0	na	<0.5	8	4	<20	0.72	8.1	<0.2	0.29	na	<5	1.19	na
09-4718	13	16	1230	1.7	na	<0.5	7	4	<20	0.73	6.97	<0.2	0.26	na	<5	1.17	na
09-4719	56	32	930	2.3	na	1.18	8	4	<20	1.19	27.2	0.28	0.36	na	<5	0.24	na
09-4720	46	30	820	2.0	na	1.11	7	2	<20	0.83	29.7	0.28	0.47	na	<5	0.17	na
09-4721	46	27	583	<1.0	na	1.19	5	2	<20	0.59	32.6	0.28	0.65	na	<5	0.19	na
09-4722	47	26	590	1.7	na	1.04	5	2	<20	0.84	30.9	0.28	0.69	na	<5	0.24	na
09-4723	44	21	491	<1.0	na	1.34	4	2	<20	0.65	31.1	0.28	0.82	na	<5	0.22	na
09-4724	34	16	445	1.6	na	1.17	3	1	<20	0.66	26.3	0.24	0.96	na	<5	0.23	na
09-4725	36	17	425	<1.0	na	0.93	3	2	<20	0.35	23.4	<0.2	2.05	na	<5	0.26	na
09-4726	28	15	377	1.1	na	0.82	3	1	<20	0.41	19.7	<0.2	3.19	na	<5	0.26	na
09-4727	33	17	394	<1.0	na	0.93	3	1	<20	0.43	22.5	<0.2	5.06	na	<5	0.32	na
09-4728	37	20	464	1.4	na	0.99	4	2	<20	0.52	22.3	<0.2	6.17	na	<10	0.39	na
09-4729	40	21	456	1.3	na	1.08	4	2	<20	0.58	23.2	0.2	5.86	na	<10	0.45	na
09-4730	40	21	487	1.6	na	1.29	4	2	<20	0.64	23.8	0.24	6.16	na	<15	0.44	na
09-4731	42	22	472	1.5	na	1.14	4	2	<20	0.6	24.4	0.23	5.84	na	<10	0.46	na
09-4732	49	33	1790	1.4	na	0.78	15	3	<20	0.87	23.2	0.3	0.98	na	<5	0.28	na
09-4733	42	30	1680	1.6	na	0.72	13	3	<20	0.87	21.1	0.26	1.08	na	<5	0.26	na
09-4734	46	31	1240	1.2	na	0.69	11	3	<20	0.76	20.2	0.28	2.06	na	<5	0.40	na
09-4735	48	33	1480	1.3	na	0.91	12	3	<20	0.82	21.2	0.28	2.60	na	<10	0.48	na
09-4736	45	32	1310	1.3	na	0.78	11	3	<20	0.82	20.9	0.44	2.59	na	<10	0.59	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Ce	Co	Cr	Cs	Cu	Eu	Fe	Hf	Ir	K	La	Lu	Mg	Mn	Mo	Na	Ni
	INAA	INAA	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	INAA	INAA	AAS	XRF	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm	ppm	%	ppm	ppm	%	ppm
09-4737	46	39	1200	3.3	na	0.66	11	3	<20	0.92	20.9	0.32	2.36	na	<15	0.65	na
09-4738	51	39	1100	2.3	na	0.92	9	4	<20	0.92	25.9	0.3	1.42	na	<10	0.80	na
09-4739	55	58	1220	1.8	na	1.19	10	4	<20	0.64	29.4	0.36	0.73	na	<10	0.87	na
09-4740	65	56	1210	2.6	na	1.4	10	4	<20	0.72	32	0.39	0.47	na	<10	0.90	na
09-4741	57	43	1160	3.4	na	0.81	9	4	<20	1.13	17.2	0.29	0.38	na	<20	0.94	na
09-4742	13	20	1350	2.1	na	0.6	12	4	<20	0.89	8.71	<0.2	0.30	na	<15	0.86	na
09-4743	37	40	1410	2.9	na	0.79	12	3	<20	0.64	21.5	0.3	0.80	na	<5	0.39	na
09-4744	34	37	1130	1.0	na	0.79	9	3	<20	0.77	18.6	0.28	0.97	na	<5	0.39	na
09-4745	32	36	1210	1.2	na	0.81	9	2	<20	0.49	17	0.25	1.59	na	<5	0.40	na
09-4746	35	37	1020	1.6	na	0.93	9	3	<20	0.53	18	0.25	2.67	na	<5	0.48	na
09-4747	31	50	1650	1.9	na	0.92	14	2	<20	<0.2	22.4	0.32	2.48	na	<10	0.59	na
09-4748	90	101	1460	<1.0	na	1.72	12	3	<20	<0.2	29.5	0.49	0.82	na	<10	0.77	na
09-4749	13	25	1760	1.7	na	0.58	13	3	<20	0.56	10.3	<0.2	0.46	na	<10	0.76	na
09-4750	10	23	2810	<1.0	na	<0.5	20	3	<20	0.28	7.19	<0.2	0.28	na	<10	0.62	na
09-4751	6	20	2810	2.0	na	<0.5	22	4	<20	0.47	5.94	<0.2	0.18	na	<15	0.57	na
09-4752	6	19	2230	3.7	na	<0.5	17	4	<20	0.41	5.5	<0.2	0.18	na	<5	0.66	na
09-4753	6	19	2410	1.3	na	<0.5	17	4	<20	<0.2	5.27	<0.2	0.19	na	<5	0.66	na
09-4754	42	35	2970	<1.0	na	0.81	16	3	<20	0.61	24.6	0.24	1.61	na	<5	0.27	na
09-4755	34	28	2190	2.2	na	0.83	13	3	<20	0.51	19.8	0.24	2.28	na	<5	0.41	na
09-4756	39	28	1700	1.4	na	0.66	10	3	<20	0.68	21.4	0.23	3.27	na	<5	0.59	na
09-4757	43	30	1660	<1.0	na	1.14	10	3	<20	0.48	23	0.3	4.44	na	<5	0.60	na
09-4758	68	52	1990	2.3	na	1.61	12	4	<20	1.13	46.4	0.46	3.01	na	<10	0.67	na
09-4759	136	115	2240	2.5	na	1.62	13	4	<20	0.82	29.8	0.42	0.57	na	<15	0.76	na
09-4760	17	21	1940	1.8	na	<0.5	11	3	<20	0.74	12.7	0.21	0.27	na	<15	0.78	na
09-4761	20	25	2040	2.0	na	<0.5	12	4	<20	0.72	12.4	0.21	0.26	na	<15	0.81	na
09-4762	12	18	2410	2.2	na	<0.5	14	4	<20	0.95	10.6	<0.2	0.23	na	<10	0.80	na
09-4763	11	18	2250	1.6	na	<0.5	13	4	<20	0.97	9.37	<0.2	0.24	na	<5	0.84	na
09-4764	10	17	2320	2.5	na	<0.5	13	5	<20	1.18	8.81	<0.2	0.23	na	<5	0.83	na
09-4765	44	40	3800	2.1	na	0.71	21	4	<20	0.86	26.1	0.28	1.42	na	<5	0.30	na
09-4766	39	33	2720	<1.0	na	0.77	15	3	<20	0.63	22.6	0.3	2.25	na	<5	0.42	na
09-4767	39	31	1950	2.3	na	0.93	11	3	<20	0.57	20.9	0.27	3.00	na	<10	0.53	na
09-4768	37	27	1460	<1.0	na	0.8	8	3	<20	0.99	20	0.25	4.99	na	<10	0.53	na
09-4769	36	26	1430	1.5	na	0.9	8	2	<20	0.78	20.1	0.21	5.92	na	<10	0.50	na
09-4770	42	30	1710	1.8	na	0.75	10	3	<20	0.9	23.3	0.27	5.42	na	<15	0.51	na
09-4771	47	34	2450	<1.0	na	1.2	14	3	<20	0.71	27.9	0.3	4.70	na	<10	0.51	na
09-4772	59	45	2400	2.2	na	2	13	3	<20	1	59.1	0.48	2.96	na	<5	0.62	na
09-4773	309	316	2800	2.3	na	2.93	16	4	<20	0.52	51.3	0.74	0.71	na	<40	0.67	na
09-4774	39	33	2530	1.4	na	0.56	14	4	<20	1.17	16.2	0.25	0.27	na	<20	0.71	na
09-4775	8	21	2530	1.5	na	<0.5	14	4	<20	1.43	11	<0.2	0.19	na	<5	0.74	na
09-4776	11	18	2380	1.6	na	<0.5	13	3	<20	1.28	10.1	<0.2	0.22	na	<5	0.74	na
09-4777	36	35	2820	2.9	na	0.63	17	4	<20	0.59	21.2	0.26	0.96	na	<5	0.32	na
09-4778	34	29	1650	3.2	na	0.7	11	3	<20	0.95	19.2	0.23	1.32	na	<5	0.43	na
09-4779	39	28	1420	<1.0	na	0.77	9	4	<20	1.04	19.6	0.25	1.61	na	<5	0.56	na
09-4780	37	30	1500	2.7	na	0.91	10	4	<20	0.97	19.8	0.24	1.57	na	<10	0.64	na
09-4781	38	34	1680	2.5	na	0.83	11	4	<20	1.1	21.3	0.3	1.25	na	<5	0.70	na
09-4782	46	36	1610	3.9	na	0.84	10	4	<20	0.81	21.8	0.3	1.00	na	<10	0.76	na
09-4783	46	35	1730	3.0	na	0.82	11	4	<20	1.35	28.5	0.33	0.81	na	<5	0.79	na
09-4784	64	51	1530	3.8	na	0.99	10	4	<20	0.57	22.6	0.38	0.59	na	<10	0.80	na
09-4785	22	25	1470	2.4	na	0.72	9	4	<20	1.17	13.1	0.21	0.46	na	<15	0.82	na
09-4786	20	24	1540	2.1	na	0.52	10	4	<20	1.49	12.6	<0.2	0.41	na	<30	0.82	na
09-4787	18	20	1570	1.3	na	<0.5	10	5	<20	0.72	10.3	<0.2	0.33	na	<40	0.81	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Th	TiO2	U	W	Yb	Zn	Zn	Zr
	XRF	INAA	INAA	INAA	INAA	INAA	XRF	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
09-4502	na	35	2.2	22	<5	3.0	na	1.7	12	na	6	<2	1.6	155	na	na
09-4503	na	46	1.7	24	<5	1.6	na	2.4	12	na	3	2	1.2	175	na	na
09-4504	na	31	2.4	19	<5	2.7	na	1.3	12	na	3	3	1.4	152	na	na
09-4505	na	39	2.9	18	<5	2.7	na	<1.0	12	na	3	<2	1.4	154	na	na
09-4506	14	26	2.3	20	<5	3.0	104	<1.0	11	0.66	<2	<2	1.5	136	70	145
09-4507	13	30	2.0	22	<5	2.6	72	<1.0	12	0.72	4	<2	1.4	171	71	161
09-4508	16	40	4.2	20	<5	2.3	73	<1.0	12	0.32	3	4	1.2	164	59	131
09-4509	22	52	6.6	21	<5	3.3	41	<1.0	13	0.63	<2	13	1.6	166	81	121
09-4510	24	54	6.2	20	<5	2.9	42	1.2	13	0.46	<2	6	1.4	167	65	120
09-4511	19	21	3.9	22	<5	3.4	49	<1.0	12	0.63	<2	2	1.4	186	82	135
09-4512	21	<20	5.0	20	<5	4.2	102	<1.0	12	0.52	<2	4	1.7	207	93	110
09-4513	36	44	7.0	22	<5	6.2	120	<1.0	12	0.55	<2	3	2.1	185	118	112
09-4514	29	49	6.4	23	<5	5.1	102	<1.0	11	0.58	3	<2	1.8	234	127	122
09-4515	28	<20	5.5	24	<5	4.5	147	<1.0	12	0.58	<2	<2	1.4	195	121	126
09-4516	45	38	13.4	27	<5	6.4	76	<1.0	14	0.60	3	7	2.0	209	129	118
09-4517	25	25	8.2	21	<5	4.0	87	1.6	12	0.54	<2	4	1.5	189	123	114
09-4518	25	29	7.2	19	<5	3.8	69	1.5	11	0.57	<2	4	1.4	174	98	126
09-4519	37	24	14.1	30	<5	5.8	74	<1.0	14	0.60	3	8	2.3	186	93	128
09-4520	31	32	12.2	29	<5	3.7	68	<1.0	13	0.61	2	7	1.7	198	102	129
09-4521	32	49	8.9	27	<5	3.5	58	<1.0	13	0.52	2	4	1.8	215	89	141
09-4522	24	29	11.2	29	<5	2.4	65	<1.0	14	0.68	<2	6	1.4	176	64	139
09-4523	34	<20	15.4	30	<5	3.7	59	<1.0	14	0.70	<2	5	1.8	169	73	137
09-4524	40	<20	16.1	35	<5	3.7	55	<1.0	15	0.69	<2	8	1.9	188	76	126
09-4525	28	30	13.6	35	<5	2.9	76	1.6	14	0.54	4	4	1.4	175	62	125
09-4526	18	24	7.5	32	<5	1.8	120	3.0	13	0.67	<2	3	1.2	175	63	152
09-4527	30	20	13.7	37	<5	1.9	98	<1.0	15	0.62	<2	<2	1.2	175	65	128
09-4528	13	38	3.5	18	<5	2.4	145	<1.0	12	0.59	4	2	1.2	146	65	130
09-4529	14	20	2.7	18	<5	2.8	147	<1.0	12	0.58	6	<2	1.3	156	68	128
09-4530	17	28	3.4	16	<5	3.1	182	<1.0	11	0.54	5	3	1.4	142	75	124
09-4531	14	26	3.0	10	<5	4.0	431	<1.0	7	0.36	<2	<2	1.5	114	52	78
09-4532	18	34	4.7	13	<5	4.4	268	<1.0	9	0.44	<2	2	1.9	122	66	94
09-4533	7	26	2.2	10	<5	4.6	294	<1.0	7	0.37	<2	<2	1.8	123	61	75
09-4534	14	25	2.4	12	<5	5.0	209	<1.0	9	0.44	<2	<2	1.9	139	78	91
09-4535	14	25	2.6	10	<5	5.4	248	<1.0	7	0.37	<2	<2	1.9	124	60	76
09-4536	15	20	1.2	11	<5	5.2	245	<1.0	8	0.39	<2	<2	1.7	118	61	78
09-4537	na	<20	1.2	28	<5	3.7	na	<1.0	6	na	<2	<2	2.1	218	na	na
09-4538	na	20	1.5	30	<5	3.7	na	<1.0	5	na	<2	<2	2.2	220	na	na
09-4539	na	29	1.1	30	<5	3.8	na	<1.0	6	na	<2	<2	2.1	237	na	na
09-4540	na	<20	2.4	29	<5	3.7	na	<1.0	5	na	<2	3	2.3	222	na	na
09-4541	na	22	2.8	34	<5	1.7	na	1.5	8	na	<2	3	1.4	179	na	na
09-4542	na	44	1.5	31	<5	4.1	na	<1.0	6	na	<2	<2	2.3	220	na	na
09-4543	na	33	1.8	30	<5	4.0	na	1.1	6	na	<2	<2	2.3	232	na	na
09-4544	na	28	1.4	28	<5	3.9	na	1.4	6	na	<2	<2	2.3	214	na	na
