PRIMARY INDUSTRIES
AND RESOURCES SA

REPORT BOOK NUMBER 98/8

GEOCHEMICAL STUDES OF THE REGOLITH AT THE MT GUNSON COPPER DEPOSITS, STUART SHELF, SOUTH AUSTRALIA

by

M J Lintern
Cooperative Research Centre for Landscape Evolution and Mineral Exploration
CSIRO Exploration and Mining

M J Sheard
Regolith Terranes Group, Minerals Division

D J Gray
Cooperative Research Centre for Landscape Evolution and Mineral Exploration
CSIRO Exploration and Mining

FEBRUARY 1998

© Department of Primary Industries and Resources South Australia, 1998
This report is subject to copyright. Apart from fair dealing for the purposes of study, research, criticism or review as permitted under the Copyright Act, no part may be reproduced without written permission of the Director-General of Primary Industries and Resources South Australia.

Distribution list

	Copy No
Stuart Metals NL	1-3
CSIRO	
Mr M. J. Lintern	4
Dr D. J. Gray	5
Dr C. R. M. Butt	6
CRC LEME Records	7
PIRSA	
Mr M. J Sheard	8
PIRSA Records	9

This is copy of 9

SUMMARY

The principal objective of the Cooperative Research Centre for Landscape Evolution and Mineral Exploration (CRC LEME) Shields Program and the Primary Industry and Resources of South Australia (PIRSA) Regolith Terranes Group in South Australia is to develop technically efficient procedures for mineral exploration in the major Cratons. This is to be achieved through a comprehensive understanding of the processes of regolith development and landscape evolution and their effects on the surface expression of concealed mineralization.

The specific objectives are to:

1. Establish broad spatial relationships between regolith, landforms and bedrock lithotypes;
2. Establish mineralogical and geochemical characteristics of regoliths in different geological, geomorphological and climatic environments;
3. Characterize the surface and sub-surface geochemical expression of major ore systems in the regolith;
4. Establish relationships between geochemical dispersion patterns, weathering processes and evolutionary stages of regolith and landform development;
5. Develop appropriate exploration procedures for different landscape situations for each of the Cratons.

This particular research report contributes to all of the above objectives. The study consisted of detailed sampling of the Quaternary units and uppermost Adelaidian sedimentary units in order to identify potential sampling media for Au and Cu mineralization using the techniques of selective extraction and total element content analyses. The study area is located at Mt Gunson where the thickness of Quaternary transported material is variable (3 m to 15 m). The depth to mineralization (beneath weakly mineralized or barren sedimentary units) is about 30 m at the Cattlegrid deposit and 70 m at Windabout prospect.

The major findings for this study are summarized below:

1. Manganese and Fe oxides and oxyhydroxides appear to accumulate base and heavy metals such as Cu, Pb, Zn, and Co and need to be considered using data normalization procedures if exploring for these metals using the upper regolith; the difficulty in recognising these materials in drill hole cuttings probably negates their specific use as sampling media.

2. The concentration of Au is generally <2 ppb and is a contributing factor as to why the distribution of Au is highly variable in the upper regolith and does not show a strong association with calcrete. Nevertheless, because of its success in other parts of the Gawler Craton, calcrete sampling sampling is recommended for Au exploration; the use of a power auger to collect the top metre composite is further recommended since this will maximize the probability of collecting carbonate. Care should be taken if attempting to remove wind blown sand by sieving as this process may remove much of the fine carbonate.

M. J. Lintern
Project Leader
February 1998

TABLE OF CONTENTS

TABLE OF FIGURES

LIST OF PHOTOGRAPHS

GEOCHEMICAL STUDIES OF THE REGOLITH AT THE MT GUNSON COPPER DEPOSITS, STUART SHELF, SOUTH AUSTRALIA

M. J. Lintern[1], M. J. Sheard[2] and D. J. Gray[3]

[1]Cooperative Research Centre for Landscape Evolution and Mineral Exploration, CSIRO Exploration and Mining c/o PIRSA GPO Box 2355 ADELAIDE SA 5001, Australia

[2]Regolith Terranes Group, PIRSA GPO Box 2355 ADELAIDE SA 5001, Australia

[3]Cooperative Research Centre for Landscape Evolution and Mineral Exploration, CSIRO Exploration and Mining, Private Mail Bag, PO Wembley WA 6014

1. INTRODUCTION

1.1 Background to study

In the late 1980s and early 1990s, CSIRO-AMIRA jointly-funded Projects (P240, P240A, P241, P241A) in the Yilgarn Craton in WA investigated the geochemical expression of primary and supergene Au mineralization in the regolith. These studies demonstrated that in relict (laterite-dominated) and erosional (saprolite-dominated) 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 was a surface expression of mineralization concealed by up to 40 m of barren sediments and/or apparently leached saprolite.

Two groups of sample media were found to have particular value for mineral exploration in the Yilgarn Craton; these were:

(i) ferruginous materials, particularly lateritic residuum, ferruginous saprolite and lag;

(ii) calcareous soil horizons, which are widespread in the semi-arid parts of the southern Yilgarn. Gold concentrations are often much greater in pedogenic carbonate, compared with immediately adjacent non-calcareous horizons.

The research was highly successful, with at least three large Au deposits (Plutonic, Bronzewing and Challenger) found using methodologies directly attributable to the CSIRO-AMIRA Projects. One of the principal outcomes of this research has been the formation of the Cooperative Research Centre for Mineral Exploration and Landscape Evolution (CRC LEME) in 1995, and with it a new impetus to continue regolith research, particularly in other parts of Australia.

In 1996, CRC LEME and the (then) Mines and Energy Department of South Australia (MESA) commenced joint regolith studies in South Australia to assist the exploration industry with precious and base metal exploration over areas of variably-covered terranes. The CRC LEME - MESA group has been approached by several companies since late 1996 offering research sites for pilot regolith studies. All sites were visited and assessed using various criteria for suitability including style and tenor of mineralization, presence of known surficial anomalies and regolith setting. In mid-1997, Stuart Metals requested an orientation study on the Mt Gunson Cu deposits located on the Stuart

Shelf about 130 km NNW of Port Augusta, South Australia. This site provided an opportunity to sample and examine exposed regolith units due to the presence of open cut mining operations, and to examine geochemical dispersion in transported materials overlying well characterized mineralization.

1.2 Previous work

Published geochemical exploration studies at Mt Gunson are extremely limited in terms of quantity and scope. Many of the studies that have undoubtedly been undertaken are presumably unavailable due to company confidentiality restrictions. However, some of the studies undertaken by CSR Minerals Ltd in the 1970s are available and have been reported in Rattigan *et al* (1977) and are summarized below:

i) Direct deep drilling of the Adelaidian units was the most successful technique in locating primary and secondary mineralization.
ii) Shallow drilling through Quaternary cover and sampling of the upper Adelaidian units showed some correlation with deeper mineralized Whyalla Sandstone units but not where mineralization is hosted by lutites.
iii) Groundwater sampling generated false anomalies but was recommended for further study.
iv) Biogeochemical sampling was successful over mineralized Whyalla Sandstone but not over lutites.
v) Stream sediment sampling was largely unsuccessful due to sampling difficulties and the failure to generate prospective anomalies.

Recently, Stuart Metals NL (Anon, 1997) have undertaken regional groundwater, soil and calcrete sampling in the Mt Gunson and surrounding areas. Numerous Au, Pb and Cu anomalies were generated and in particular over the Mt Gunson deposits and in a large area to the south (Figure 1). Calcrete has been successfully used as an exploration medium for copper and gold throughout southern Australia (Lintern and Butt, 1993; Lintern, 1997; Edgecombe, 1997; Wills, 1997).

1.3 Aim and scope of present study

Exploration in the Mt Gunson area has been hampered by the presence of cover in the form of salt lakes, sand dunes and un-mineralized units of the Adelaidian sequence. Dune soils in particular have been largely ignored as a sample medium with exploration strategies to date concentrating on drilling through to saprolite and bedrock beneath. Stuart Metals NL has partly addressed this oversight by undertaking regional calcrete sampling, often in dune-dominated landforms over its leases centred on the Mt Gunson area. This study was designed to assist exploration using the Quaternary units by (i) identifying potential regolith sample media, and (ii) determine the most appropriate ways to explore in the area using this material.

Cattle Grid and Windabout were the two sites examined during this study. The exposures of the Mt Gunson open cut mining operations at Cattle Grid were taken full advantage of: high quality samples were obtained from several pit faces and regolith relationships were easily observed and documented during the sampling phase. At the other site, Windabout, where there were no mining operations, sampling of two backhoe-excavated pits, specifically put in for this project, were used in conjunction with diamond drill hole cuttings. Specifically, the scope of the study was to (i) undertake the collection of approximately 50 high quality surficial and pit face samples and (ii) to investigate chemical associations of metals with phases mostly within the Quaternary cover.