09-4545	na	36	2.8	37	<5	4.4	na	<1.0	6	na	<2	<2	2.5	224	na	na
09-4546	na	34	1.3	29	<5	4.0	na	<1.0	6	na	<2	<2	2.3	199	na	na
09-4547	na	50	1.3	29	<5	4.1	na	2.4	7	na	<2	<2	2.2	242	na	na
09-4548	na	46	1.6	31	<5	4.2	na	<1.0	7	na	<2	<2	2.3	251	na	na
09-4549	na	38	1.5	31	<5	4.2	na	1.3	7	na	<2	<2	2.3	230	na	na
09-4550	na	37	1.2	28	<5	3.6	na	2.2	7	na	<2	<2	2.1	202	na	na
09-4551	na	22	1.9	29	<5	3.5	na	<1.0	6	na	<2	<2	2.1	199	na	na
09-4552	na	<20	2.2	35	<5	1.7	na	<1.0	7	na	<2	9	1.3	185	na	na
09-4553	na	22	1.3	25	<5	3.3	na	1.5	7	na	<2	<2	1.8	184	na	na
09-4554	na	25	1.8	34	<5	3.2	na	<1.0	6	na	3	<2	1.8	217	na	na
09-4555	na	<20	1.2	27	<5	2.9	na	<1.0	8	na	<2	5	1.3	157	na	na
09-4556	na	<20	1.5	29	<5	3.8	na	<1.0	6	na	<2	<2	2.1	218	na	na
09-4557	na	29	1.5	32	<5	4.1	na	1.8	7	na	<2	<2	2.3	238	na	na
09-4558	na	35	1.1	27	<5	4.3	na	<1.0	9	na	<2	<2	1.9	204	na	na
09-4559	na	33	1.1	27	<5	4.2	na	<1.0	9	na	<2	<2	2.0	209	na	na
09-4560	na	28	1.1	24	<5	3.8	na	1.8	8	na	<2	<2	1.9	171	na	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Th	TiO2	U	W	Yb	Zn	Zn	Zr
	XRF	INAA	INAA	INAA	INAA	INAA	XRF	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
09-4561	na	39	2.2	40	<5	4.1	na	<1.0	9	na	<2	<2	2.3	224	na	na
09-4562	na	28	1.9	29	<5	3.8	na	<1.0	10	na	<2	<2	1.9	169	na	na
09-4563	na	31	1.2	27	<5	3.6	na	<1.0	9	na	<2	<2	1.8	157	na	na
09-4564	na	30	1.6	26	<5	3.6	na	1.5	8	na	<2	<2	1.9	191	na	na
09-4565	na	33	1.9	35	<5	4.2	na	<1.0	9	na	<2	<2	2.3	200	na	na
09-4566	na	29	1.5	31	<5	4.0	na	1.5	9	na	<2	<2	2.2	201	na	na
09-4567	na	23	1.4	32	<5	4.2	na	1.3	9	na	<2	<2	2.1	224	na	na
09-4568	na	29	2.1	33	<5	4.2	na	<1.0	8	na	2	<2	2.1	229	na	na
09-4569	na	47	2.1	39	<5	4.2	na	2.8	10	na	2	4	2.5	244	na	na
09-4570	na	<20	2.3	35	<5	3.3	na	<1	8	na	<2	<2	1.9	179	na	na
09-4571	na	<20	3.1	38	<5	4.2	na	1.2	8	na	<2	<2	2.3	213	na	na
09-4572	na	46	1.9	31	<5	4.3	na	<1	9	na	<2	<2	2.3	205	na	na
09-4573	na	35	1.3	30	<5	4.0	na	<1	8	na	<2	<2	2.3	214	na	na
09-4574	na	32	1.6	29	<5	4.0	na	<1	8	na	<2	<2	2.1	172	na	na
09-4575	na	37	1.6	30	<5	4.0	na	<1	8	na	<2	<2	2.0	217	na	na
09-4576	na	<20	1.3	24	<5	3.9	na	<1	6	na	<2	<2	2.1	150	na	na
09-4577	na	<20	1.7	27	<5	4.2	na	<1	8	na	<2	<2	2.3	176	na	na
09-4578	na	46	2.0	29	<5	3.9	na	1.3	8	na	<2	<2	2.0	235	na	na
09-4579	na	30	1.3	24	<5	3.6	na	1.5	8	na	<2	<2	1.9	189	na	na
09-4580	na	<20	0.4	6	<5	2.4	na	<1	3	na	<2	4	1.2	<100	na	na
09-4581	na	<20	1.1	15	<5	2.1	na	<1	4	na	3	4	1.2	168	na	na
09-4582	na	<20	1.4	15	<5	2.9	na	<1	7	na	<2	<2	1.4	167	na	na
09-4583	na	40	1.2	15	<5	2.9	na	<1	7	na	<2	<2	1.5	155	na	na
09-4584	na	24	0.9	11	<5	2.1	na	<1	5	na	<2	<2	1.1	135	na	na
09-4585	na	23	1.0	16	<5	2.5	na	<1	6	na	3	<2	1.3	197	na	na
09-4586	na	24	1.2	16	<5	2.9	na	<1	6	na	<2	<2	1.7	222	na	na
09-4587	na	23	1.7	16	<5	2.8	na	1.5	6	na	<2	<2	1.6	212	na	na
09-4588	na	26	3.4	43	<5	1.7	na	<1	3	na	2	<2	1.0	388	na	na
09-4589	na	<20	0.8	12	<5	1.9	na	<1	3	na	2	<2	1.2	120	na	na
09-4590	na	<20	1.1	12	<5	2.4	na	<1	6	na	<2	<2	1.3	129	na	na
09-4591	na	21	0.8	10	<5	2.4	na	<1	5	na	<2	<2	1.1	125	na	na
09-4592	na	28	1.1	13	<5	2.6	na	1.1	6	na	2	<2	1.3	177	na	na
09-4593	na	<20	0.5	5	<5	1.4	na	<1	3	na	<2	4	0.7	<100	na	na
09-4594	na	<20	0.3	3	<5	1.2	na	<1	2	na	<2	4	0.7	100	na	na
09-4595	na	33	1.2	18	<5	3.1	na	<1	7	na	<2	<2	1.6	142	na	na
09-4596	na	41	2.2	29	<5	4.1	na	1.5	9	na	<2	<2	2.0	219	na	na
09-4597	na	24	1.8	28	<5	4.0	na	<1	9	na	<2	<2	2.2	220	na	na
09-4598	na	25	1.7	26	<5	3.8	na	1.4	7	na	<2	<2	2.1	184	na	na
09-4599	na	28	7.0	28	<5	3.4	na	<1.0	12	na	<2	5	1.7	190	na	na
09-4600	na	24	14.6	26	<5	2.9	na	<1.0	13	na	<2	6	1.3	137	na	na
09-4601	na	<20	7.7	28	<5	3.6	na	1.5	13	na	<2	<2	1.6	152	na	na
09-4602	na	<20	4.7	27	<5	3.7	na	1.7	12	na	2	4	2.0	188	na	na
09-4603	na	29	5.3	29	<5	1.3	na	<1.0	13	na	2	<2	1.1	181	na	na
09-4604	na	<20	5.0	29	<5	1.2	na	2.8	13	na	<2	3	0.9	160	na	na
09-4605	na	40	4.2	29	<5	1.0	na	<1.0	13	na	3	5	1.0	185	na	na
09-4606	na	34	4.5	29	<5	0.9	na	<1.0	12	na	2	6	0.9	151	na	na
09-4607	na	32	4.2	30	<5	0.9	na	1.8	12	na	3	3	0.8	184	na	na
09-4608	na	<20	4.5	30	<5	1.0	na	1.4	12	na	<2	<2	0.9	174	na	na
09-4609	na	25	4.2	30	<5	0.9	na	3.0	13	na	<2	<2	1.2	162	na	na
09-4610	na	30	13.4	25	<5	5.1	na	<1.0	15	na	<2	5	1.6	179	na	na
09-4611	na	38	13.7	27	<5	5.5	na	<1.0	15	na	<2	3	1.6	211	na	na
09-4612	na	<20	12.4	26	<5	5.4	na	<1.0	13	na	<2	<2	1.7	197	na	na
09-4613	na	<20	1.2	27	<5	3.6	na	1.2	6	na	<2	<2	2.3	220	na	na
09-4614	na	31	1.1	28	<5	3.7	na	1.3	6	na	<2	<2	2.2	220	na	na
09-4615	na	40	1.0	28	<5	3.7	na	2.5	6	na	<2	<2	2.0	222	na	na
09-4616	na	41	1.2	27	<5	3.6	na	3.6	6	na	<2	<2	2.2	220	na	na
09-4617	na	<20	1.4	26	<5	3.6	na	<1	5	na	<2	<2	2.0	194	na	na
09-4618	na	32	1.2	26	<5	3.6	na	<1	5	na	<2	<2	2.0	197	na	na
09-4619	na	28	1.4	26	<5	3.5	na	<1	5	na	<2	<2	2.0	181	na	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Th	TiO2	U	W	Yb	Zn	Zn	Zr
	XRF	INAA	INAA	INAA	INAA	INAA	XRF	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
09-4620	na	<20	1.5	26	<5	3.4	na	2.2	5	na	<2	<2	1.9	195	na	na
09-4621	na	<20	2.7	30	<5	4.0	na	1.9	5	na	2	<2	2.3	210	na	na
09-4622	na	<20	2.5	31	<5	3.9	na	<1	5	na	<2	<2	2.3	203	na	na
09-4623	na	41	1.8	27	<5	3.5	na	<1	5	na	<2	<2	2.3	202	na	na
09-4624	na	<20	1.3	24	<5	3.1	na	1.3	5	na	<2	<2	1.9	185	na	na
09-4625	na	29	1.1	21	<5	2.6	na	1.7	4	na	<2	<2	1.8	168	na	na
09-4626	na	38	1.3	23	<5	2.7	na	2.2	4	na	<2	<2	1.8	191	na	na
09-4627	na	<20	1.7	26	<5	3.2	na	1.8	5	na	<2	<2	2.0	207	na	na
09-4628	na	<20	2.7	33	<5	3.7	na	<1.0	5	na	<2	<2	2.3	230	na	na
09-4687	na	30	6.6	23	<5	5.4	na	1.9	12	na	2	<2	1.5	203	na	na
09-4688	na	44	6.0	26	<5	5.3	na	<1.0	13	na	4	4	1.7	195	na	na
09-4689	na	36	6.0	27	<5	7.6	na	<1.0	14	na	5	<2	2.2	191	na	na
09-4690	na	41	6.0	27	<5	2.5	na	1.1	13	na	12	<2	1.2	158	na	na
09-4691	na	35	5.6	27	<5	1.9	na	<1.0	13	na	7	5	1.1	172	na	na
09-4692	na	52	5.1	26	<5	1.2	na	2.2	13	na	4	4	1.0	180	na	na
09-4693	na	24	5.0	26	<5	1.1	na	1.4	13	na	3	3	0.9	158	na	na
09-4694	na	43	4.7	26	<5	1.0	na	<1.0	12	na	<2	3	1.0	176	na	na
09-4695	na	<20	4.8	25	<5	1.0	na	<1.0	12	na	<2	<2	0.9	160	na	na
09-4696	na	30	8.4	22	<5	5.8	na	<1.0	12	na	2	<2	2.0	192	na	na
09-4697	na	32	5.7	20	<5	6.4	na	1.2	11	na	<2	<2	2.1	184	na	na
09-4698	na	33	5.5	25	<5	7.5	na	<1.0	12	na	4	<2	2.7	209	na	na
09-4699	na	25	6.4	27	<5	5.4	na	<1.0	13	na	6	<2	2.2	181	na	na
09-4700	na	26	4.8	27	<5	3.4	na	<1.0	14	na	8	<2	1.5	225	na	na
09-4701	na	30	3.8	27	<5	1.7	na	<1.0	13	na	3	<2	1.0	192	na	na
09-4702	na	31	4.2	28	<5	1.4	na	1.6	13	na	4	<2	1.1	174	na	na
09-4703	na	35	3.0	28	<5	1.3	na	1.3	13	na	4	<2	1.1	212	na	na
09-4704	na	49	2.9	28	<5	1.3	na	<1.0	13	na	2	<2	1.0	185	na	na
09-4705	na	24	3.0	29	<5	1.2	na	<1.0	13	na	2	<2	0.9	194	na	na
09-4706	na	34	2.7	29	<5	1.1	na	1.9	13	na	2	<2	0.9	211	na	na
09-4707	na	32	2.7	30	<5	1.2	na	1.4	13	na	<2	<2	0.9	209	na	na
09-4708	na	32	4.9	20	<5	3.0	na	1.1	13	na	<2	<2	1.5	170	na	na
09-4709	na	62	3.0	20	<5	2.9	na	1.2	12	na	3	<2	1.5	152	na	na
09-4710	na	42	3.1	20	<5	2.9	na	<1.0	11	na	<2	<2	1.3	160	na	na
09-4711	na	56	3.9	20	<5	2.8	na	<1.0	12	na	<2	<2	1.4	128	na	na
09-4712	na	43	4.0	22	<5	2.8	na	<1.0	13	na	<2	4	1.6	183	na	na
09-4713	na	61	3.1	23	<5	2.5	na	1.7	12	na	2	<2	1.4	148	na	na
09-4714	na	53	3.4	23	<5	3.3	na	2.6	13	na	5	<2	1.5	129	na	na
09-4715	na	47	2.5	23	<5	4.1	na	2.1	12	na	4	<2	1.7	157	na	na
09-4716	na	67	2.8	24	<5	2.5	na	1.5	12	na	6	<2	1.7	179	na	na
09-4717	na	47	2.7	24	<5	1.6	na	1.2	13	na	4	<2	1.1	173	na	na
09-4718	na	45	2.3	24	<5	1.2	na	1.9	11	na	3	<2	1.0	139	na	na
09-4719	na	32	3.2	17	<5	4.6	na	1.1	12	na	<2	<2	1.9	196	na	na
09-4720	na	25	3.1	13	<5	5.0	na	<1.0	9	na	<2	<2	1.9	113	na	na
09-4721	na	<20	1.8	11	<5	5.3	na	1.2	7	na	<2	<2	1.9	101	na	na
09-4722	na	24	1.8	11	<5	5.2	na	<1.0	8	na	<2	<2	2.0	106	na	na
09-4723	na	33	1.3	10	<5	5.3	na	1.7	7	na	<2	<2	2.2	103	na	na
09-4724	na	<20	1.0	9	<5	4.5	na	<1.0	6	na	<2	<2	1.7	100	na	na
09-4725	na	27	1.4	8	<5	4.0	na	<1.0	6	na	3	<2	1.5	100	na	na
09-4726	na	<20	1.0	7	<5	3.3	na	<1.0	5	na	3	<2	1.3	100	na	na
09-4727	na	<20	1.2	9	<5	3.9	na	<1.0	6	na	4	<2	1.4	106	na	na
09-4728	na	<20	1.3	11	<5	4.0	na	<1.0	7	na	6	<2	1.6	121	na	na
09-4729	na	31	1.2	12	<5	4.3	na	<1.0	7	na	6	<2	1.8	104	na	na
09-4730	na	<20	1.3	12	<5	4.2	na	<1.0	8	na	9	<2	1.7	112	na	na
09-4731	na	27	1.0	13	<5	4.5	na	1.7	8	na	7	<2	2.0	108	na	na
09-4732	na	24	1.8	30	<5	4.0	na	1.1	14	na	<2	<2	2.3	218	na	na
09-4733	na	<20	2.0	27	<5	3.7	na	<1.0	12	na	<2	<2	1.9	163	na	na
09-4734	na	43	1.5	27	<5	3.7	na	<1.0	11	na	2	<2	1.8	170	na	na
09-4735	na	34	1.7	31	<5	3.9	na	<1.0	13	na	7	<2	1.8	173	na	na
09-4736	na	42	1.5	31	<5	4.0	na	2.1	14	na	9	<2	3.4	189	na	na