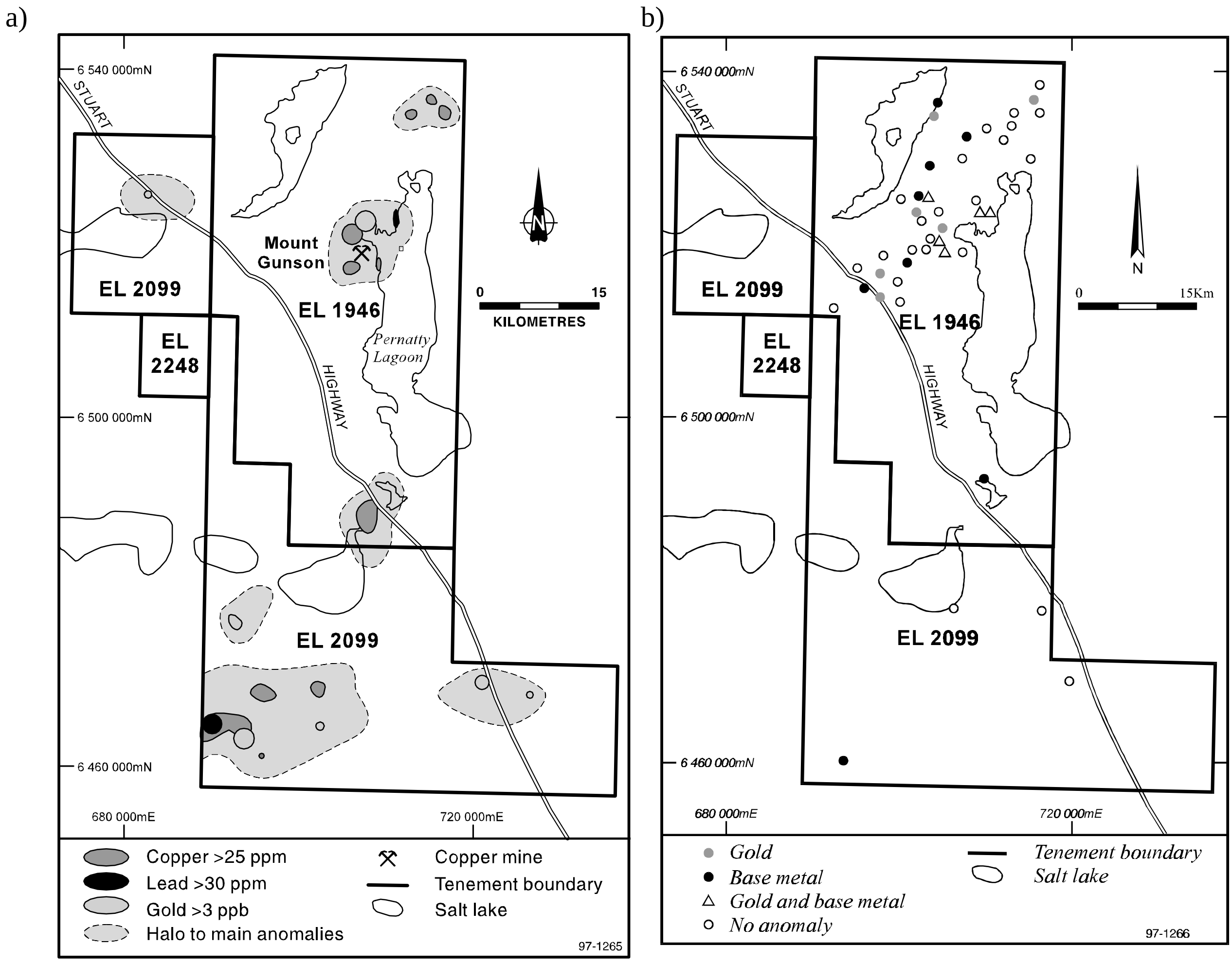


Figure 1: Principal geochemical anomalies in a) calcrete and b) groundwater in the Mt Gunson area (from Anon, 1997).

2. SITE DESCRIPTION

2.1 Regional Geology

The Mount Gunson copper deposits occur in the Neoproterozoic Stuart Shelf, overlying the eastern edge of the Gawler Craton (Figure 2). They are located 60 km west of the Torrens Hinge Zone, which separates the Shelf from the Adelaide Geosyncline (Thomson *et al*, 1975; Preiss 1987; Tonkin and Creelman, 1990) and coincide with a NNW trending transcontinental gravity lineament (the G2 corridor) which also extends through the Olympic Dam Deposit (O'Driscoll, 1986; Preiss, 1993) (Figure 2).

A detailed account of the Mt Gunson area geology and copper mineralization is provided in Tonkin and Creelman, 1990. In the vicinity of Mt Gunson a complex horst structure of Mesoproterozoic basement (the Pernatty Culmination; Johns, 1974) strongly influenced Neoproterozoic sedimentation, promoting units to thin or be absent over this horst structure (inlier). Rock porosity and mineral trapping potential was enhanced near to and over the Pernatty Culmination - allowing copper-rich solutions to deposit in this location. Rock units considered important in controlling copper mineralization are the Mesoproterozoic basement - Pandurra Formation and the Stuart Shelf sediments - Tapley Hill Formation, Whyalla Sandstone and the Tregolana Shale (Neoproterozoic).

Discontinuities between these units are considered mineralization loci, the most important being that between the Pandurra Formation and the Whyalla Sandstone (Tonkin and Creelman, 1990).

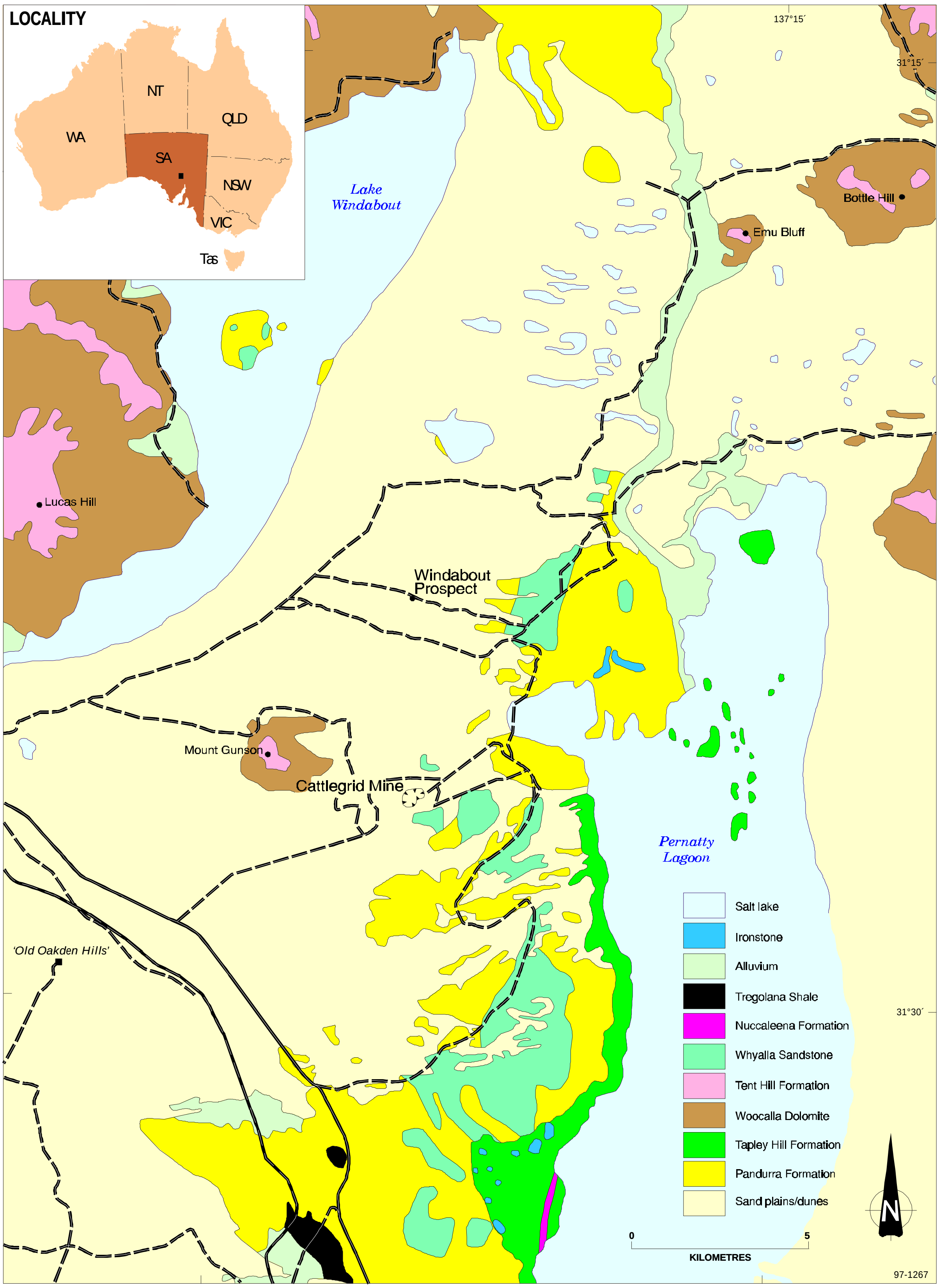


Figure 2: Location and regional geology of the Mt Gunson area. Extract from the Torrens 1:250000 geology sheet.

2.2 Landforms

The area surrounding the local high point of Mt Gunson (259 m AHD, ~100 m above the surrounding area) has relatively low topographic relief and is dominated by low rises related to Proterozoic basement outcrop and/or near surface occurrences. The copper deposits are located just west of Pernatty Lagoon - a large dry salt pan (~NS elongated), one of a number in this region. Cainozoic sediments, in particular, the Quaternary orange sand dunes and related sand spreads, mantle the pre-Cainozoic land surface and impose a local and regional topographic pattern (~ E-W to ESE-WNW). Wind-borne dust as clay, silt, carbonate and gypsum, have been incorporated by illuviation and solution into the otherwise sandy (mostly aeolian derived) Cainozoic sedimentary landforms.