Table A3.1: Tabulated geochemical data from the regolith (continued)

Sample	Pb	Rb	Sb	Sc	Se	Sm	Sr	Ta	Th	TiO2	U	W	Yb	Zn	Zn	Zr
	XRF	INAA	INAA	INAA	INAA	INAA	XRF	INAA	INAA	XRF	INAA	INAA	INAA	INAA	INAA	XRF
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
09-4737	na	29	1.3	33	<5	3.9	na	<1.0	14	na	11	<2	2.5	168	na	na
09-4738	na	50	1.4	35	<5	4.3	na	<1.0	14	na	7	<2	2.4	166	na	na
09-4739	na	38	1.6	41	<5	5.5	na	1.4	15	na	5	<2	2.8	211	na	na
09-4740	na	36	1.4	39	<5	5.8	na	<1.0	14	na	6	<2	2.6	202	na	na
09-4741	na	48	1.3	40	<5	3.9	na	1.9	14	na	16	<2	2.4	187	na	na
09-4742	na	46	1.9	40	<5	1.5	na	2.7	14	na	11	<2	1.6	195	na	na
09-4743	na	32	1.7	30	<5	4.0	na	<1.0	10	na	<2	<2	2.5	217	na	na
09-4744	na	26	1.8	26	<5	3.6	na	1.3	9	na	<2	<2	2.1	186	na	na
09-4745	na	23	1.4	28	<5	3.3	na	<1.0	7	na	2	<2	1.9	193	na	na
09-4746	na	27	1.3	25	<5	3.6	na	<1.0	7	na	3	<2	2.0	175	na	na
09-4747	na	27	1.8	31	<5	4.1	na	1.0	6	na	9	<2	2.4	186	na	na
09-4748	na	37	1.8	36	<5	7.1	na	<1.0	10	na	7	<2	4.0	168	na	na
09-4749	na	34	1.5	37	<5	2.0	na	<1.0	11	na	5	<2	1.3	167	na	na
09-4750	na	24	3.4	41	<5	1.6	na	<1.0	13	na	6	<2	1.1	177	na	na
09-4751	na	<20	3.6	38	<5	1.1	na	2.6	14	na	9	<2	1.3	151	na	na
09-4752	na	26	2.5	35	<5	0.9	na	1.9	12	na	5	<2	1.1	158	na	na
09-4753	na	<20	2.5	34	<5	0.9	na	1.9	12	na	<2	<2	1.0	159	na	na
09-4754	na	40	2.4	25	<5	4.0	na	2.3	12	na	<2	<2	2.0	196	na	na
09-4755	na	31	1.7	20	<5	3.4	na	<1.0	10	na	<2	<2	1.8	165	na	na
09-4756	na	35	1.4	20	<5	3.7	na	<1.0	10	na	4	<2	1.8	150	na	na
09-4757	na	42	1.4	21	<5	4.1	na	2.0	10	na	4	<2	2.1	148	na	na
09-4758	na	40	1.5	28	<5	7.1	na	1.9	13	na	6	<2	3.4	184	na	na
09-4759	na	37	1.5	36	<5	6.1	na	<1.0	14	na	10	<2	3.5	143	na	na
09-4760	na	35	1.4	30	<5	1.7	na	<1.0	13	na	11	<2	1.5	151	na	na
09-4761	na	22	1.5	28	<5	2.0	na	2.1	14	na	12	<2	1.6	137	na	na
09-4762	na	40	1.8	29	<5	1.4	na	<1.0	16	na	5	<2	1.0	135	na	na
09-4763	na	24	1.8	29	<5	1.4	na	2.1	15	na	<2	<2	0.9	144	na	na
09-4764	na	28	1.8	28	<5	1.2	na	2.0	14	na	3	<2	1.4	133	na	na
09-4765	na	<20	2.8	30	<5	4.2	na	1.4	13	na	<2	<2	2.0	200	na	na
09-4766	na	27	2.1	24	<5	4.0	na	1.5	11	na	<2	<2	2.2	148	na	na
09-4767	na	40	1.8	22	<5	3.7	na	<1.0	11	na	5	<2	1.9	151	na	na
09-4768	na	23	1.4	20	<5	3.6	na	<1.0	9	na	5	<2	1.9	138	na	na
09-4769	na	25	1.1	20	<5	3.6	na	1.1	8	na	8	<2	1.8	132	na	na
09-4770	na	21	1.3	23	<5	4.2	na	<1.0	9	na	9	<2	1.8	138	na	na
09-4771	na	38	1.9	27	<5	4.7	na	<1.0	10	na	6	<2	2.3	145	na	na
09-4772	na	43	1.8	31	<5	9.0	na	1.6	12	na	4	<2	3.7	151	na	na
09-4773	na	25	2.1	40	<5	11.5	na	1.9	14	na	26	<2	5.9	191	na	na
09-4774	na	48	1.8	39	<5	2.2	na	<1.0	14	na	14	<2	1.9	162	na	na
09-4775	na	<20	2.0	39	<5	1.2	na	1.1	14	na	5	<2	1.1	156	na	na
09-4776	na	29	1.9	37	<5	1.4	na	1.7	14	na	<2	<2	0.8	159	na	na
09-4777	na	41	2.5	25	<5	3.7	na	<1.0	13	na	<2	<2	1.9	168	na	na
09-4778	na	47	1.6	22	<5	3.5	na	<1.0	12	na	<2	<2	1.6	145	na	na
09-4779	na	54	1.7	22	<5	3.6	na	<1.0	12	na	2	<2	1.7	170	na	na
09-4780	na	32	1.3	23	<5	3.5	na	1.7	13	na	5	<2	1.8	172	na	na
09-4781	na	50	1.6	26	<5	3.7	na	1.2	14	na	5	<2	2.3	166	na	na
09-4782	na	37	1.6	27	<5	4.0	na	1.6	15	na	6	<2	2.4	163	na	na
09-4783	na	46	1.6	29	<5	4.7	na	1.4	17	na	4	<2	2.3	158	na	na
09-4784	na	36	1.6	29	<5	4.7	na	1.1	15	na	7	<2	2.7	168	na	na
09-4785	na	45	1.3	29	<5	2.2	na	1.4	14	na	11	<2	1.4	155	na	na
09-4786	na	41	1.3	30	<5	2.0	na	<1.0	15	na	17	<2	1.3	165	na	na
09-4787	na	53	1.6	31	<5	1.8	na	<1.0	15	na	24	<2	1.4	153	na	na

Table A3.2: Tabulated geochemical data from the regolith. na denotes sample not analysed for that element.

Sample	Easting	Northing	Site	av depth	Au	Au	Au	Au	Au	Ag	Co	Ni	Pd
				(m)	INAA	water	iodide	cyanide	MMI	MMI	MMI	MMI	MMI
					ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb
09-4396	378300	6485025	N.Graveyard	0.05	8	na	na	na	na	na	na	na	na
09-4397	378300	6485025	N.Graveyard	0.15	13	na	na	na	na	na	na	na	na
09-4398	378283	6485025	N.Graveyard	0.30	5	na	na	na	na	na	na	na	na
09-4429	378283	6485025	N.G/yard	0.80	4	na	na	na	na	na	na	na	na
09-4399	378283	6485025	N.Graveyard	1.70	20	na	na	na	na	na	na	na	na
09-4400	378283	6485025	N.Graveyard	2.00	1	na	na	na	na	na	na	na	na
09-4430	382380	6481730	N.Pluto	0.05	8	na	na	na	na	na	na	na	na
09-4431	382380	6481730	N.Pluto	0.15	15	na	na	na	na	na	na	na	na
09-4432	384005	6482630	Mercury	0.05	10	na	na	na	na	na	na	na	na
09-4433	384005	6482630	Mercury	0.15	13	na	na	na	na	na	na	na	na
09-4434	384700	6482400	Mercury	0.05	4	na	na	na	na	na	na	na	na
09-4435	384700	6482400	Mercury	0.15	1	na	na	na	na	na	na	na	na
09-4436	378361	6485827	Vine	0.05	115	na	na	na	na	na	na	na	na
09-4437	378361	6485827	Vine	0.15	370	na	na	na	na	na	na	na	na
09-4438	378361	6485827	Vine	0.40	310	na	na	na	na	na	na	na	na
09-4439	378361	6485827	Vine	0.90	85	na	na	na	na	na	na	na	na
09-4930	379500	6481880	SH16901	0.05	na	0.6	3.5	1.3	2.9	7	159	1090	0.69
09-4931	379580	6481880	SH16903	0.05	na	0.4	3.2	1.1	3.1	8	214	1095	0.57
09-4932	379620	6481880	SH16904	0.05	na	0.2	2.1	0.8	2.0	9	149	1225	0.38
09-4933	379660	6481880	SH16905	0.05	na	0.9	3.1	1.1	3.5	8	137	860	0.69
09-4934	379700	6481880	SH16906	0.05	na	0.3	1.6	0.6	1.8	6	294	3795	0.32
09-4935	379740	6481880	SH16907	0.05	na	0.1	2.1	1.3	2.4	7	71	1170	0.40
09-4936	379780	6481880	SH16908	0.05	na	0.8	3.9	1.1	4.2	12	153	935	0.44
09-4937	379820	6481880	SH16909	0.05	na	0.7	4.0	0.8	3.5	9	180	2490	0.39
09-4938	379860	6481880	SH16910	0.05	na	1.0	3.7	1.0	4.9	14	225	2925	0.48
09-4939	379900	6481880	SH16911	0.05	na	0.6	3.2	1.1	4.1	9	210	1765	0.45
09-4940	379940	6481880	SH16912	0.05	na	0.4	1.8	0.5	2.2	6	156	2435	0.29
09-4941	379980	6481880	SH16913	0.05	na	0.6	1.7	0.8	2.4	7	95	1670	0.40
09-4942	380020	6481880	SH16914	0.05	na	0.8	3.9	1.2	3.7	9	159	915	0.87
09-4943	380060	6481880	SH16915	0.05	na	0.7	3.7	2.0	4.1	12	143	1070	0.74
09-4944	380140	6481880	SH16917	0.05	na	1.5	3.6	0.9	4.8	14	239	1150	0.87
09-4945	380220	6481880	SH16919	0.05	na	0.6	3.2	1.2	2.9	10	179	1330	0.67
09-4946	380300	6481880	SH16921	0.05	na	0.6	1.4	0.5	1.8	11	208	1745	0.34
09-4947	380380	6481880	SH16923	0.05	na	0.5	2.6	0.9	3.2	14	231	3295	0.58
09-4948	380460	6481880	SH16925	0.05	na	0.9	2.6	0.9	3.5	17	185	1970	0.53
09-4949	380540	6481880	SH16927	0.05	na	0.1	1.8	1.1	1.6	11	89	2755	<0.25
09-4950	380620	6481880	SH16929	0.05	na	0.4	4.0	1.4	3.7	21	214	1790	0.46
09-4951	380660	6481880	SH16930	0.05	na	0.7	3.7	3.3	3.7	14	94	2180	0.44
09-4952	380700	6481880	SH16931	0.05	na	1.2	6.9	2.9	8.4	20	53	1055	0.61
09-4953	380740	6481880	SH16932	0.05	na	0.8	5.4	2.0	5.4	18	124	1520	0.49
09-4954	380780	6481880	SH16933	0.05	na	0.7	3.9	2.5	4.3	16	135	1480	0.51
09-4955	380820	6481880	SH16934	0.05	na	0.2	2.3	2.9	2.2	12	72	1585	0.39
09-4956	380860	6481880	SH16935	0.05	na	0.5	2.8	1.8	2.8	11	92	1390	0.41
09-4957	380900	6481880	SH16936	0.05	na	0.3	2.3	1.5	2.6	9	87	2690	0.52
09-4958	380940	6481880	SH16937	0.05	na	0.1	2.4	2.5	2.5	18	209	32	0.56
09-4959	380980	6481880	SH16939	0.05	na	0.7	3.0	2.5	3.8	26	74	1525	0.68

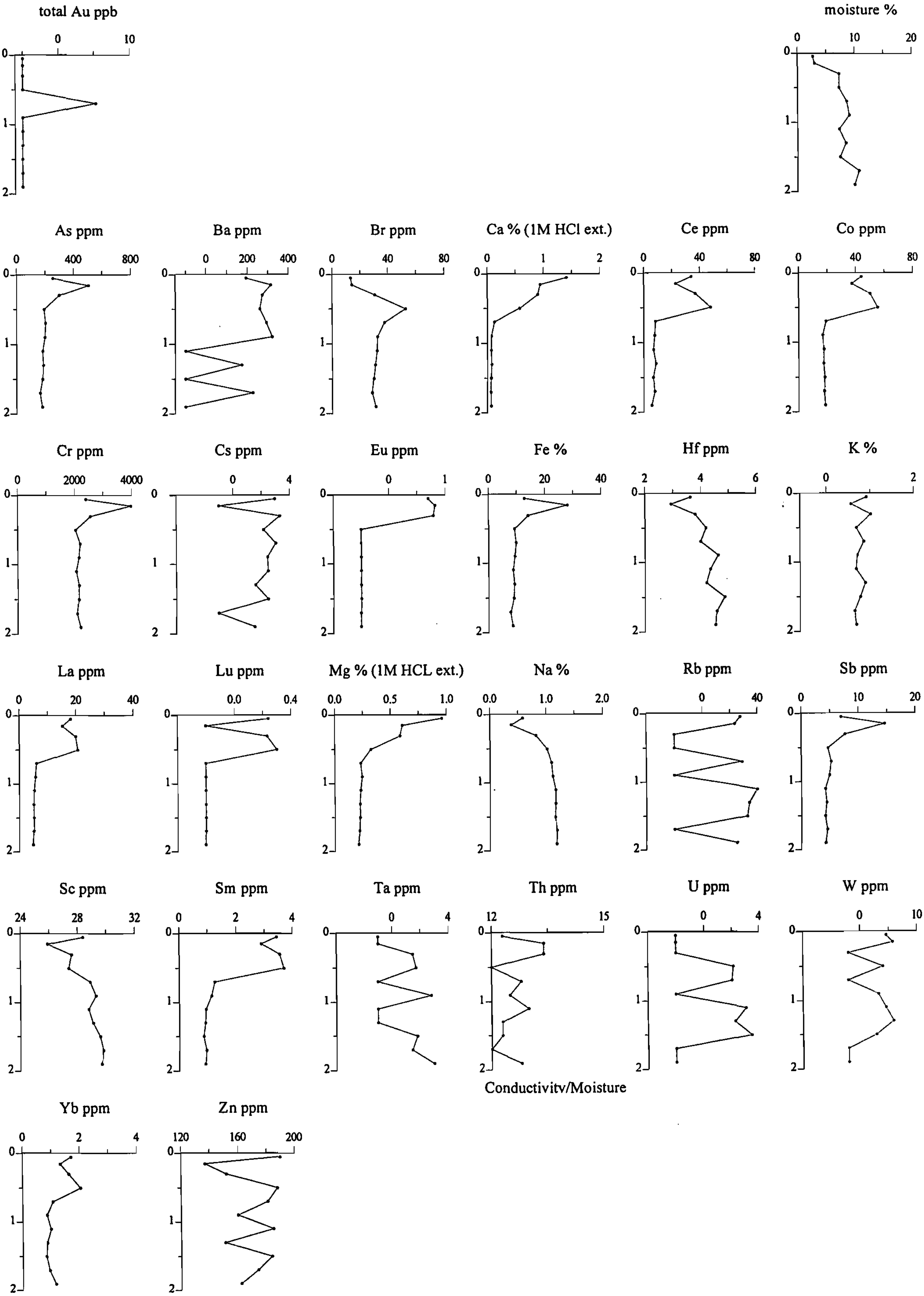


Figure A4.1 : Elemental abundancies for Profile A at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5)
data were near or below detection indicated in parentheses (ppm). Y axis is Depth (m)