2.3 Upper regolith

The available mine pit sections provided an excellent window into the regolith that otherwise is poorly exposed in this area. Tertiary and Quaternary weathering and concomitant cementing–indurating processes–events have modified these profiles which are now exposed in mine pit walls.

Surficial pedogenic silicification of the pre-Cainozoic sediments during the Mid-Tertiary has yielded some silcrete and/or amorphous silica cementation of the Whyalla Sandstone. This process indicates that these Stuart Shelf sediments were exposed as a land surface at some stage - probably during the Mid-Tertiary. The silicification process requires either (i) highly alkaline or strongly acidic conditions acting on quartz or (ii) milder pH conditions if derived from materials such as feldspars, to prevail long enough to dissolve and redeposit amorphous silica as cement in the substrate sandstones.

Crystalline gypsum veining is common within the Quaternary sand spreads, this veining appears to pre-date the calcrete influx and usually underlies it. Large (cm scale) individual euhedral gypsum crystals are also located in the red-mottled gley clays that overlie the Stuart Shelf sediments at Windabout. These gley clays may be either Mid- to Late Tertiary or early to mid-Quaternary in age, they may represent slow deposition under water-logged conditions.

Carbonate occurs as silt, sand, earthy coatings and segregations or as more indurated forms of calcrete-grain cement/coatings, pisolites and nodules. Carbonate is present generally throughout the Quaternary sands in the Cattlegrid area but at Windabout it is restricted to close to the surface and near the base of the sands (16-17 m) - just 2 m above the gley clays. Manganese oxides–hydrous oxides are present as ped cutans and gypcrete coatings or inclusions; these occur low in the Cainozoic sand profile (>6 m). A distinct narrow zone of dark Mn oxides was observed in two profiles and were found to be important as loci for elevated metal concentrations. Location and regolith stratigraphy of profiles are displayed in Figure 3 and Figure 4 with detailed logs provided in Appendix 1.

2.4 Mineralization

Minor mineralization occurs in many units of the Adelaidian sequence including the Pandurra Formation, McLeay Beds, Tapley Hill Formation, Whyalla Sandstone and Tregolana Shale. Two major styles of mineralization are recognized at Mt Gunson and exemplified by the two areas studied in this report.

2.4.1 Cattle Grid

Mineralization generally occurs at the interface between the Pandurra Formation and Whyalla Sandstone (Figures 5 to 8). According to Van Herk *et al* (1975), this is a flat-lying, stratiform epigenetic ore lying beneath 15 to 35 m of Whyalla Sandstone and up to 10 m of Quaternary sand. The mineralized unit (termed Cattle Grid breccia) consists of a blanket of silicified brecciated red bed Pandurra Formation sandstone (quartzite) averaging 4.5 m thickness (Williams and Tonkin, 1985; Preiss, 1987). The dominantly chalcopyrite ($CuFeS_2$) - chalcocite (Cu_2S) - bornite (Cu_5FeS_4) ore also carries Ag, Zn, Pb, Co, Ni, As, Bi and traces of Au (Tonkin and Creelman, 1990; Rattigan *et al*, 1977).

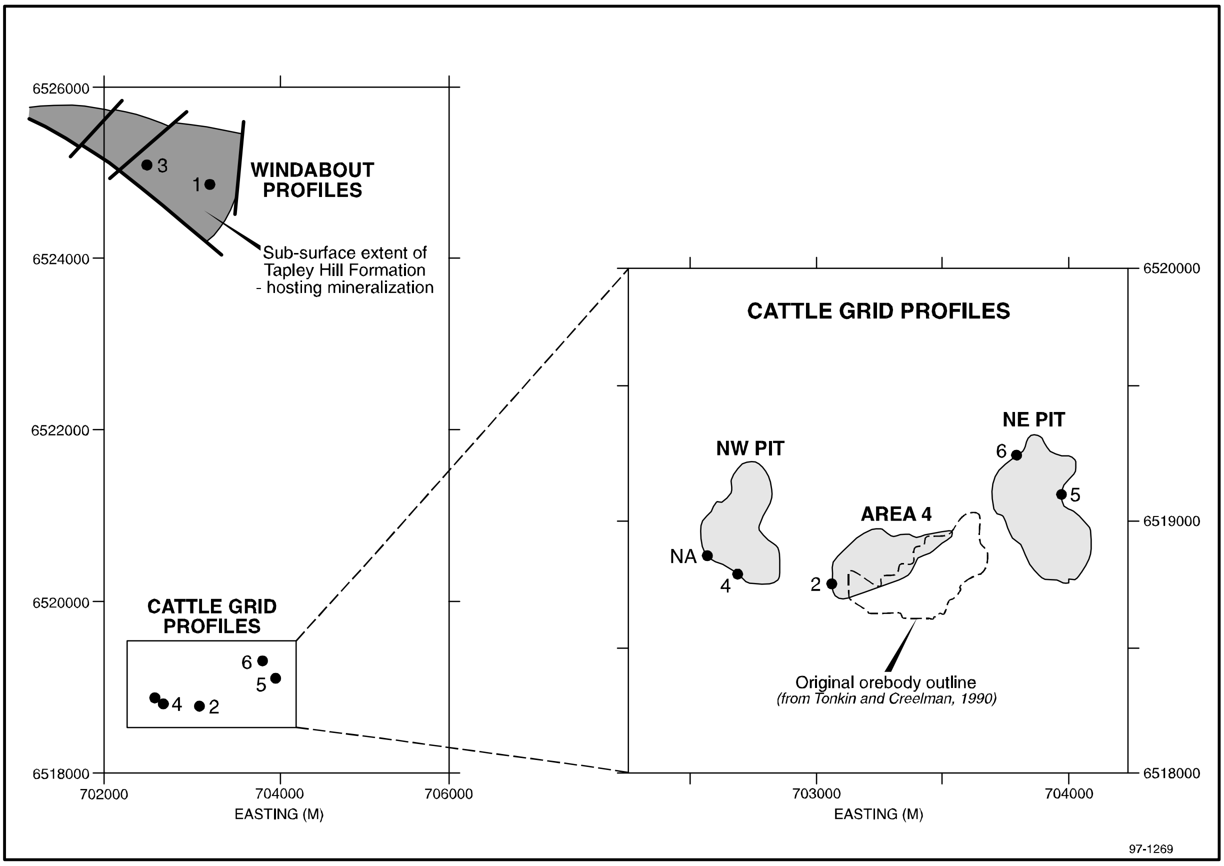


Figure 3: Location of the Windabout and Cattlegrid profiles. Mineralized Tapley Hill Formation location derived from information provided by Cobalt Resources NL.

2.4.2 Windabout

Copper mineralization is largely confined within black calcareous shales of the Tapley Hill Formation and is associated with Pb, Zn, Mn and Ba (Johns, 1974; Rattigan *et al*, 1977). The mineralization is located at about 70 m depth in the area sampled. Mineralization occurs as chalcopyrite, bornite, chalcocite and carrollite (Anon, 1995). Copper (and Co) mineralization beneath Profile 1 and 3 is hosted by the Tapley Hill Formation; at Windabout, this Formation occurs as shallow as 65 m and can extend to 97 m, with a general thickness of the order of 15 to 25 m. It is separated from the Quaternary units by Tregolana Shale and Whyalla Sandstone. The richest Cu grades for drill hole LW 121 (702512E 6524999N, close to Profile 3) occur from 69 m to 72 m (average of 2.6% Cu) and for drill hole LW 196 (703402E 6524870N, close to Profile 1) occur from 67 m to 69 m (average of 1.52% Cu). Copper in the regolith above the Tapley Hill Formation was generally not analysed for by the exploration company although Cu concentrations in Whyalla Sandstone immediately above the Tapley Hill Formation were generally of the order of 10 to 100 ppm Cu.

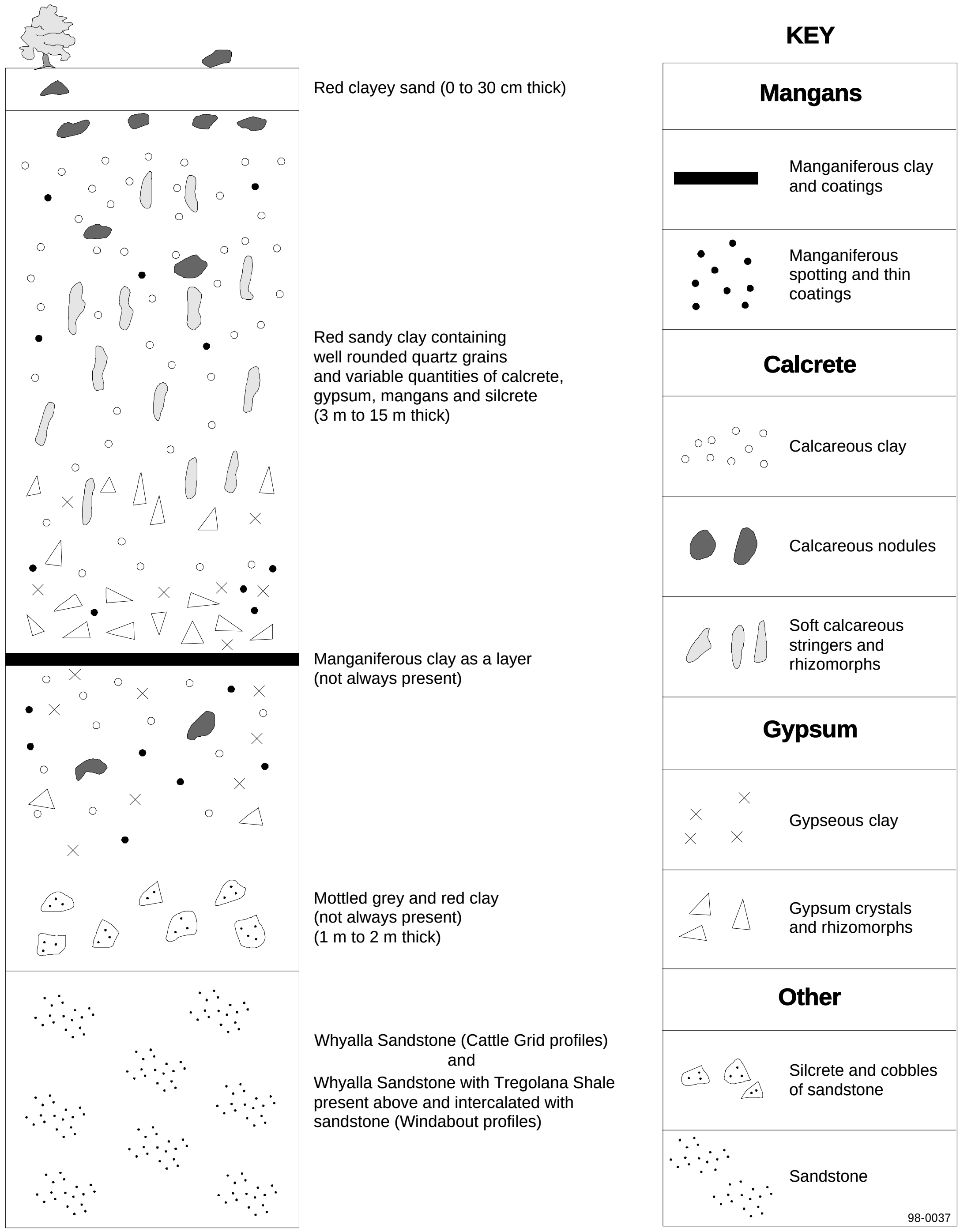


Figure 4: Typical section through the profiles sampled at Mt Gunson.

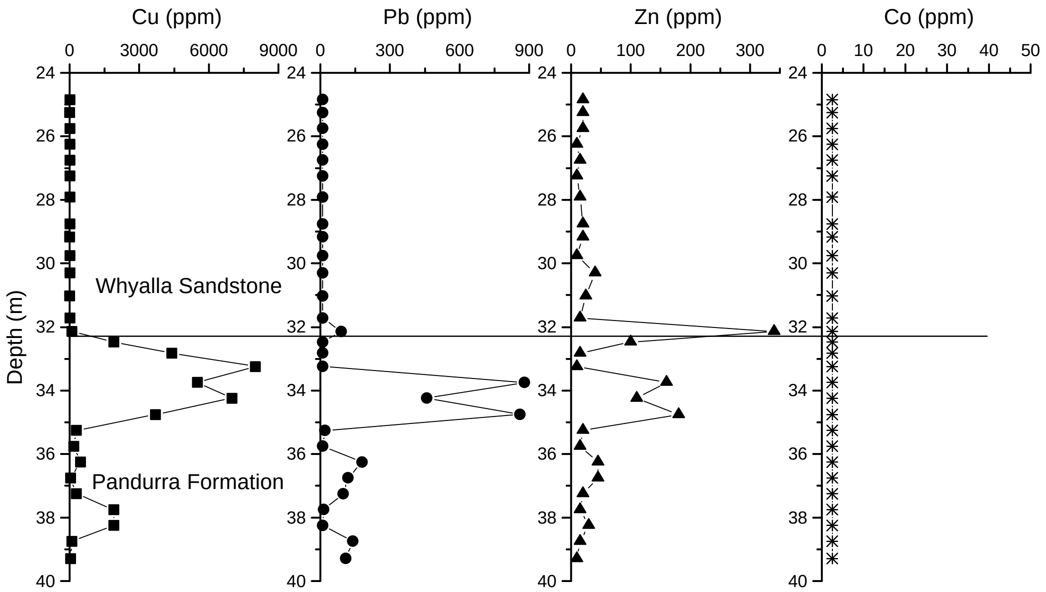


Figure 5: Geochemistry of Profile CG9D (adjacent to Profile 5). Data derived from Mount Gunson Mines Pty Ltd.

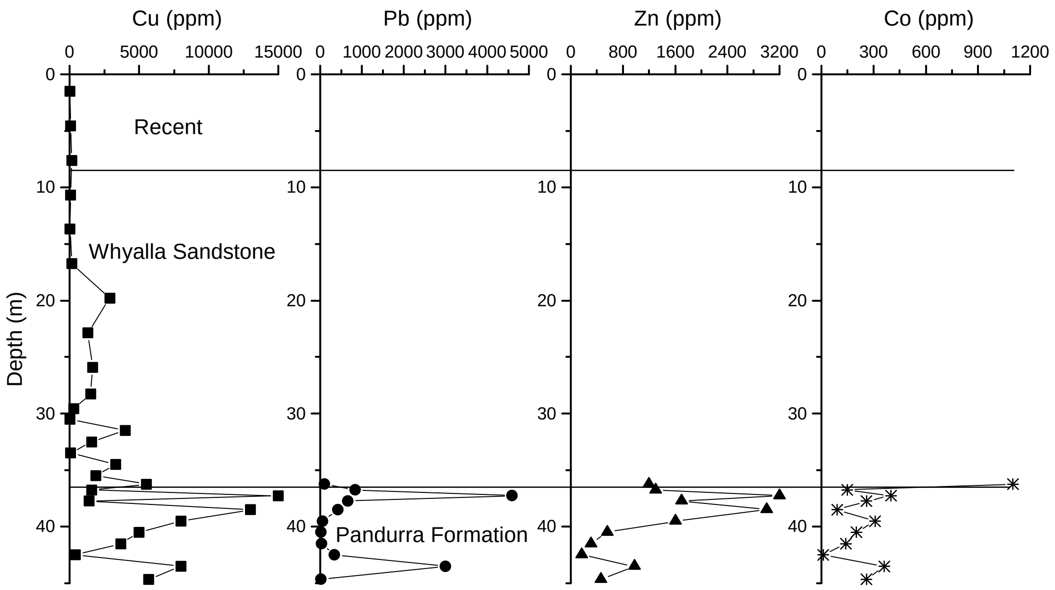


Figure 6: Geochemistry of Profile CG58D (adjacent to Profile 2). Data derived from Pacminex Pty Ltd.

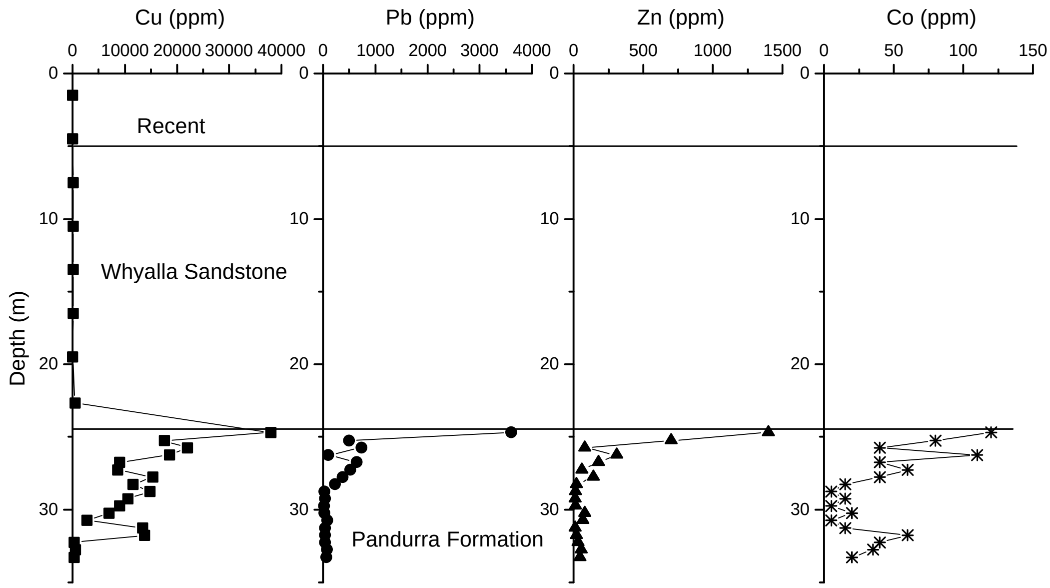


Figure 7: Geochemistry of Profile CG78D (adjacent to Profile 6). Data derived from Pacminex Pty Ltd.