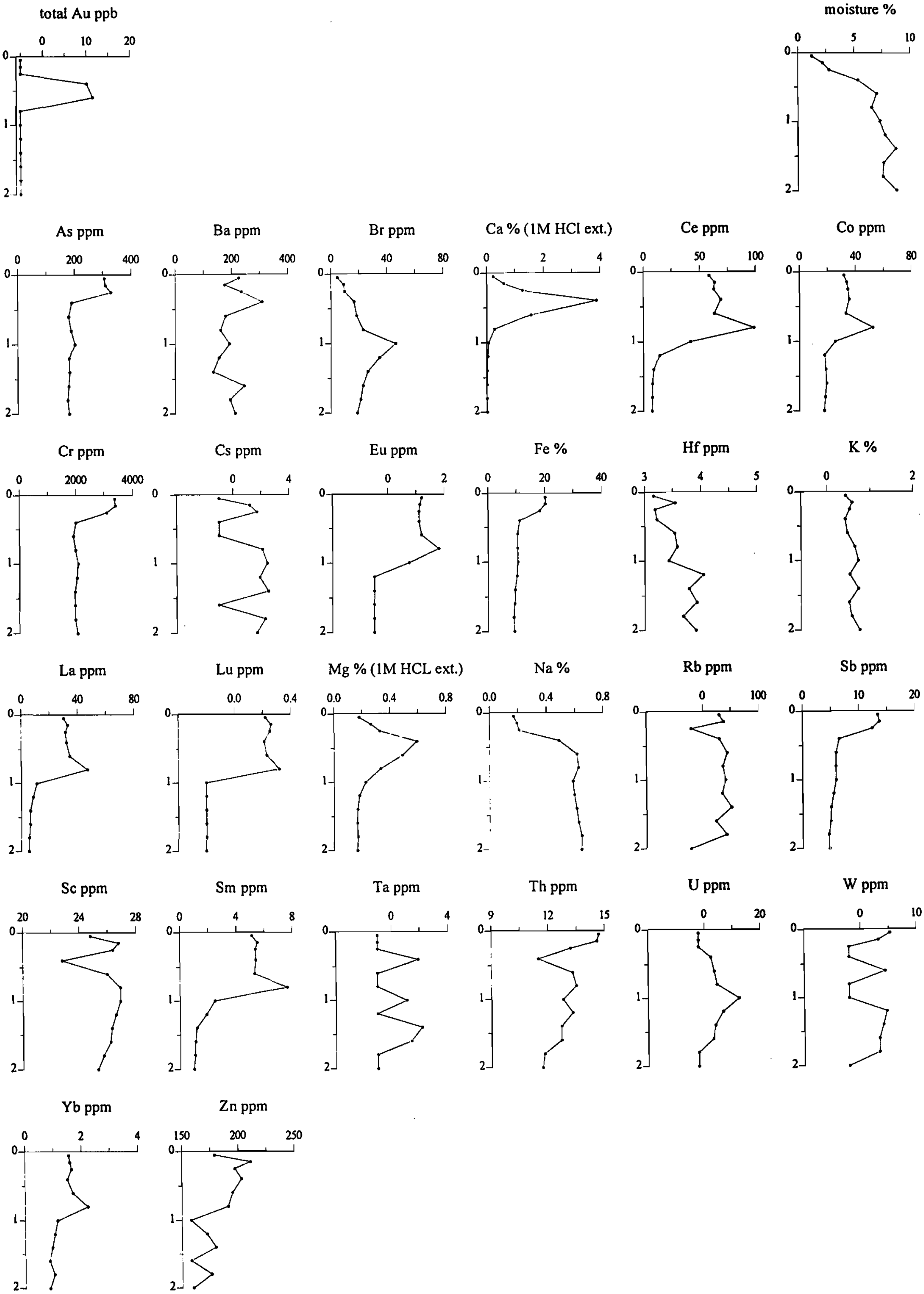


Figure A4.2 : Elemental abundancies for Profile B at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5)
data were near or below detection indicated in parentheses (ppm). Y axis is Depth (m)

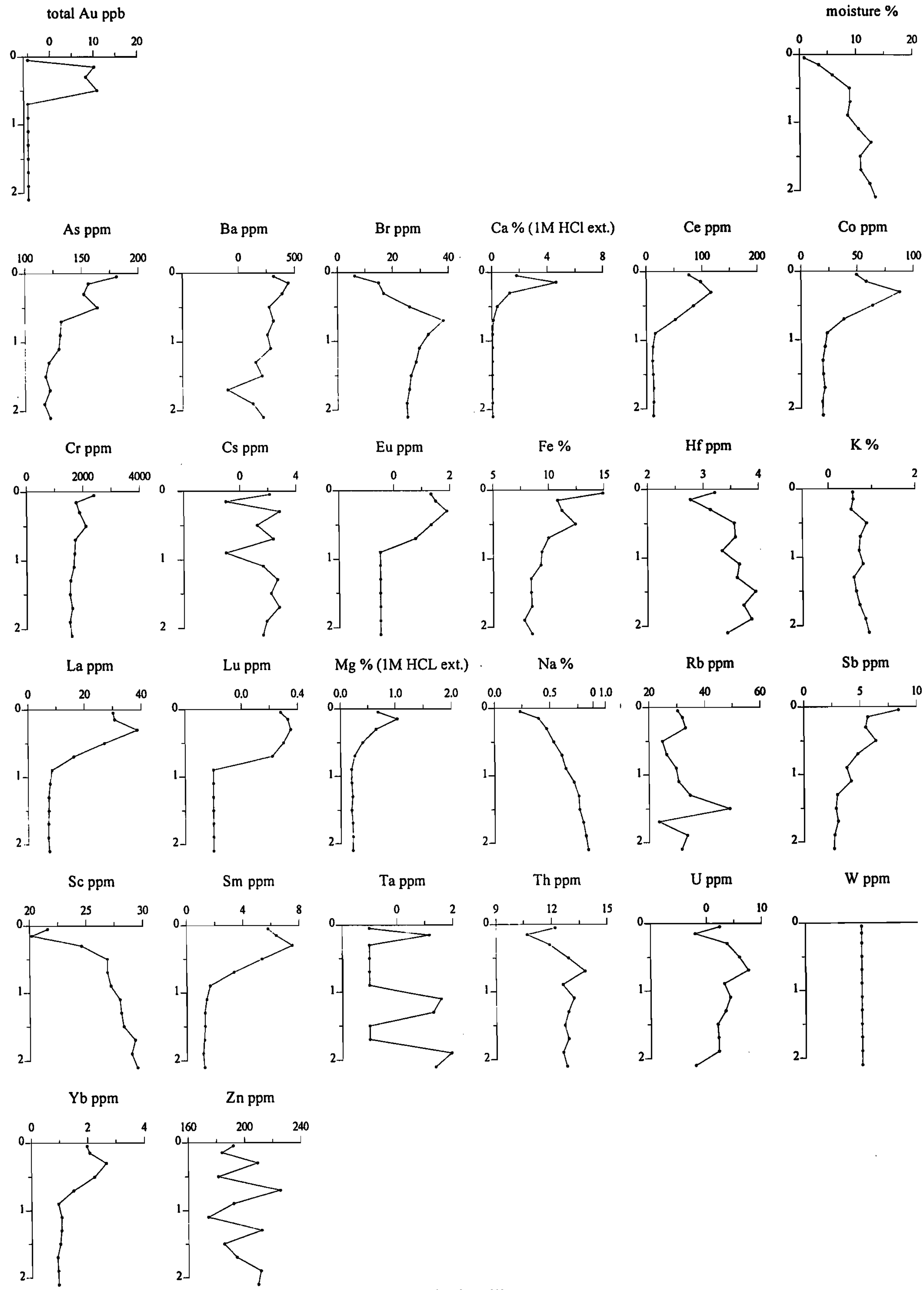


Figure A4.3 : Elemental abundancies for Profile C at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

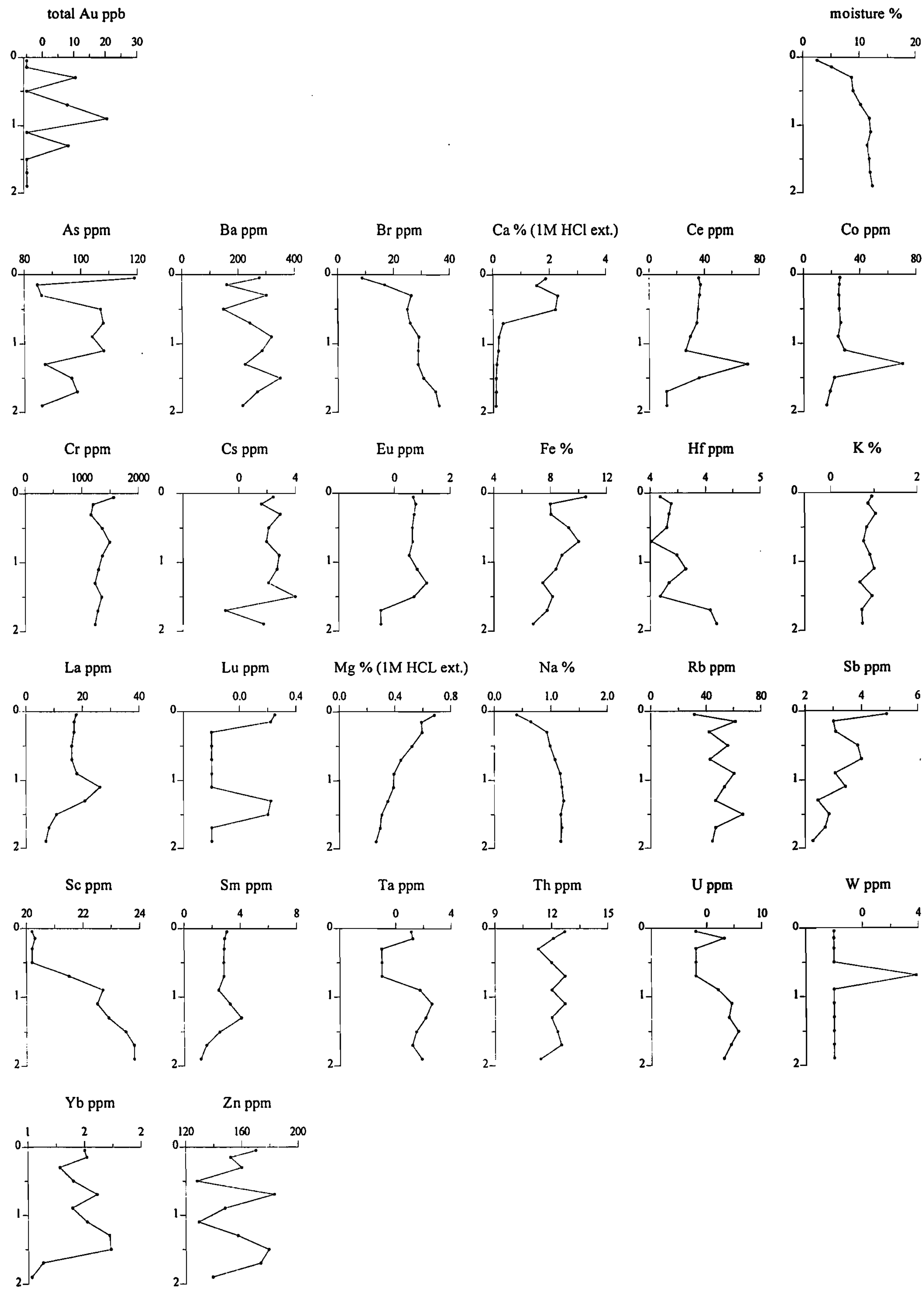


Figure A4.4 : Elemental abundancies for Profile D at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

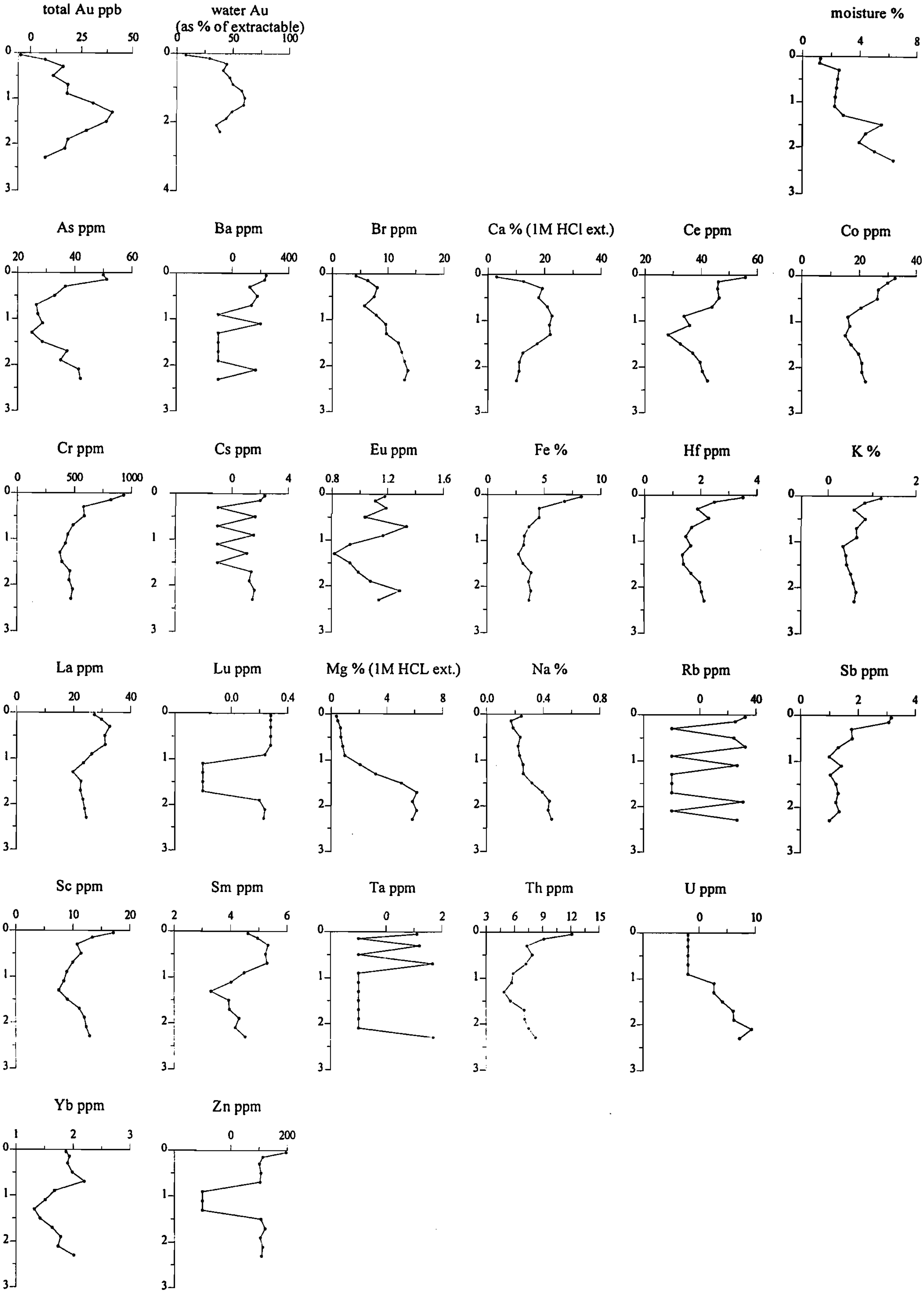


Figure A4.5 : Elemental abundancies for Profile E at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