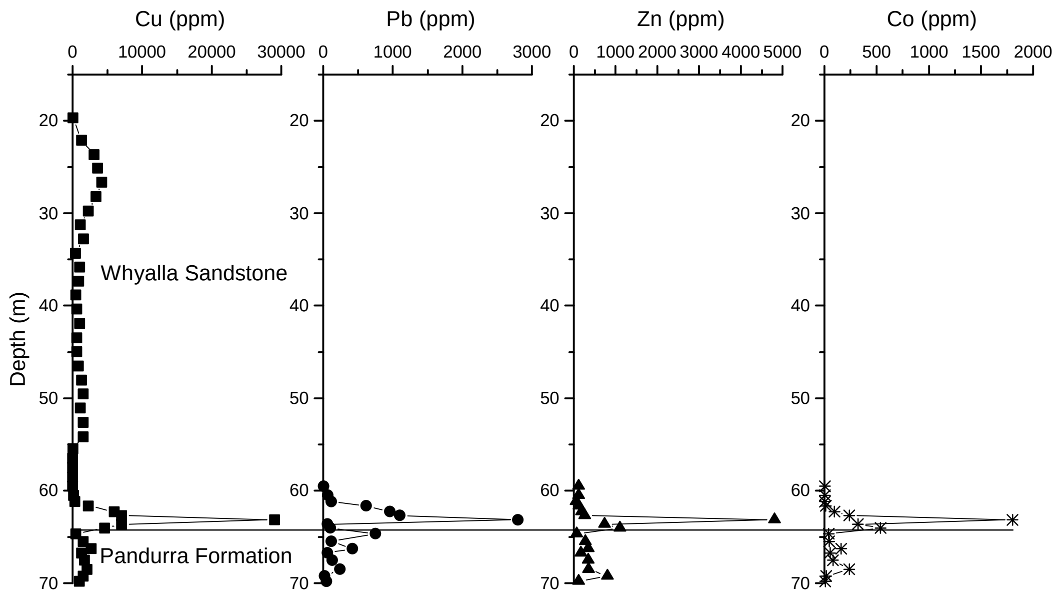


Figure 8: Geochemistry of Profile CG16 (adjacent to Profile 4). Data derived from Pacminex Pty Ltd.

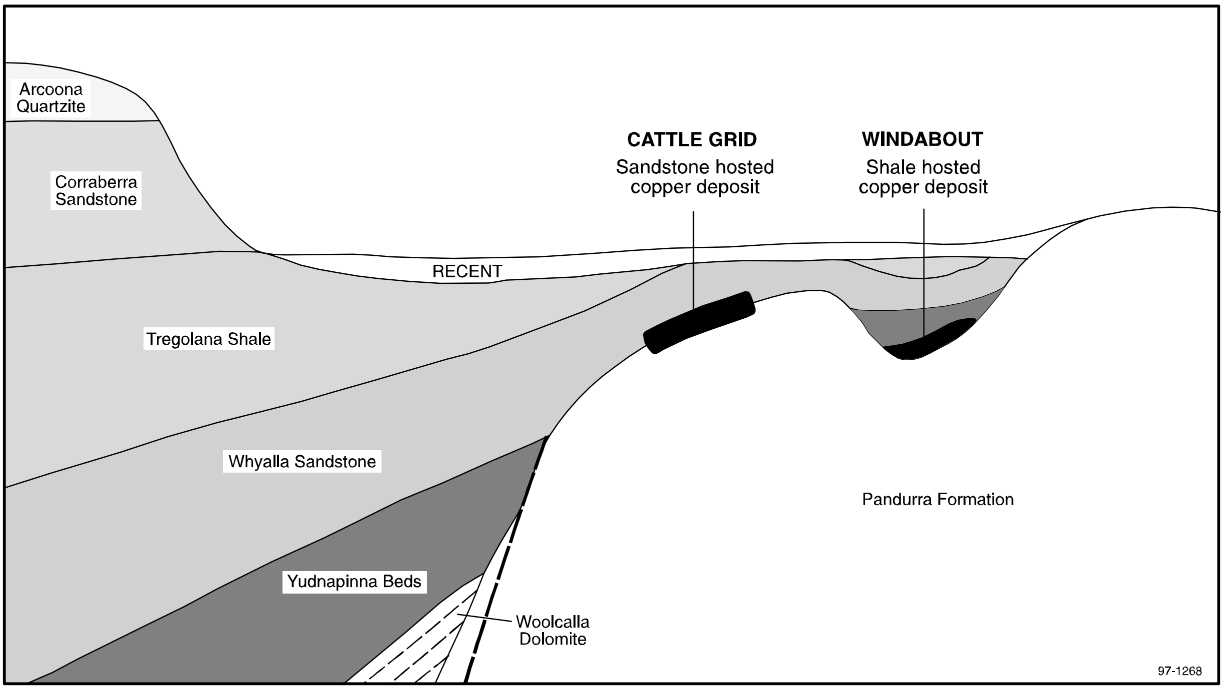


Figure 9: Stylized section showing stratigraphy and mineralization hosts (modified after Tonkin and Creelman, 1990).

3. SAMPLING AND ANALYSIS

3.1 Sample collection

The Mt Gunson site was visited during late June, 1997 for the purpose of sample collection. Samples were collected using three separate procedures as follows:

(i) pit wall samples were collected by abseiling down mining faces and using a geological hammer and bucket to collect material at specific intervals or when recognisable horizons were encountered. Surface material was first cleaned off, prior to sample collection using the geological hammer;

(ii) near surface samples were collected by first excavating small pits with either a spade or a back hoe, cleaning down the exposed faces, and sampling using a dustpan and geological hammer; and

(iii) deeper samples from the Windabout deposit were collected by sub-sampling core material from two diamond holes.

3.2 Sample preparation and analyses

Samples were mixed and approximately 200 g were split off by incremental extraction, with the remainder kept as a reference. The split samples were sent to Analabs for crushing (if required) and were then fine pulverized in a tungsten-carbide mill. They were then stored in paper bags.

Aliquots of pulverized samples were dissolved with a triple acid digest and analysed for Ca, Mg, Fe and Mn by ICP-AES and for Ag, As, Bi, Co, Cr, Cu, Ni, Pb, Th, U and Zn by ICP-MS.

3.3 X-ray diffraction analysis

X-Ray diffraction of selected samples was performed using a Philips PW1050 diffractometer, fitted with a graphite crystal diffracted beam monochromator. CuK$\propto$ radiation was used. Each sample was scanned over the range 2-65º 2θ at a speed of 1º 2θ a per minute and data were collected at 0.02º 2 θ intervals. Mineralogical compositions were determined by comparison with JCPDS files and laboratory standard traces.

3.4 Selective extractions

The three methods detailed below are observed to be commonly highly selective for particular mineral phases in soils (Chao, 1984). Five grams of sample were weighed into a centrifuge tube and then sequentially extracted by the methods described below:

3.4.1 pH 5 acetate (carbonates and surface adsorbed metals).

The 5.00 g of sample was shaken with 95 mL 1 mole/litre (M) ammonium acetate at pH 5 for 6 hours. The mixture was then centrifuged (4000 rpm, 15 minutes) and the supernatant decanted. The extraction was repeated. The solid was then mixed with 10 mL 0.1 M ammonium chloride and centrifuged. The three aliquots were combined for analysis by ICP-AES for Ca, Mg, Fe, Mn and S and by ICPMS for Ag, As, Bi, Ce, Co, Cr, Cu, Ni, Pb, Th, U and Zn.

3.4.2 0.1M hydroxylamine (Mn oxides).

The residual solid from the extraction was then mixed with 90 mL 0.1 M hydroxylamine hydrochloride in 0.01 M HNO_3 for at least 30 minutes. The mixture was centrifuged and the supernatant decanted and analysed by ICPMS for the same suite of elements as the pH 5 extraction (Section 3.4.1).

3.4.3 0.25M hydroxylamine (amorphous Fe oxides).

The residual solid from the extraction was then mixed with 90.0 mL 0.25 M hydroxylamine hydrochloride in 0.25 M HCl at 50°C for at least 30 minutes. The mixture was centrifuged and the supernatant decanted and analysed by ICPMS for the same suite of elements as the pH 5 extraction (Section 3.4.1).

3.5 Partial extractions

Three in-house partial extraction solutions, discussed in detail in Gray and Lintern (1993), were used to test the solubility of Au, although the procedure was modified in that pulverzied material was used in place of unpulverized material. In all cases, a 25 g portion of sample material was mixed with 50 mL of extractant in a screw-cap polyethylene plastic 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 / 1 M $NaHCO_3$ pH 7.4 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 Au encapsulated within resistant material such as quartz.

The partial extraction tests were performed as a sequential extraction using 3 different carbon sachets, commencing with deionised water and finishing with cyanide.

4. RESULTS

XRD results are summarized in Table 1. The profiles contain considerable quantities of evaporative minerals NaCl and $CaSO_4$, indicative of saline groundwaters. Of interest is the ubiquitous presence of low quantities of what appears to be a poorly crystalline interstratified mica. Though the genesis of this mineral is unknown, it may be a useful indicator mineral for the strata in this region.

Table 1: Compiled XRD results for selected Mt Gunson study area samples.

Sample	Quartz	Calcite	Gypsum**	Halite	Feldspar	Kaolin	Int. Mica *	Hematite	Goethite
SMR1	XXXX	X				X	X		
SMR3	XXXX	XXX				X	X		
SMR5	XX		XXXX			X			
SMR6	XXXX		XX			X	X		
SMR7	XXXX			X		X	X		
SMR8	XXXX			XX		X	X		
SMR9	XXXX			XX		X			
SMR18	XXX	XXX				X	XX		
SMR20	XXXX					X	X	X	
SMR21	XXXX								
SMR30	XXX	XXXX							
SMR31	XXXX			X	X	X	X		
SMR32	XXXX		XX			X		X	
SMR33	XXXX		X	XXX		X			X
SMR40	XXXX		X		X	X	X		
SMR41	XXXX			X		X	X		
SMR43	XXXX			XX		X	X	X	X
SMR44	XXXX					X	X		
SMR46	XXX	XXX				X			
SMR49	XXXX					X			
SMR66	XXX		XX			XX	X		

X: trace XX: minor XXX: major XXXX: dominant

* Interstratified mica

** Mineral present is in fact bassanite which is a dehydrated form of gypsum that can form from heating gypsum to 70°C or greater. It has almost certainly been formed as an artifact during sample preparation (J. Keeling, pers. comm.).

Elemental and extraction results are compiled in Appendix 2 and shown in Figure 11 - Figure 58. Calcium is commonly present as gypsum and/or calcite (Table 1). Extractable S is generally low, or equimolar with Ca (Figure 10), indicating that samples commonly contain either gypsum OR calcite but seldom both. Comparing Ca and S depth plots (*e.g.*, Figure 11 and Figure 13) will indicate where calcite and/or gypsum occur: in most cases calcite occurs close to the surface. The exception to these observations is the only deep sample, from Profile 4, 35.5 m, which contained 8770 ppm extractable S (Figure 37), most with pH 5 acetate, but with only enough extractable Ca (Figure 35) to account for ~ 40% of this S (this sample is indicated by the circled point in Figure 10). The remainder of the S may be accounted for as epsomite (40%; see Figure 35) and CuSO4 (20%; see Figure 39).

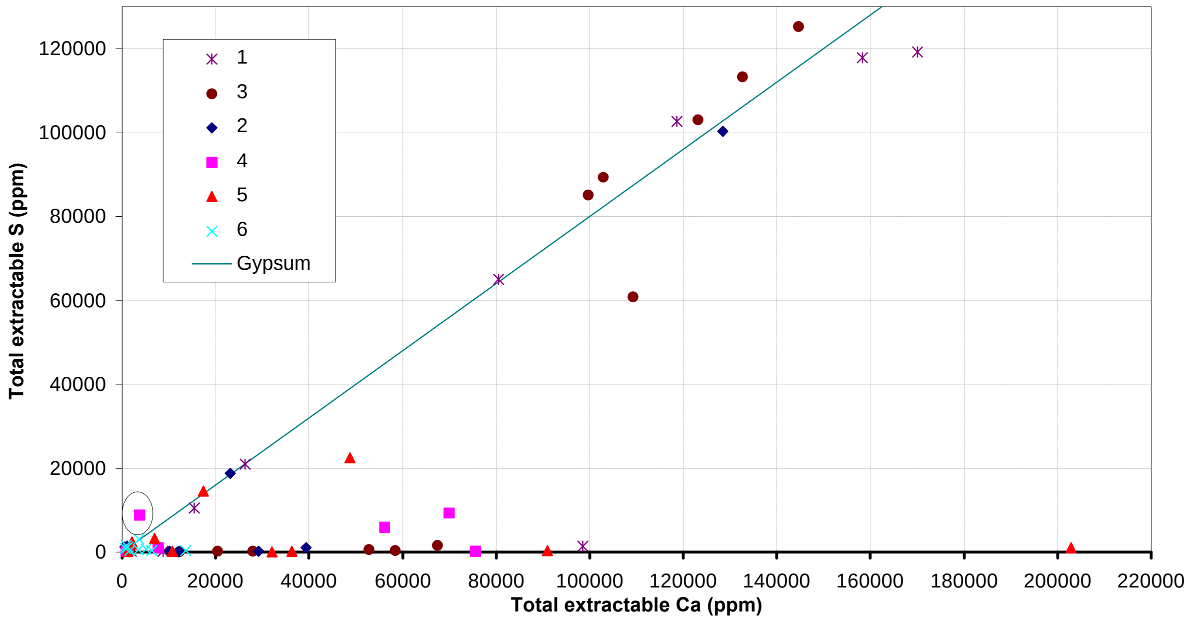


Figure 10: Extractable S vs. Ca for Mt Gunson profiles

With the exception of the deep Profile 4 sample described above, Mg contents are much lower than Ca, with poor solubility, indicating little, if any, dolomite or epsomite. Only minor amounts of Fe are dissolved with the reagents, with the greatest dissolution for 0.25 M hydroxylamine, consistent with this reagent dissolving amorphous Fe oxides. In most samples extractable Mn is low, with most dissolved Mn in the pH 5 acetate solution, possibly representing trace Mn substitution in calcite or separate phase rhodochrosite. Very high Mn concentrations were obtained from selected manganiferous samples (*i.e.*, Profile 2, 6 m, Figure 20; and Profile 5, 7 m, Figure 44). In these samples most of the Mn is extracted with 0.1 M hydroxylamine, which is designed to dissolve separate phase Mn oxides. These samples also have high concentrations of total and extractable Co, Cu, Pb and possibly U. However, Mn-rich materials are probably poor sample medium for exploration as they are expected to be difficult to distinguish and sample from drill core or chips.

Cobalt showed high solubility in the reagents, showing (as expected) similar behaviour to Mn. The other base metals and chalcophiles had low solubilities. Gold is mostly <2 ppb with one sample having 6 ppb (Profile 2 surface), and shows moderate to low solubility in the iodide reagent. A small but significant proportion of the Au is water soluble, suggesting that some is potentially mobile.

The Windabout profiles (1 and 3) showed poorer surface soil responses for most base metals and chalcophiles than at Cattle grid (Profiles 2, 4, 5 and 6) (Table 2), with Ni, Cu, Pb and Zn appearing to be at background at Windabout. In contrast, Co appears to be anomalous, particularly within the top 20 cm.

Table 2: Total element compositions of surface samples (all elements are totals and in ppm, except Au which is cyanide extractable and in ppb).

Pro-file	Depth (m)	Ca	Mg	Fe	Mn	Cr	Co	Ni	Cu	Zn	Pb	As	Bi	Th	U	Ag	Au
2	0.15	10100	6700	20700	196	30	18	55	65	63	11	5	0.3	5.35	0.7	<0.5	6.13
4	0.15	51800	3300	11900	72	15	14	7	16	15	7	5	0.1	2.95	1.4	<0.5	1.02
5	0.15	1400	2400	11200	74	15	32	5	17	21	6	3	0.1	3.25	0.5	<0.5	1.16
6	0.15	1900	4100	17300	156	20	104	10	39	36	8	3	0.2	4.9	0.65	<0.5	0.98
1	0.03	2100	1500	9800	92	15	54	5	8	16	8	1.5	<0.1	2.55	0.35	<0.5	0.64
	0.15	8700	2000	11400	82	20	30	6	8	17	7	1.5	<0.1	3	0.35	<0.5	0.48
	0.38	92100	2700	10300	57	10	12	7	9	18	6	6.5	<0.1	3.15	0.45	<0.5	2.44
3	0.03	2000	1900	9900	82	15	44	6	7	15	6	3	<0.1	2.85	0.4	<0.5	1.01
	0.15	1800	2500	10500	73	15	50	6	7	18	6	2.5	<0.1	2.9	0.35	<0.5	0.84
	0.38	11900	2600	9400	65	20	26	6	7	13	6	2.5	<0.1	2.75	0.4	<0.5	1.34

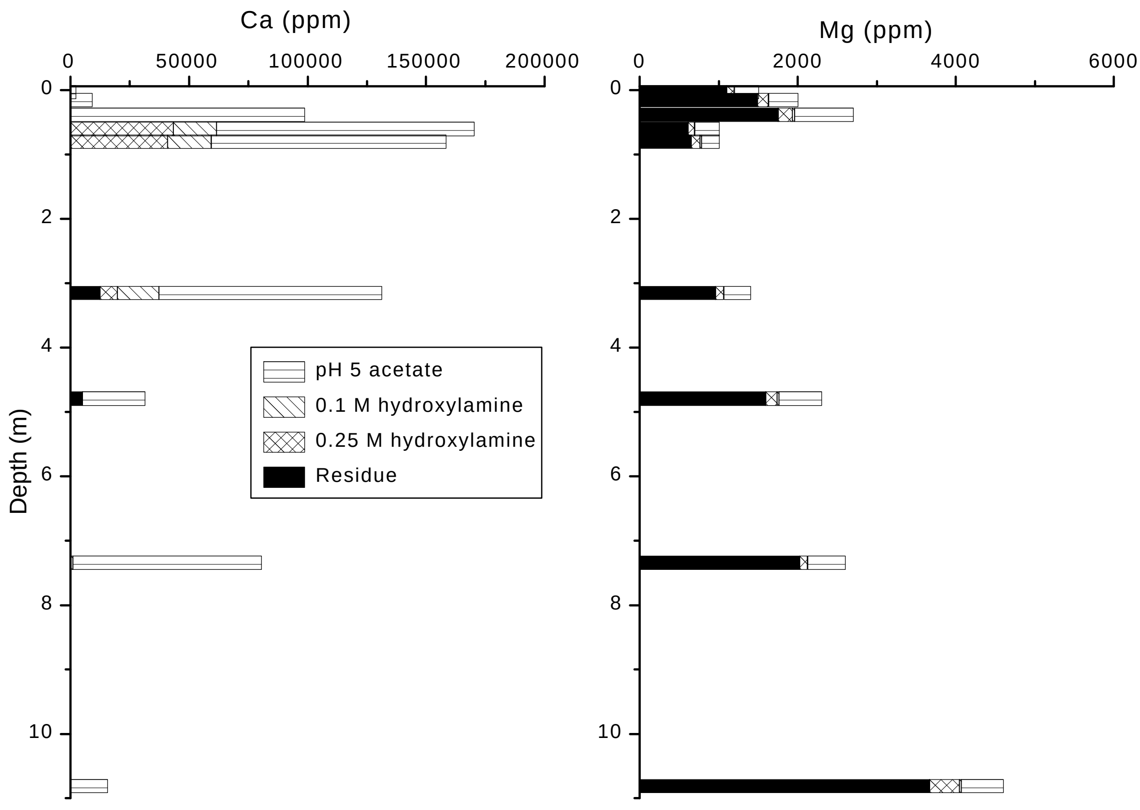


Figure 11: Ca and Mg data for Profile 1 (Windabout).