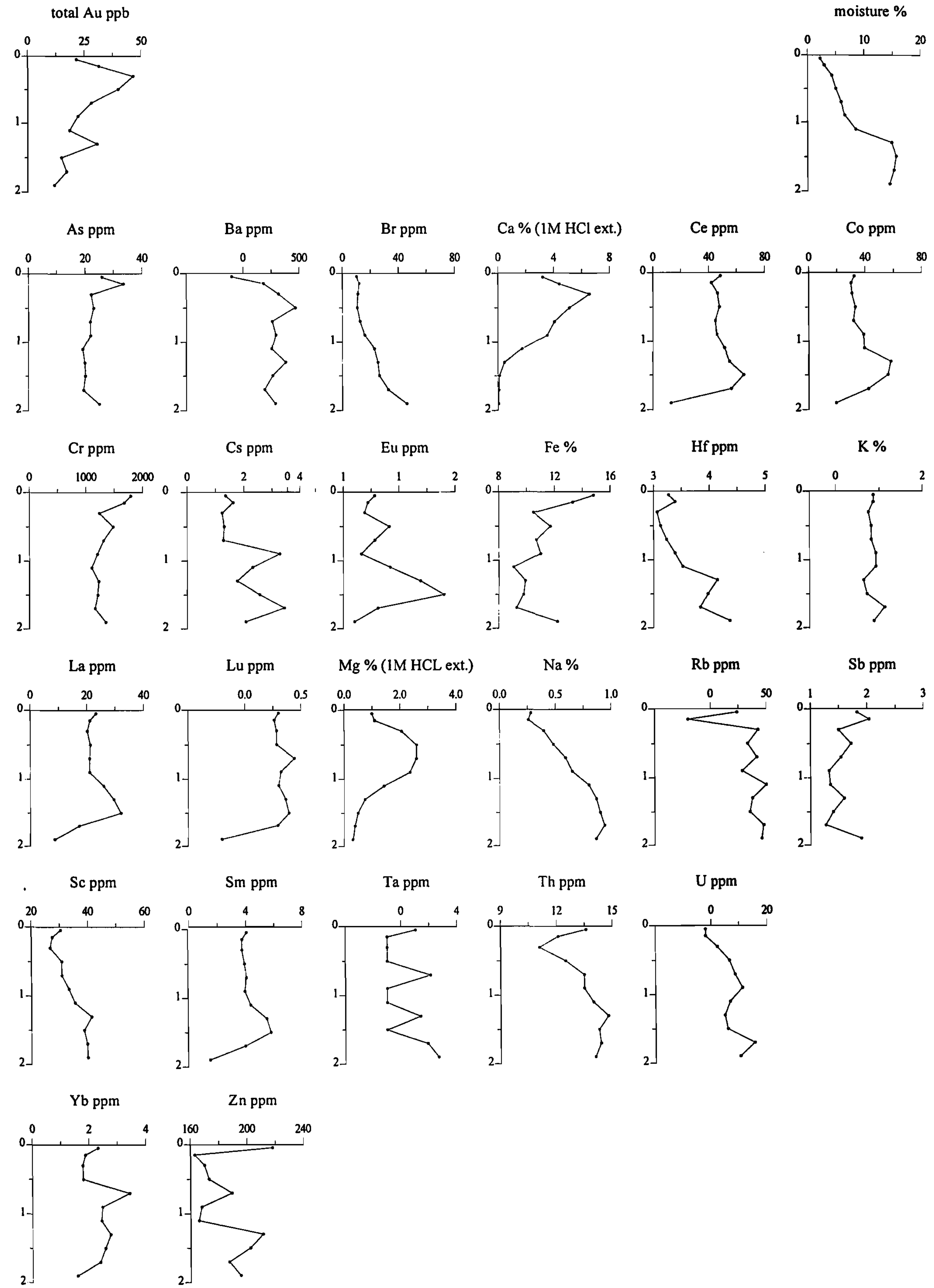


Figure A4.6 : Elemental abundancies for Profile F at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

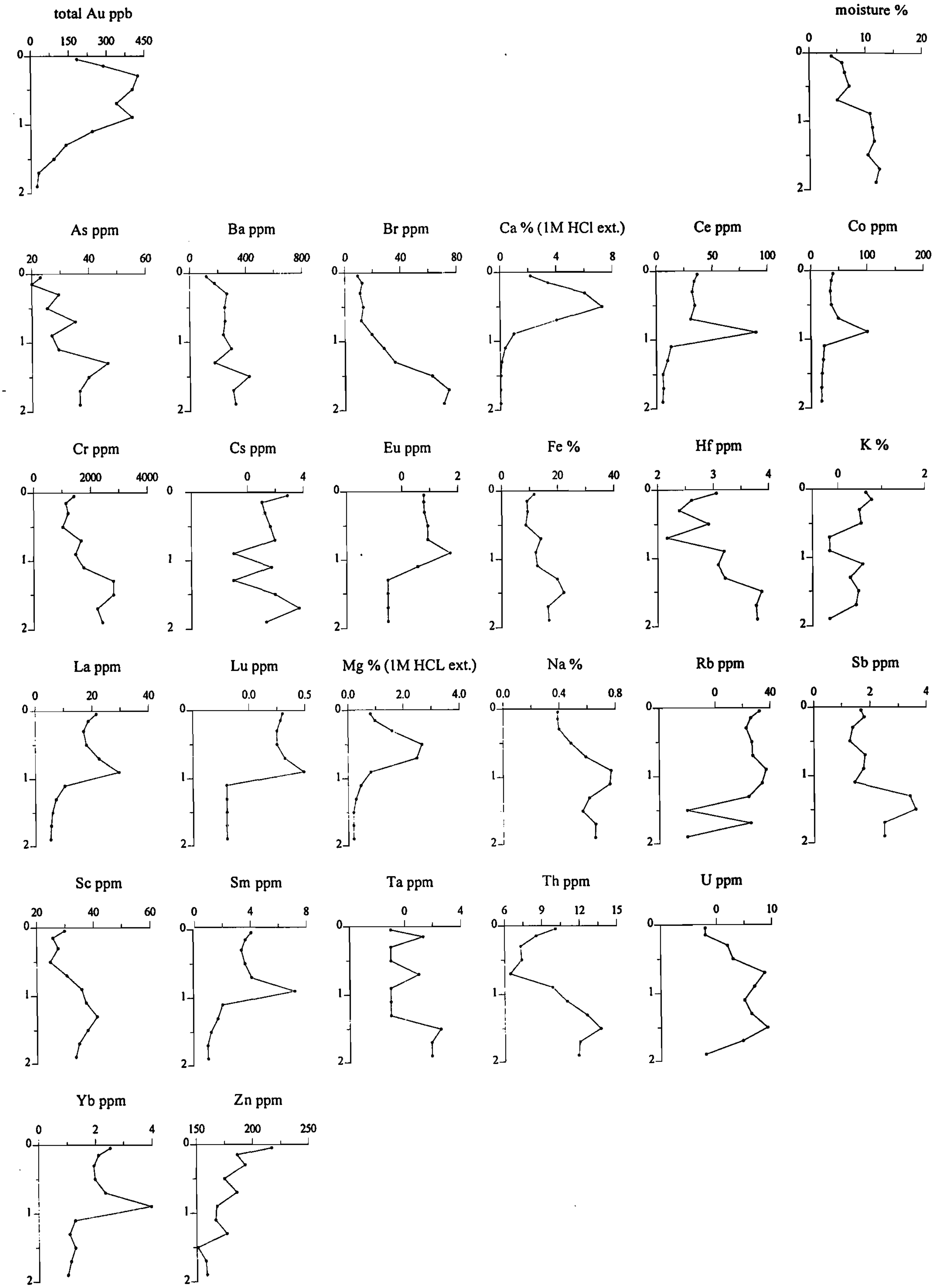
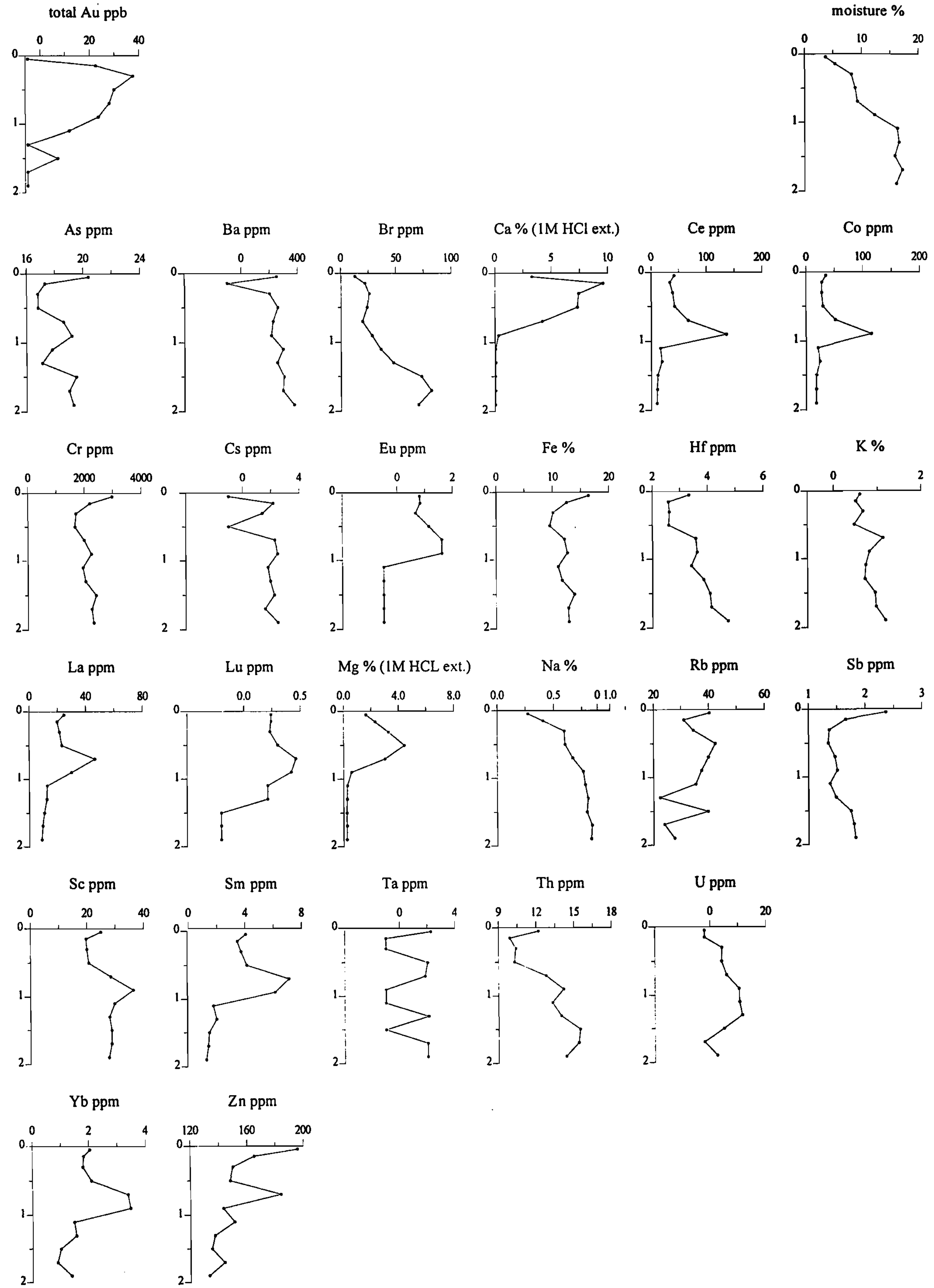


Figure A4.7 : Elemental abundancies for Profile G at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)



FigureA4.8 : Elemental abundancies for Profile H at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

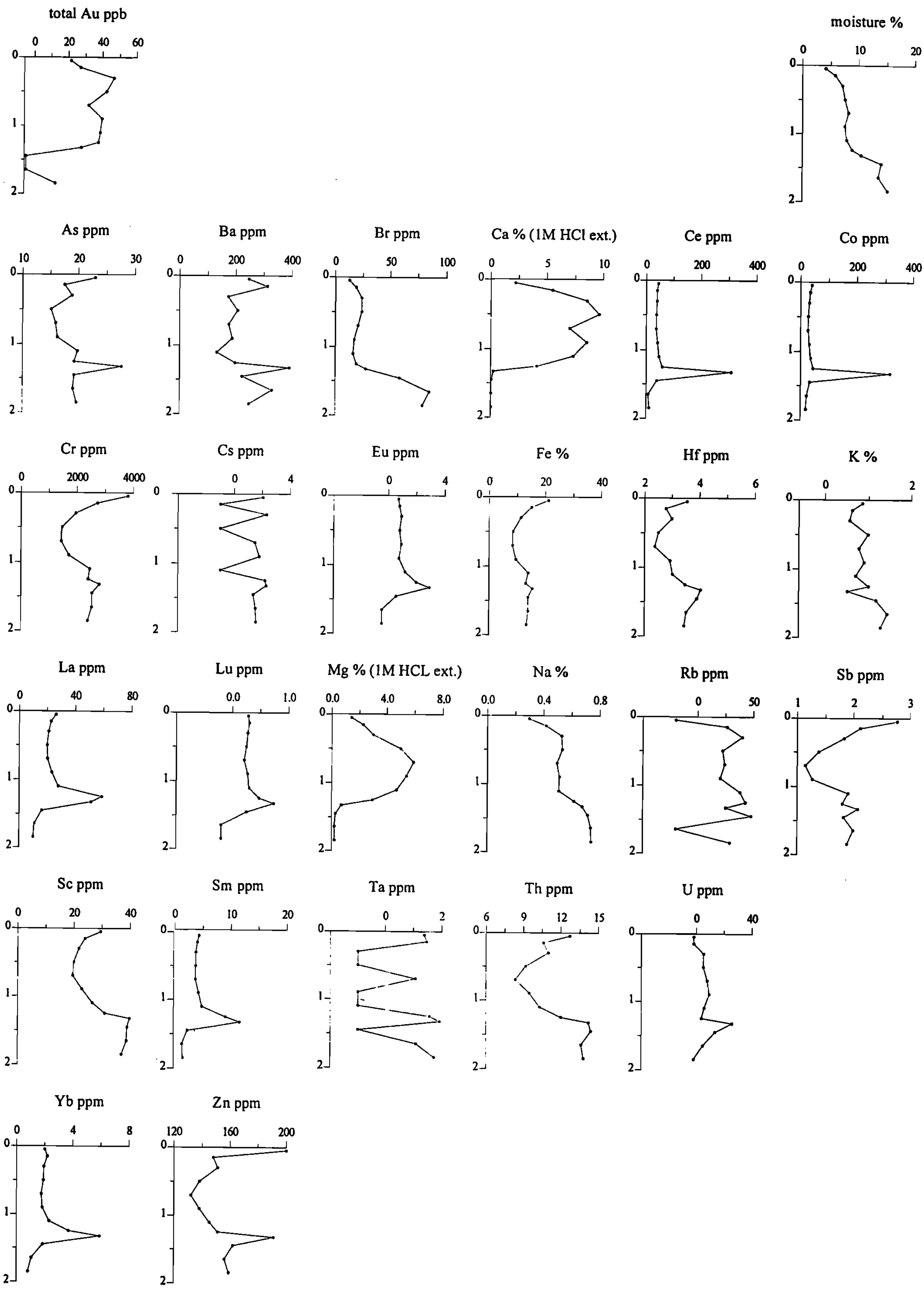


Figure A4.9 : Elemental abundancies for Profile I at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

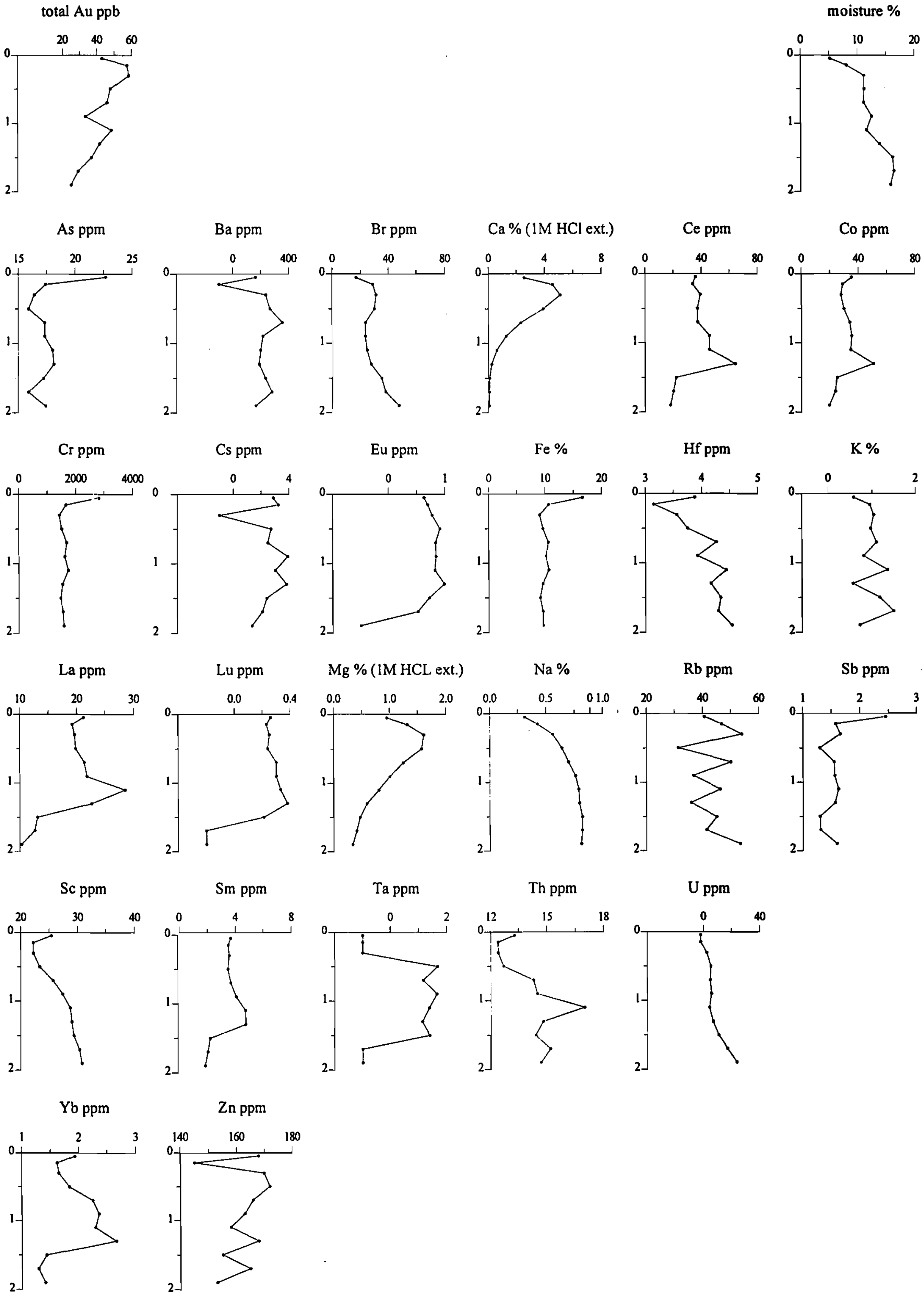


Figure A4.10 : Elemental abundancies for Profile J at Higginsville.
For all samples Ag (5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm).
Y axis is Depth (m)

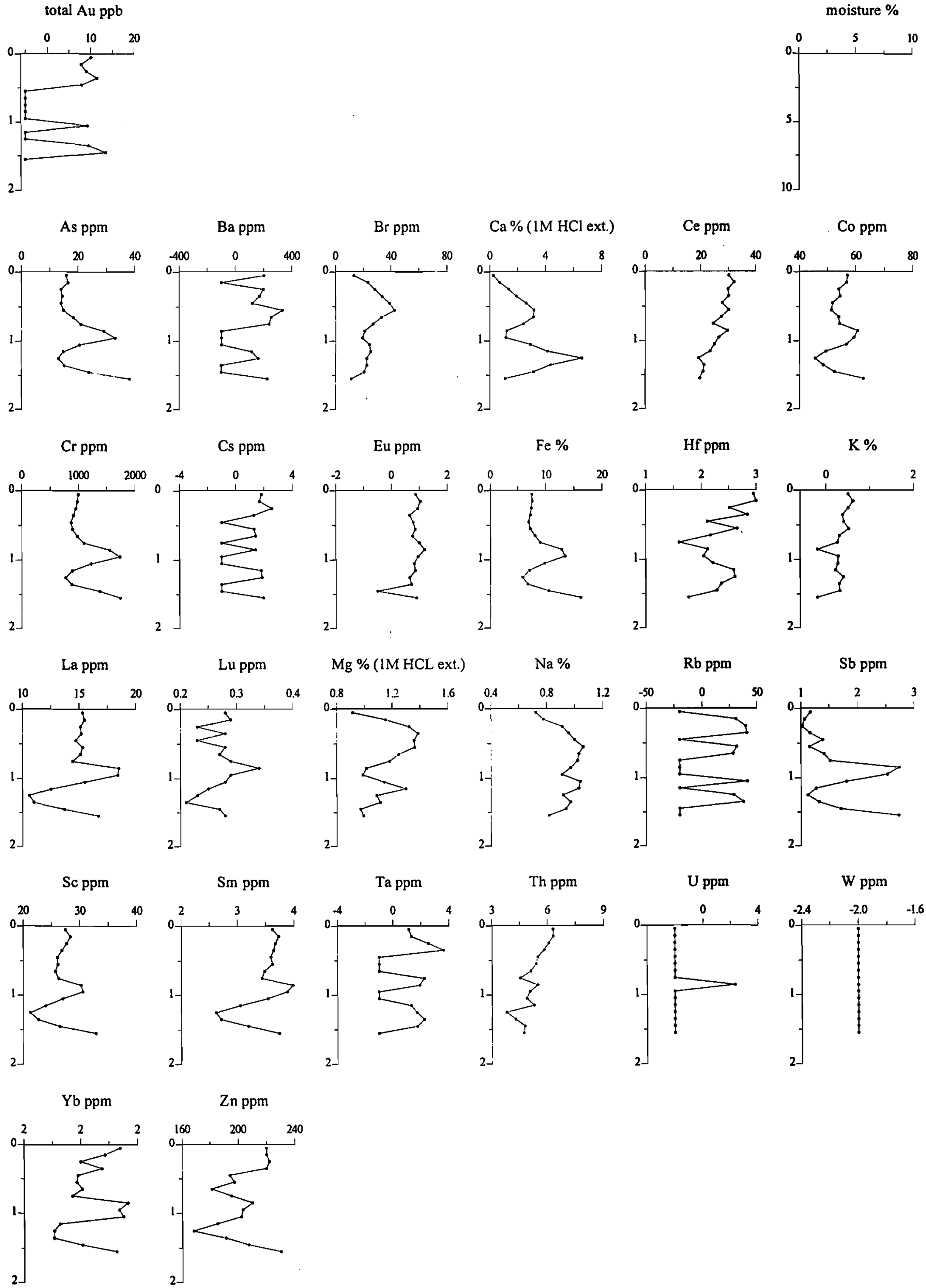


Figure A4.11 : Elemental abundancies for Profile K at Higginsville.
For all samples Ag (5), Eu (0.5), Ir (0.02) and Mo (5) and Se (5) data were near or below detection indicated in parentheses (ppm). Y axis is Depth (m)

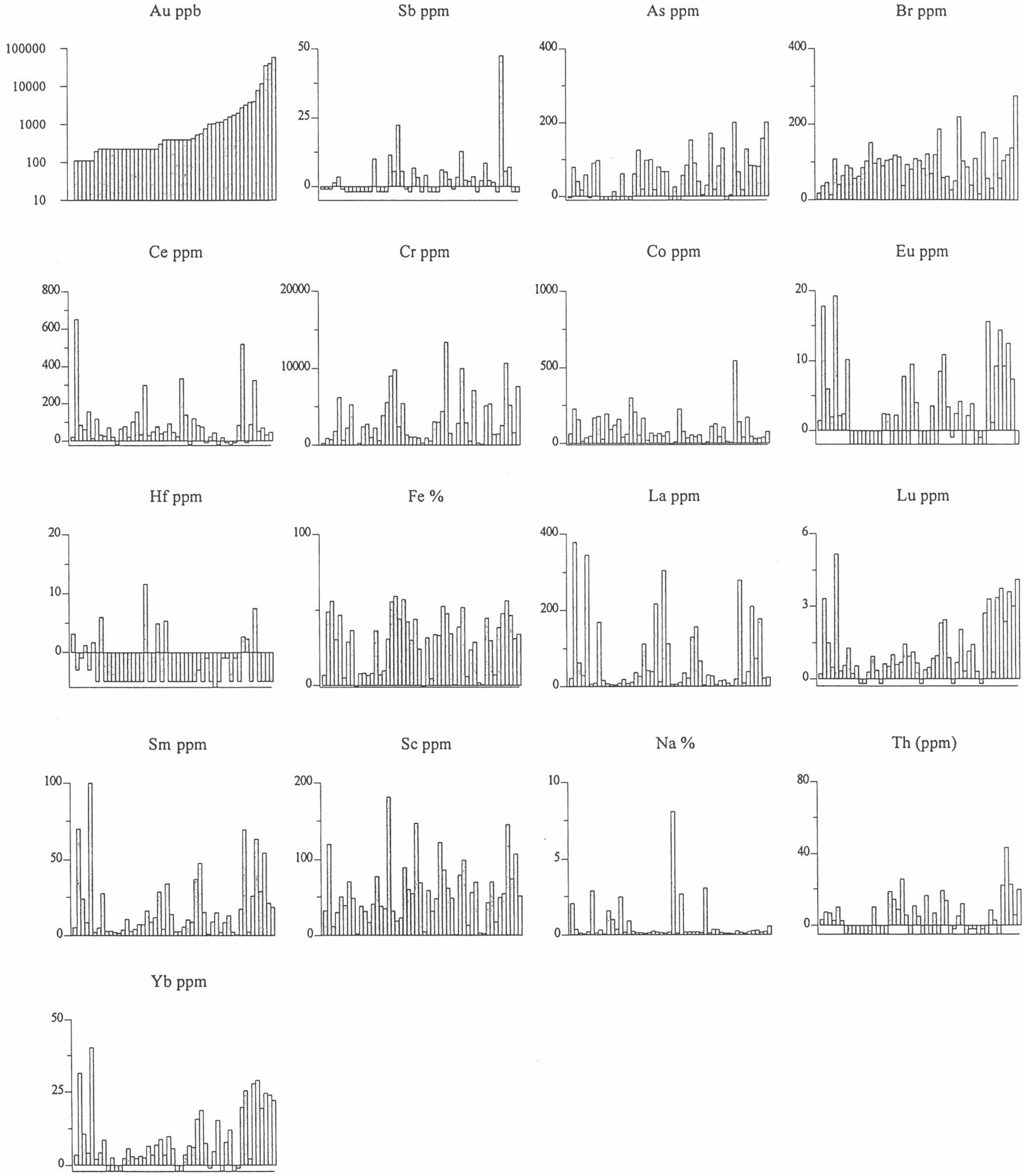


Figure A5.1 : Elemental abundancies for individual ferruginous granule samples from soil profile G at Higginsville. Samples are ranked according to greater Au concentration from left to right.
Negative data below detection.

Table A5.2: Tabulated geochemical data for individual ferruginous granules separated out from sample 09-4748 (Profile G)

Sample_id	Au	Ag	As	Ba	Br	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ir	K	La
09-4748	ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppb	%	ppm
1	<40	<20	<4	<2000	18	21	65	239	<5	1	7	3	<50	<1	22
2	<100	<50	91	<2000	64	118	168	2240	<20	2	29	<5	<100	<2	9
3	<100	<50	97	<2000	92	33	179	5240	<20	10	37	6	<100	<2	169
4	<40	<50	80	<2000	37	651	227	891	<5	18	49	<3	<100	<2	378
5	331	<20	5	<2000	27	<10	<2	37	<5	<1	1	<1	<50	<1	4
6	577	<20	132	3590	39	<10	105	7140	<5	4	29	<1	<50	<1	16
7	1720	<20	18	<2000	31	<10	41	1410	<5	1	7	2	<50	<1	8
8	41	<20	<4	<2000	41	14	49	624	<5	2	5	2	<50	<1	6
9	230	<50	41	<2000	62	75	56	1560	<20	3	35	<5	<100	<2	68
10	73	<50	19	<2000	38	77	52	1340	<5	8	42	5	<50	<1	217
11	100	<50	80	<2000	94	40	65	1060	<20	<2	30	<5	<100	<2	12
12	<40	<20	41	<2000	46	85	157	728	<5	6	56	<1	<50	<1	63
13	<100	<50	<10	<2000	84	27	28	38	<20	<2	<1	<5	<100	<2	17
14	158	<20	91	<2000	59	84	44	13400	<5	11	48	<3	<50	<1	157
15	<100	<50	<10	<2000	57	72	195	252	<20	<2	8	<5	<100	<2	7
16	<100	<50	<10	<2000	63	22	92	2400	<20	<2	8	<5	<100	<2	5
17	1390	<20	67	<2000	57	520	141	5350	<5	16	30	3	<50	<1	279
18	1810	<50	129	<2000	164	89	170	1440	<20	9	39	<5	<100	<2	39
19	466	<20	83	<2000	87	19	44	550	<5	2	24	<1	<50	<1	15
20	145	<50	153	<2000	187	120	56	4400	<20	9	53	<5	<100	<2	130
21	100	<50	68	<2000	82	50	49	1060	<20	10	44	5	<100	<2	305
22	658	<50	<10	<2000	110	<20	13	282	<20	<2	2	<5	<100	<2	8
23	100	<50	68	2010	109	93	78	957	<20	4	24	<5	<100	<2	113
24	100	<50	<10	<2000	104	48	<10	280	<20	<2	<1	<5	<100	<2	5
25	<100	<50	14	<2000	86	<20	121	2730	<20	<2	7	<5	<100	<2	3
26	<40	<20	18	<2000	14	62	15	1820	<5	2	31	1	<50	<1	29
27	<100	<50	<10	<2000	103	65	159	1010	<20	<2	8	<5	<100	<2	9
28	112	<50	85	<2000	120	<20	36	2980	<20	<2	33	<5	<100	<2	22
29	<100	<50	62	<2000	152	77	43	2220	<20	<2	37	<5	<100	<2	19
30	347	<50	31	<2000	50	22	10	2860	<20	2	39	<5	<100	<2	30
31	100	<50	26	<2000	83	24	10	947	<20	<2	32	<5	<100	<2	5
32	27700	<100	81	<2000	120	70	33	5170	<20	13	46	<5	<100	<2	177
33	<100	<50	<10	<2000	97	22	61	565	<20	<2	7	<5	<100	<2	8
34	100	<50	<10	<2000	122	337	226	528	<20	<2	5	<5	<100	<2	10
35	<100	<50	<10	<2000	109	103	299	3890	<20	<2	10	<5	<100	<2	11
36	<100	<50	62	<2000	91	157	207	5540	<20	2	31	<5	<100	<2	37
37	<100	<50	126	<2000	105	35	54	9020	<20	2	56	<5	<100	<2	27
38	4270	<20	84	<2000	58	326	46	2530	<5	14	48	7	<50	<1	210
39	100	<50	57	<2000	70	141	80	3050	<20	4	34	<5	<100	<2	36
40	32400	<50	157	<2000	138	32	39	1600	<20	7	31	<5	<100	<2	21
41	756	<20	5	<2000	16	<10	6	133	<5	<1	1	<1	<50	<1	1
42	<100	<50	20	<2000	107	301	167	9850	<20	<2	59	12	<100	<2	112
43	<40	<20	59	<2000	108	158	38	6210	<5	19	47	<3	<100	<2	345
44	<100	<50	98	<2000	119	31	21	2410	<20	2	44	<5	<100	<2	42
45	<100	<50	100	<2000	114	50	69	5430	<20	<2	57	<5	<100	<2	39
46	385	<100	171	<2000	221	46	111	10000	<20	4	52	<6	<200	<4	27
47	1130	<100	201	<2000	179	84	544	5110	<20	<2	45	<5	<100	<4	19
48	391	<50	20	<2000	103	<20	128	2900	<20	<2	6	<5	<100	<2	5
49	7030	<100	83	<2000	104	53	31	10700	<20	9	56	<5	<100	<2	74
50	51800	<100	201	<2000	276	48	77	7640	<20	<2	34	<5	<200	<4	23