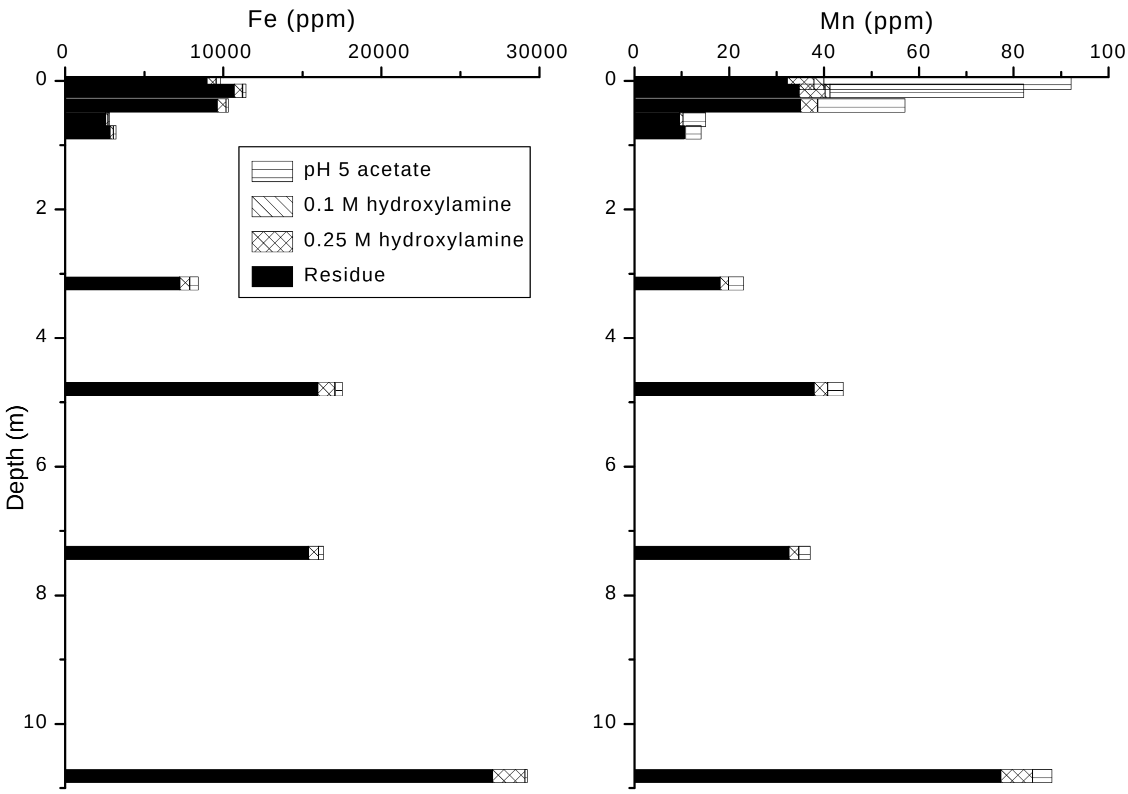


Figure 12: Fe and Mn data for Profile 1 (Windabout).

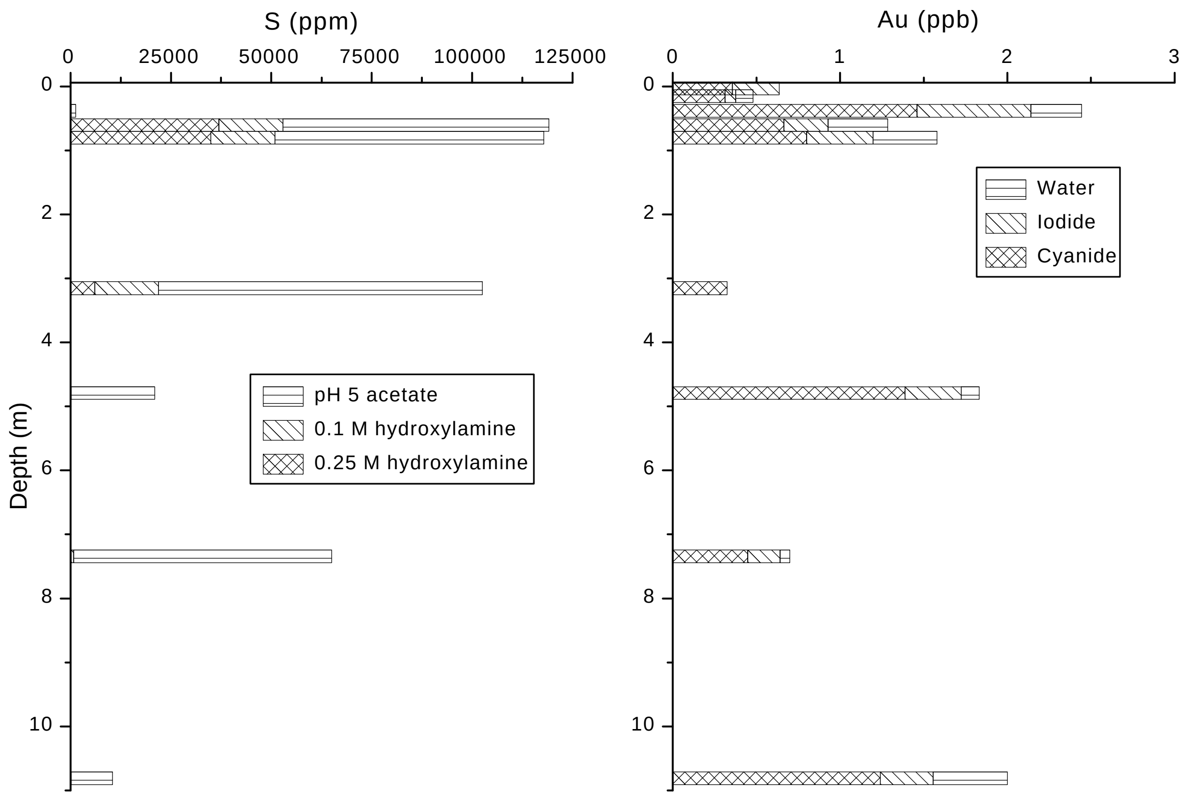


Figure 13: S and Au data for Profile 1 (Windabout).

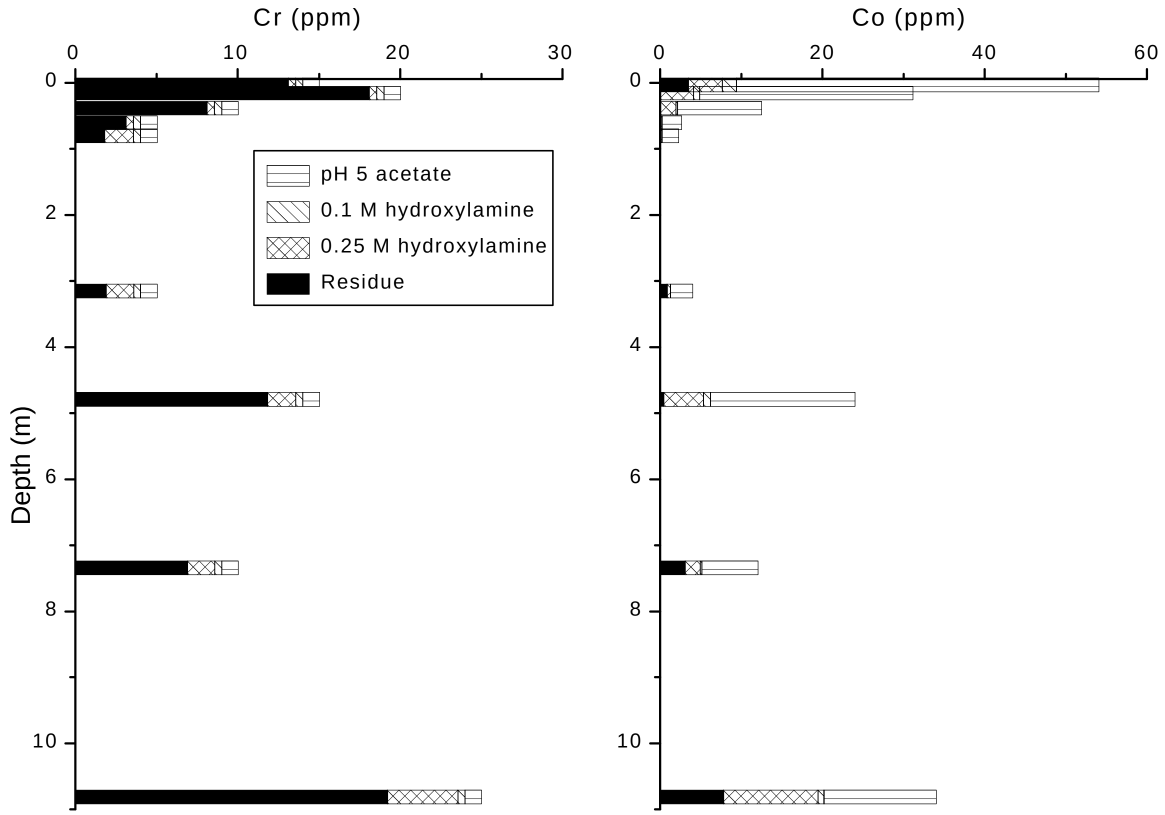


Figure 14: Cr and Co data for Profile 1 (Windabout).