Table A5.2: Tabulated geochemical data for individual ferruginous granules separated out from sample 09-4748 (Profile G)

Sample_id	Lu	Mo	Na	Rb	Sb	Sc	Se	Sm	Ta	Th	U	W	Yb
09-4748	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1	0.22	<30	2.0	77	<1	32	<20	5	<5	3	10	<10	4
2	0.56	<50	0.1	<200	<2	70	<50	5	<10	<5	<30	<20	5
3	1.29	<50	0.3	<200	<2	48	<50	27	<10	<5	<30	<20	9
4	3.32	<30	0.4	158	<1	120	<20	70	<5	7	14	<20	32
5	<0.2	<30	3.0	<50	<1	1	<20	1	<5	<2	<10	<10	<1
6	1.43	<50	0.1	<50	4	70	<20	13	<5	<2	35	<10	12
7	0.28	<30	0.1	<50	2	17	<20	2	<5	3	<10	<10	2
8	0.34	<30	2.9	<50	<1	39	<20	2	<5	3	<10	<10	2
9	0.89	<50	0.1	<200	3	48	<50	15	<10	<5	<30	<20	8
10	1.45	<30	0.2	<50	<1	60	<20	29	<5	6	<10	<10	9
11	0.94	<50	0.1	<200	<2	54	<50	4	<10	<5	<30	<20	4
12	1.50	<30	0.1	<50	<1	12	<20	24	<5	7	<10	<10	11
13	0.23	<50	0.1	<200	<2	2	<50	3	<10	<5	<30	<20	<2
14	2.45	<50	0.2	<50	5	61	<20	48	<5	14	<10	<10	19
15	0.55	<50	1.6	<200	<2	38	<50	3	<10	<5	<30	<20	3
16	<0.2	<50	1.0	<200	<2	31	<50	2	<10	<5	<30	<20	<2
17	3.30	<30	0.1	<50	2	70	<20	69	<5	8	<10	<10	26
18	3.36	<50	0.2	<200	<2	49	<50	26	<10	<5	32	<20	28
19	1.16	<30	0.2	<50	2	56	<20	9	<5	<2	13	<10	8
20	2.32	<50	0.2	<200	6	87	<50	37	<10	19	<30	<20	16
21	1.13	<50	0.1	<200	7	147	<50	34	<10	11	<30	<20	10
22	0.32	<50	0.1	<200	<2	3	<50	2	<10	<5	<30	<20	<2
23	0.67	<50	0.2	<200	3	69	<50	14	<10	5	<30	<20	6
24	<0.2	<50	8.1	<200	<2	5	<50	3	<10	<5	<30	<20	<2
25	<0.2	<50	0.4	<200	<2	17	<50	2	<10	<5	<30	<20	<2
26	0.49	<30	0.1	<50	1	30	<20	8	<5	3	<10	<10	4
27	0.29	<50	2.5	<200	<2	41	<50	4	<10	<5	<30	<20	3
28	0.96	<50	0.2	<200	<2	122	<50	9	<10	<5	<30	<20	6
29	0.94	<50	0.2	<200	10	78	<50	11	<10	10	<30	<20	6
30	0.68	<50	0.1	<200	3	80	<50	9	<10	5	<30	<20	5
31	0.39	<50	0.1	<200	4	59	<50	3	<10	16	<30	<20	<2
32	3.61	<100	0.2	<200	7	74	<100	54	<10	23	<30	<20	25
33	0.37	<50	0.9	<200	<2	38	<50	3	<10	<5	<30	<20	3
34	0.48	<50	2.7	<200	<2	31	<50	6	<10	<5	<30	<20	4
35	<0.2	<50	0.2	<200	<2	35	<50	4	<10	<5	<30	<20	3
36	0.64	<50	0.2	<200	<2	181	<50	7	<10	<5	<30	<20	3
37	0.52	<50	0.1	<200	12	32	<50	7	<10	19	<30	<20	3
38	3.75	<30	0.3	<100	48	54	<20	63	<5	22	22	<10	29
39	0.86	<50	0.2	<200	<2	48	<50	10	<10	7	<30	<20	7
40	3.02	<100	0.2	<200	<2	107	<50	21	<10	6	<30	<20	24
41	<0.2	<30	0.1	<50	2	3	<20	1	<5	<2	<10	<10	<1
42	1.01	<100	0.1	<200	6	19	<50	16	<10	14	<30	<20	7
43	5.16	<50	0.2	<100	4	50	<20	100	<5	10	<10	<10	40
44	0.60	<100	0.1	<200	22	23	<100	9	<10	9	<30	<20	4
45	0.70	<100	0.2	<200	6	90	<50	12	<10	26	46	<20	7
46	2.05	<200	0.4	<200	13	99	<50	15	<10	12	42	<40	15
47	2.73	<50	0.2	<200	9	43	<50	17	<10	<5	<30	<20	20
48	0.33	<50	0.3	<200	2	13	<50	2	<10	<5	<30	<20	<2
49	2.38	<100	0.3	<200	6	145	<50	29	<10	43	30	<20	20
50	4.12	<200	0.6	<200	<2	51	<50	19	<10	20	<30	<20	22

Table A5.3: Tabulated geochemical data for selected dry and wet sieved samples. Wet weight calculated from wet sieving the >1000um dry fraction.

Sample	size fraction	dry wt	dry wt	wet wt	Au	Ca	Mg
		g	%	g	ppb	%	%
09-4743	>1000	98.5	19.8	66.9	19	0.44	0.38
09-4743	>250	166.5	33.4		179	2.20	0.64
09-4743	>63	195.4	39.3		198	2.21	0.58
09-4743	<63	37.4	7.5		322	3.80	1.36
09-4745	>1000	262.8	53.0	61.2	247	2.27	1.35
09-4745	>250	125.2	25.3		401	5.72	1.16
09-4745	>63	90.2	18.2		470	6.08	1.13
09-4745	<63	17.4	3.5		771	9.45	1.93
09-4748	>1000	330.5	66.1	84.9	633	0.27	0.44
09-4748	>250	116.0	23.2		404	1.11	0.67
09-4748	>63	45.4	9.8		450	1.59	0.85
09-4748	<63	8.0	1.6		826	2.77	1.42
09-4773	>1000	265.6	54.0	112.0	<5	0.05	0.23
09-4773	>250	133.0	27.1		33	0.16	0.45
09-4773	>63	80.9	16.5		36	0.16	0.41
09-4773	<63	11.9	2.4		68	0.29	0.88
09-4767	>1000	239.1	47.6	75.5	<5	4.58	1.63
09-4767	>250	127.6	25.4		44	9.30	3.00
09-4767	>63	111.9	22.3		49	8.54	2.57
09-4767	<63	23.9	4.7		78	12.36	4.02
09-4726	>1000	291.6	57.4	204.4	63	29.60	2.32
09-4726	>250	110.7	21.8		24	12.80	2.77
09-4726	>63	54.2	10.7		34	12.76	3.16
09-4726	<63	51.3	10.1		33	23.09	6.21
09-4697	>1000	207.8	41.4	47.2	<5	0.86	0.18
09-4697	>250	170.3	34.0		9	3.96	0.76
09-4697	>63	104.8	20.9		16	5.41	1.01
09-4697	<63	18.4	3.7		19	8.92	1.76
09-4542	>1000	247.2	49.9	40.7	<5	0.62	0.56
09-4542	>250	128.1	25.9		32	0.82	0.53
09-4542	>63	95.2	19.2		32	0.88	0.57
09-4542	<63	24.8	5.0		48	1.22	1.05
09-4555	>1000	187.2	38.0	148.7	100	6.40	1.41
09-4555	>250	100.9	20.5		118	4.18	1.33
09-4555	>63	156.1	31.7		117	4.12	1.29
09-4555	<63	48.4	9.8		218	8.34	2.76

Table A6.1 Tabulated geochemical data for ferruginous and carbonaceous samples.

Sample	Description	Au	Fe	Zn	Cu	Ni	TiO2	Zr	Sr	Mn	Pb	Bi
		XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF	XRF
		ppb	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
k5607	09-4791+1mm wet	2.5	50.2	77	68	342	0.7	99	2	224	98	2
k5608	09-4793+1mm wet	2.5	36.9	454	84	600	0.7	113	5	2243	51	2
k5609	09-4806+1mm wet	5	25.1	76	48	2835	0.1	46	<5	70	281	<2
k5610	09-4808	25.5	3.1	23	70	150	0.6	145	7	154	37	<2
Sample	**Description**	**Au**										
		XRF										
		ppb										
k5601	09-4666+09-4667+09-4668	2.5										
k5602	09-4669+09-4670+09-4671	2.5										
k5603	09-4672+09-4673+09-4674+09-4675	2.5										
k5604	09-4676+09-4677+09-4678	2.5										
k5605	09-4679+09-4680+09-4681	2.5										
k5606	09-4682+09-4683+09-4684	2.5										
Sample	Northing	Easting	Av Depth									
	(m)	(m)	(m)									
09-4666	6481880	379927	2.5									
09-4667	6481880	379927	4									
09-4668	6481880	379927	5.5									
09-4669	6481880	379886	4									
09-4670	6481880	379886	2.5									
09-4671	6481880	379886	6.5									
09-4672	6481880	379843	2.5									
09-4673	6481880	379843	4									
09-4674	6481880	379843	6.5									
09-4675	6481880	379843	9.5									
09-4676	6481880	379803	3									
09-4677	6481880	379803	5									
09-4678	6481880	379803	9.5									
09-4679	6481880	379763	3									
09-4680	6481880	379763	5.5									
09-4681	6481880	379763	9.5									
09-4682	6481880	379716	2.5									
09-4683	6481880	379716	4.5									
09-4684	6481880	379716	7									
09-4791	6480980	382214	6.5									
09-4793	6480980	382214	9									
09-4806	6480980	382214	35									
09-4808	6480980	382214	38.5									

Table A7: Tabulated geochemical data for vegetation

Sample	Easting	Northing	location	Au	Ag	As	Ba	Br	Ce	Co	Cr	Cs	Eu
Maireana				INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA
				ppb	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
09-4835	381640	6481000	pluto	1.08	<0.66	0.54	<13	64	0.64	<0.13	3.36	<0.07	<0.026
09-4836	381690	6481000	pluto	0.92	<0.66	0.75	14	68	0.68	0.28	3.73	<0.07	<0.027
09-4837	381740	6481000	pluto	1.25	<0.63	0.63	<13	75	0.56	<0.13	3.20	<0.06	<0.025
09-4838	381790	6481000	pluto	1.06	<0.58	0.57	<12	58	0.44	<0.12	3.28	<0.06	<0.023
09-4839	381840	6481000	pluto	1.34	<0.59	0.68	<12	72	0.56	0.31	4.41	<0.06	<0.024
09-4840	381890	6481000	pluto	0.74	<0.63	0.84	<13	83	0.56	0.26	4.46	<0.06	<0.025
09-4841	381940	6481000	pluto	2.73	<0.63	0.86	<13	69	0.89	0.40	6.13	<0.06	<0.025
09-4842	381980	6481000	pluto	1.12	<0.56	0.53	<11	48	0.57	0.20	5.56	0.06	<0.022
09-4843	382020	6481000	pluto	1.34	<0.50	0.84	16	38	0.79	0.45	6.89	0.09	<0.020
09-4844	382060	6481000	pluto	<0.20	<0.20	<0.08	<4	40	<0.04	<0.04	0.18	<0.02	<0.008
09-4845	382080	6481000	pluto	<0.20	<0.20	<0.08	<4	32	<0.04	<0.04	0.22	<0.02	<0.008
09-4846	382100	6481000	pluto	<0.23	<0.23	<0.09	<5	39	0.06	<0.05	0.52	<0.02	<0.009
09-4847	382140	6481000	pluto	<0.19	<0.19	<0.07	<4	35	<0.04	<0.04	0.15	<0.02	<0.007
09-4848	382180	6481000	pluto	<0.20	<0.20	<0.08	<4	32	<0.04	<0.04	0.20	<0.02	<0.008
09-4849	382220	6481000	pluto	<0.22	<0.22	<0.09	<4	34	<0.04	<0.04	0.21	<0.02	<0.009
09-4850	382260	6481000	pluto	<0.21	<0.21	<0.09	<4	27	<0.04	<0.04	0.30	<0.02	<0.009
09-4851	382300	6481000	pluto	<0.20	<0.20	<0.08	<4	26	<0.04	<0.04	0.25	<0.02	<0.008
09-4852	382320	6481000	pluto	<0.19	<0.19	<0.07	<4	25	<0.04	0.05	<0.07	<0.02	<0.007
09-4853	382340	6481000	pluto	<0.20	<0.20	<0.08	<4	31	<0.04	<0.04	0.37	<0.02	<0.008
09-4854	382390	6481000	pluto	<0.20	<0.20	<0.08	<4	32	<0.04	0.04	0.22	<0.02	<0.008
09-4855	382440	6481000	pluto	<0.19	<0.19	<0.07	<4	27	<0.04	<0.04	0.07	<0.02	<0.007
09-4856	382490	6481000	pluto	<0.18	<0.18	<0.07	<4	33	<0.04	<0.04	0.11	<0.02	<0.007
09-4857	382540	6481000	pluto	<0.19	<0.19	<0.08	<4	39	<0.04	<0.04	0.10	<0.02	<0.008
09-4858	382590	6481000	pluto	<0.20	<0.20	<0.08	<4	36	<0.04	<0.04	0.12	<0.02	<0.008
09-4859	382640	6481000	pluto	<0.20	<0.20	<0.08	<4	44	<0.04	<0.04	0.23	<0.02	<0.008

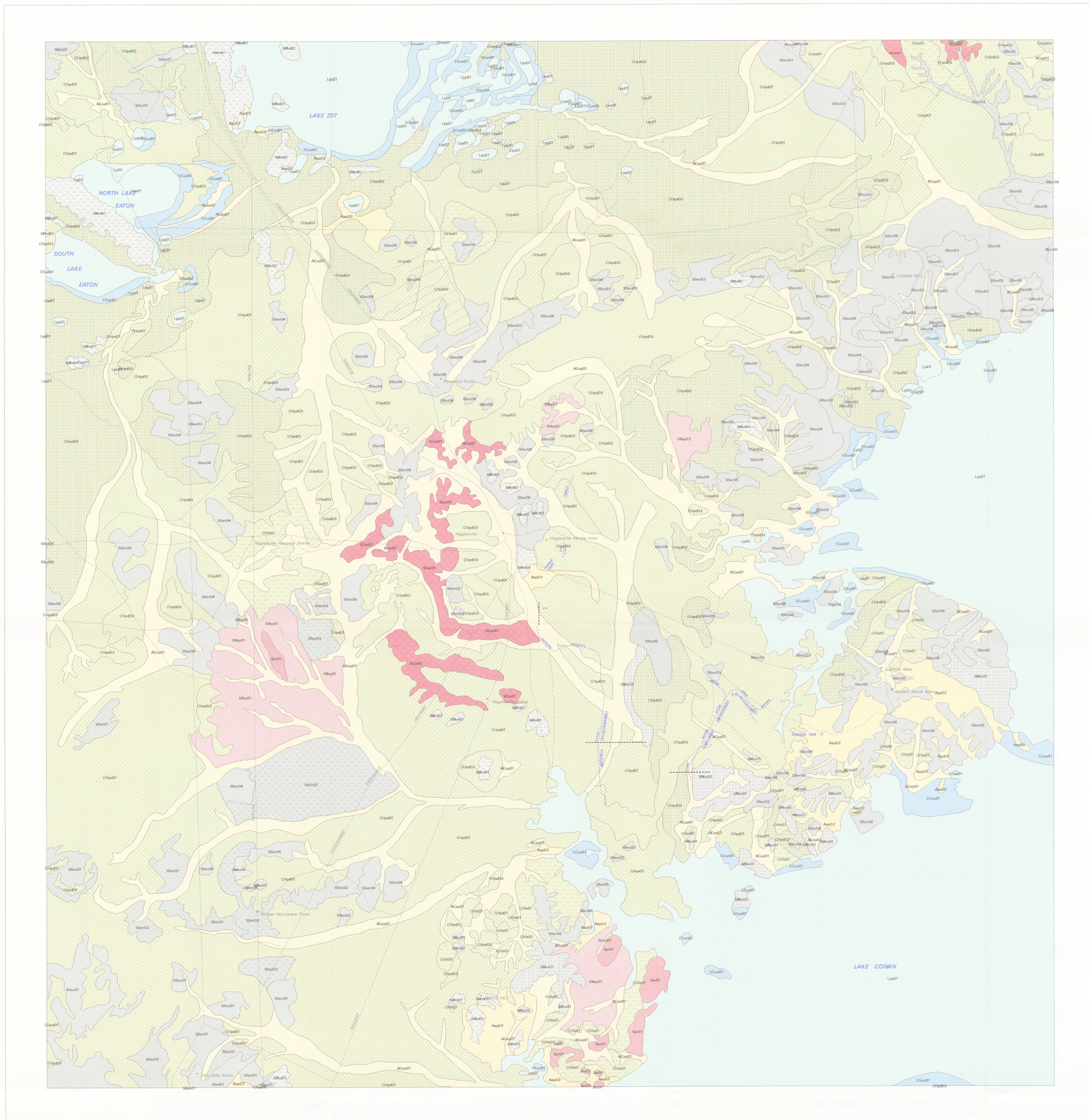
Table A7: Tabulated geochemical data for vegetation (continued).

Sample	Fe	Hf	Ir	K	La	Lu	Mo	Na	Rb	Sb	Sc	Se	Sm
Maireana	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA
	%	ppm	ppb	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
09-4835	0.028	<0.026	<2.6	0.67	0.198	<0.007	<0.66	2.26	<2.6	<0.026	0.118	<0.66	0.041
09-4836	0.033	0.038	<2.7	0.56	0.244	<0.007	<0.66	2.22	<2.7	<0.027	0.153	<0.66	0.048
09-4837	0.030	<0.025	<2.7	0.75	0.199	<0.006	<0.63	1.84	<2.5	<0.027	0.118	<0.63	0.043
09-4838	0.026	<0.023	<2.7	0.67	0.210	<0.006	<0.58	1.88	<2.3	0.033	0.118	<0.58	0.042
09-4839	0.038	0.038	<2.7	0.74	0.260	<0.006	<0.59	1.75	<2.4	<0.024	0.159	<0.59	0.049
09-4840	0.035	<0.025	<2.7	1.02	0.231	<0.006	<0.63	1.78	<2.5	<0.025	0.151	<0.63	0.045
09-4841	0.054	0.059	<2.7	0.83	0.380	<0.006	<0.63	1.90	<2.5	<0.025	0.218	<0.63	0.066
09-4842	0.041	0.040	<2.7	0.84	0.317	<0.006	<0.56	1.79	<2.2	<0.022	0.194	<0.56	0.054
09-4843	0.049	0.059	<2.7	0.41	0.374	<0.005	<0.50	1.52	<2.0	<0.020	0.236	<0.50	0.061
09-4844	<0.002	<0.008	<2.7	0.34	0.008	<0.002	<0.20	0.77	<0.8	<0.008	0.004	<0.20	0.003
09-4845	<0.002	<0.008	<2.7	0.36	0.007	<0.002	<0.20	0.64	<0.8	<0.008	0.004	<0.20	<0.002
09-4846	0.005	<0.009	<2.7	0.19	0.023	<0.002	<0.23	0.73	<0.9	<0.009	0.013	<0.23	0.005
09-4847	<0.002	<0.007	<2.7	0.26	0.007	<0.002	<0.19	0.59	<0.7	<0.007	0.004	<0.19	0.002
09-4848	<0.002	<0.008	<2.7	0.27	0.009	<0.002	<0.20	0.68	<0.8	<0.008	0.007	<0.20	0.003
09-4849	<0.002	<0.009	<2.7	0.25	0.006	<0.002	<0.22	0.71	<0.9	<0.009	0.007	<0.22	0.003
09-4850	<0.002	<0.009	<2.7	0.18	0.013	<0.002	0.61	0.72	<0.9	<0.009	0.006	<0.21	0.003
09-4851	<0.002	<0.008	<2.7	0.20	0.013	<0.002	<0.20	0.65	<0.8	<0.008	0.006	<0.20	0.003
09-4852	<0.002	<0.007	<2.7	0.26	0.004	<0.002	<0.19	0.59	<0.7	<0.007	0.002	<0.19	<0.002
09-4853	0.002	<0.008	<2.7	0.31	0.014	<0.002	<0.20	0.68	<0.8	<0.008	0.007	<0.20	0.003
09-4854	<0.002	<0.008	<2.7	0.25	0.005	<0.002	<0.20	0.72	<0.8	<0.008	0.004	<0.20	<0.002
09-4855	<0.002	<0.007	<2.7	0.16	<0.004	<0.002	<0.19	0.62	<0.7	<0.007	<0.002	<0.19	<0.002
09-4856	<0.002	<0.007	<2.7	0.21	<0.004	<0.002	<0.18	0.63	<0.7	<0.007	0.003	<0.18	<0.002
09-4857	<0.002	<0.008	<2.7	0.43	<0.004	<0.002	<0.19	0.55	<0.8	<0.008	0.003	<0.19	0.002
09-4858	<0.002	<0.008	<2.7	0.22	<0.004	<0.002	<0.20	0.62	<0.8	<0.008	0.002	<0.20	<0.002
09-4859	<0.002	<0.008	<2.7	0.32	<0.004	<0.002	<0.20	0.67	<0.8	<0.008	0.004	<0.20	0.002

Table A7: Tabulated geochemical data for vegetation (continued).

Sample	Ta	Th	U	W	Yb
Maireana	INAA	INAA	INAA	INAA	INAA
	ppm	ppm	ppm	ppm	ppm
09-4835	0.29	0.10	<0.26	<0.53	<0.013
09-4836	0.38	<0.07	<0.27	<0.53	<0.013
09-4837	<0.13	0.09	<0.25	<0.50	<0.013
09-4838	<0.12	0.07	<0.23	0.65	0.018
09-4839	0.21	0.10	<0.24	<0.47	0.013
09-4840	0.14	0.16	<0.25	0.50	<0.013
09-4841	0.20	0.16	<0.25	<0.50	<0.013
09-4842	<0.11	0.12	<0.22	<0.44	<0.011
09-4843	0.12	0.11	<0.20	<0.40	0.020
09-4844	<0.04	<0.02	<0.08	<0.16	<0.004
09-4845	<0.04	<0.02	<0.08	<0.16	<0.004
09-4846	<0.05	<0.02	<0.09	<0.18	<0.005
09-4847	<0.04	<0.02	<0.07	<0.15	<0.004
09-4848	<0.04	<0.02	<0.08	<0.16	<0.004
09-4849	<0.04	<0.02	<0.09	<0.18	<0.004
09-4850	<0.04	<0.02	<0.09	<0.17	<0.004
09-4851	<0.04	<0.02	<0.08	<0.16	<0.004
09-4852	<0.04	<0.02	<0.07	<0.15	<0.004
09-4853	<0.04	<0.02	<0.08	<0.16	<0.004
09-4854	<0.04	<0.02	<0.08	<0.16	<0.004
09-4855	<0.04	<0.02	<0.07	<0.15	<0.004
09-4856	<0.04	<0.02	<0.07	<0.15	<0.004
09-4857	<0.04	<0.02	<0.08	<0.15	<0.004
09-4858	<0.04	<0.02	<0.08	<0.16	<0.004
09-4859	<0.04	<0.02	<0.08	<0.16	<0.004

HIGGINSVILLE REGOLITH LANDFORMS SCHEMATIC DIAGRAM



Relict/Erosional

SCer01 — *Mafic/ultramafic bedrock sequences developed as rises (>9m local relief) and having lateritic duricrusts (iron rich in places) occurring on sub-crestal to crestal regions with a matrix of shallow reddish to khaki very fine sandy clays. Ferruginous saprolite exposures (>3m thick), and ferruginous nodular and granular lags.*

Erosional

Ser01 — *Saprolitic ultramafic bedrock exposures developed as rises (>9m local relief) and rarer low hills (9-30m local relief) with minor colluvial mantles on flanking slopes.*

Very highly weathered bedrock

SVep01 — *Very weathered mafic to ultramafic and metabasaltic bedrock exposures developed on erosional plains. In places, may be bounded by erosional scarps usually at the head of drainage tracts.*

SVep02 — *Erosional plains with exposures of deeply weathered saprolite, and clearly bounded by erosional scarps at the head of drainage tracts.*

Moderately weathered bedrock

SMer01 — *Dominantly greenstone lithologies developed as rises (>9m local relief) with calcareous colluvial mantles of very fine sandy light-textured clays.*

SMel01 — *Greenstone bedrock exposures forming low hills (30-90m local relief) with a mantle of colluvium containing bedrock fragments; lithic fragments in places present as surface lag.*

Slightly weathered bedrock

SSec01 — *Slightly weathered granitic bedrock exposures forming etched planar to slightly undulating platforms of limited extent with little or no colluvial mantle remaining.*

SSec02 — *Slightly weathered, dominantly metasedimentary, bedrock sequences developed as etched planar to slightly undulating platforms, with little or no colluvial mantle.*

SSec03 — *Slightly weathered mafic to ultramafic bedrock exposures and developed as etched planar platforms with little to no colluvial mantle.*

SSec04 — *Slightly weathered mafic to ultramafic dyke-form bedrock exposures developed as etched planar platforms with distinct colluvial mantle.*

SSer01 — *Slightly weathered granitic bedrock exposures forming gently to moderately inclined surfaces on the flanks of erosional rises and having a patchy, thin veneer of colluvial sheetflow sediments.*

SSer02 — *Slightly weathered granitic bedrock exposures forming gently to moderately inclined surfaces on the flanks of erosional rises and having an extensive, but mostly shallow, veneer of sandy to slightly clayey colluvial sheetflow sediments.*

SSer03 — *Slightly weathered, dominantly greenstone bedrock lithologies developed as bedrock rises, in places with granitic interbeds. Commonly occurring as the flanking region of the near-crestal portion of bedrock rises. Calcareous sandy, clayey colluvial mantle containing lithic fragments and possibly some calcareous nodules.*

SSer04 — *Slightly to moderately weathered metasedimentary sequences developed as bedrock rises (>9m local relief) with a colluvial mantle of clayey, silty sands through to sandy clays.*

SSer05 — *Slightly weathered mafic to ultramafic dyke-form bedrock exposures and Mg basalts developed as rises (>9m local relief); little or no colluvial mantle on flanking slopes.*

SSer06 — *Slightly weathered mafic to ultramafic dyke-form bedrock exposures and Mg basalts developed as rises (>9m local relief), with distinct colluvial, calcareous sandy light-textured clay mantles present on flanking slopes.*

SSel01 — *Slightly weathered granitic bedrock exposures forming low hills (30-90m local relief) with little or no colluvial mantle present.*

Depositional

Alluvial sediments

Aap02 — *Alluvial sediments with minor colluvium derived from nearby slopes. Calcareous sandy silty clays and clayey silty sands are exposed on an alluvial plain and smaller tracts between rises and low hills.*

ACap01 — *Alluvial channel sediments consisting of various combinations of quartz sands, clays and silts.*

Colluvial sediments

CHfs01 — *Sheetflow deposits consisting of colluvial sediments derived from ultramafic bedrock exposures, and having surface lags consisting of ferruginous granules over calcareous soils.*

CHpd01 — *Calcareous sheetflow sediments: red-brown sandy, light to medium textured clays to a depth of more than 70cm and occurring on and inclined to gently undulating depositional plains. Some areas of quartzofeldspathic sandy lag at the surface and with less than 2 per cent of ferruginous granular lithic bedrock fragments derived from local greenstone.*

CHpd02 — *Sheetflow deposits consisting of highly calcareous khaki-coloured very fine sandy clays over calcareous nodules at about 20cm depth.*

CHpd03 — *Sheetflow deposits consisting of highly calcareous silty clay loams, sometimes gritty, to a depth of 60cm overlying calcareous medium to heavy textured red-brown clays. Very rare calcareous nodules present at the surface, but mostly dominated by black ferruginous (1-4 mm) lag.*

Dunefield sediments

EGun01 — *Lunettes and single dune forms consisting of combinations of quartz sands, silts and some halite, with associated playa plains and lakes.*

Lacustrine sediments

Lpl01 — *Lacustrine sediments consisting of saline gypsiferous red-brown muds (ie clays and silt mixtures) forming mud flats on the edge of saline lakes and broad playa plains.*

Lpp01 — *Lacustrine sediments with some halite, and gypsiferous red-brown clays and silts forming salt lake playa plains.*

INDURATION MODIFIER

Calcareous earths, soil carbonate, calcareous nodules

Lag-variable composition, but dominantly gravel-sized, consisting of bedrock fragments

Lag-gravels: dominantly sandy quartzofeldspathic, or quartzofeldspathic granules or mixtures

Ferruginous fragments - mixed composition: lateritic residuum, duricrust, Fe segregations, Fe-saprolite and Fe-stained hardpan.

Ferruginous fine gravel lags

Black lightly magnetic haematite - maghematite rich ferruginous granules

EROSIONAL LANDFORMS

er	*Rises*
ep	*Erosional plain*
el	*Low hills*
ec	*Etchplain*

DEPOSITIONAL LANDFORMS

ap	*Alluvial plain*
fs	*Sheet-flood fan*
pd	*Depositional plain*
un	*Lunette*
pl	*Lacustrine plain*
pp	*Playa plain*

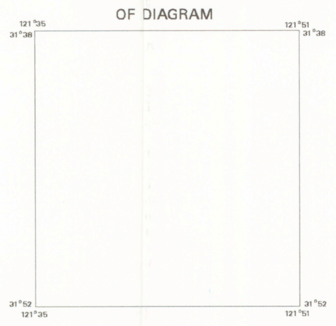
Traverses

Roads, tracks, fences and powerlines

Palaeochannel

MAP LOCALITY

APPROXIMATE LOCATION OF DIAGRAM



APPROXIMATE SCALE 1:50 000

1000 0 1 2 3 4 5

Metres Kilometres

UNIVERSAL TRANSVERSE MERCATOR PROJECTION

Latitude of Origin : 0°, Longitude of Origin : 123 °
Scale Reduction Factor 0.9996

Compiled by M. A. Craig (CRC LEME/AGSO), 1996

Diagram composition by P. Ursem and M. A. Craig (AGSO), 1996

This diagram forms part of the following document:

Report number 275R
THE DISTRIBUTION OF GOLD AND OTHER ELEMENTS IN SURFICIAL MATERIALS FROM THE HIGGINSVILLE PALAEOCHANNEL GOLD DEPOSITS, NORSEMAN, WA
M. J. Lintern, M. A. Craig, D. Walsh, and N. Sheridan

The regolith diagram is based on the interpretation of 1:86 000 RC9 panchromatic aerial photography (1967) of the Borabbin and/or Widgiemooltha 250k sheet areas and selected field traverses. This diagram provides a broad overview of regolith landforms as a framework for more detailed local knowledge. Boundaries and polygon descriptions are generalised to show the main regolith and landform types. The diagram is not a true map. It is not fully spatially rectified. The scale is non linear and is only approximate. Relative spatial relationships are approximate.

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Topographic information shown on this diagram has been derived from 1:86 000 RC9 panchromatic aerial photography 1967.

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