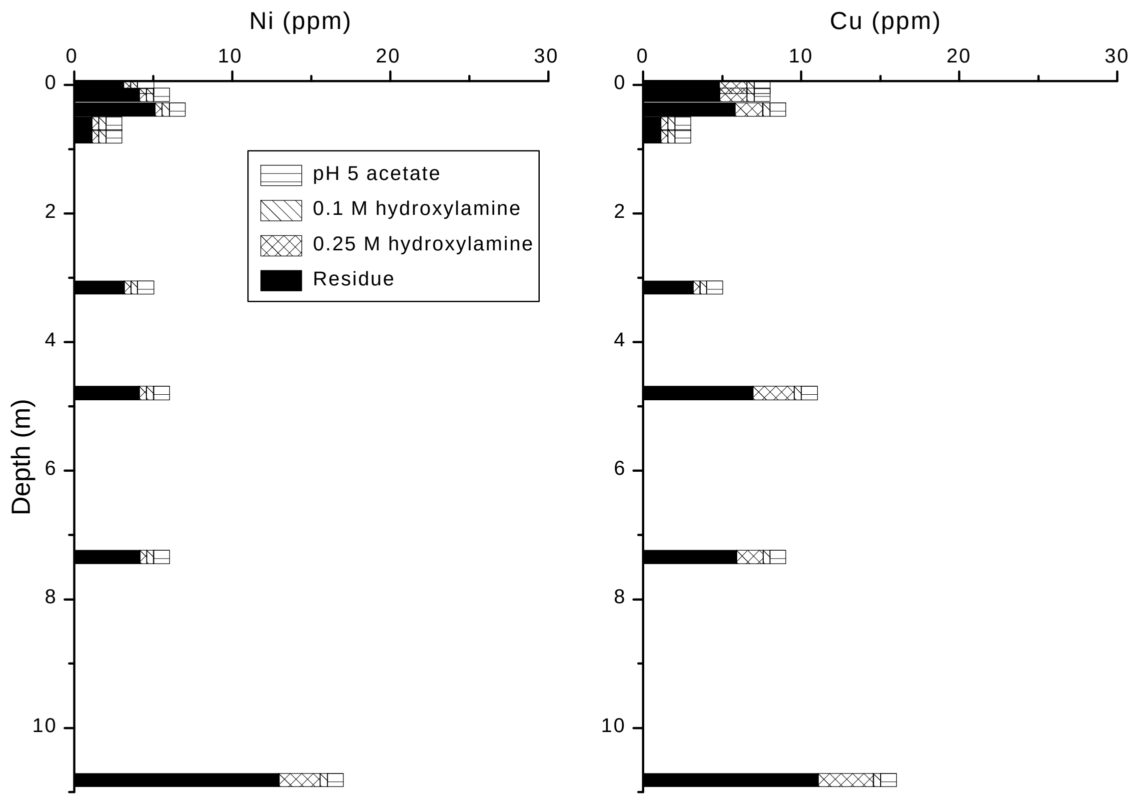


Figure 15: Ni and Cu data for Profile 1 (Windabout).

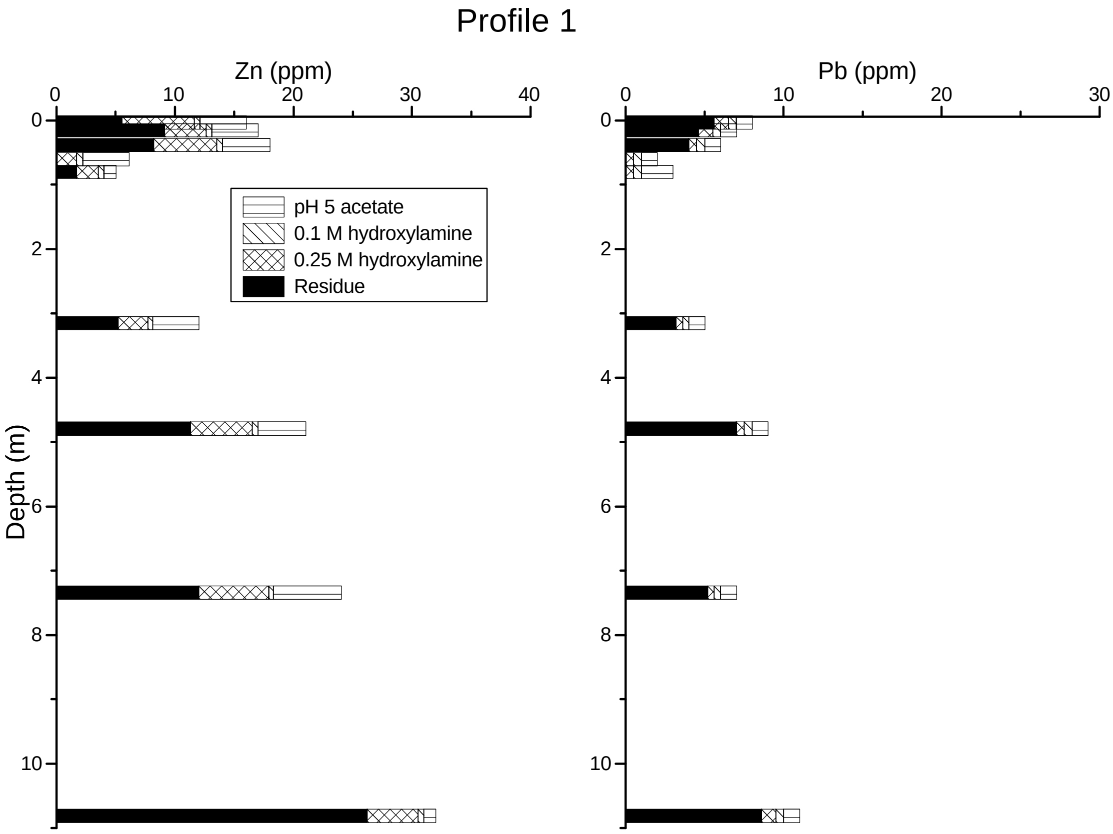


Figure 16: Zn and Pb data for Profile 1 (Windabout).

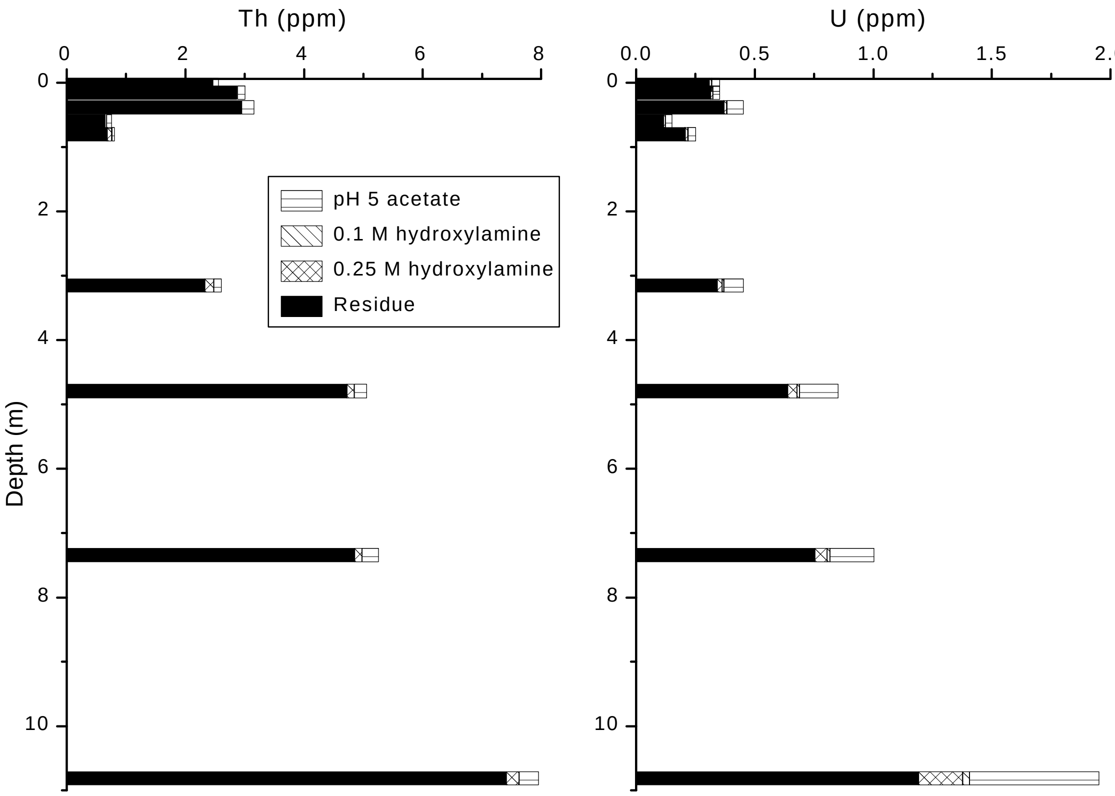


Figure 17: Th and U data for Profile 1 (Windabout).

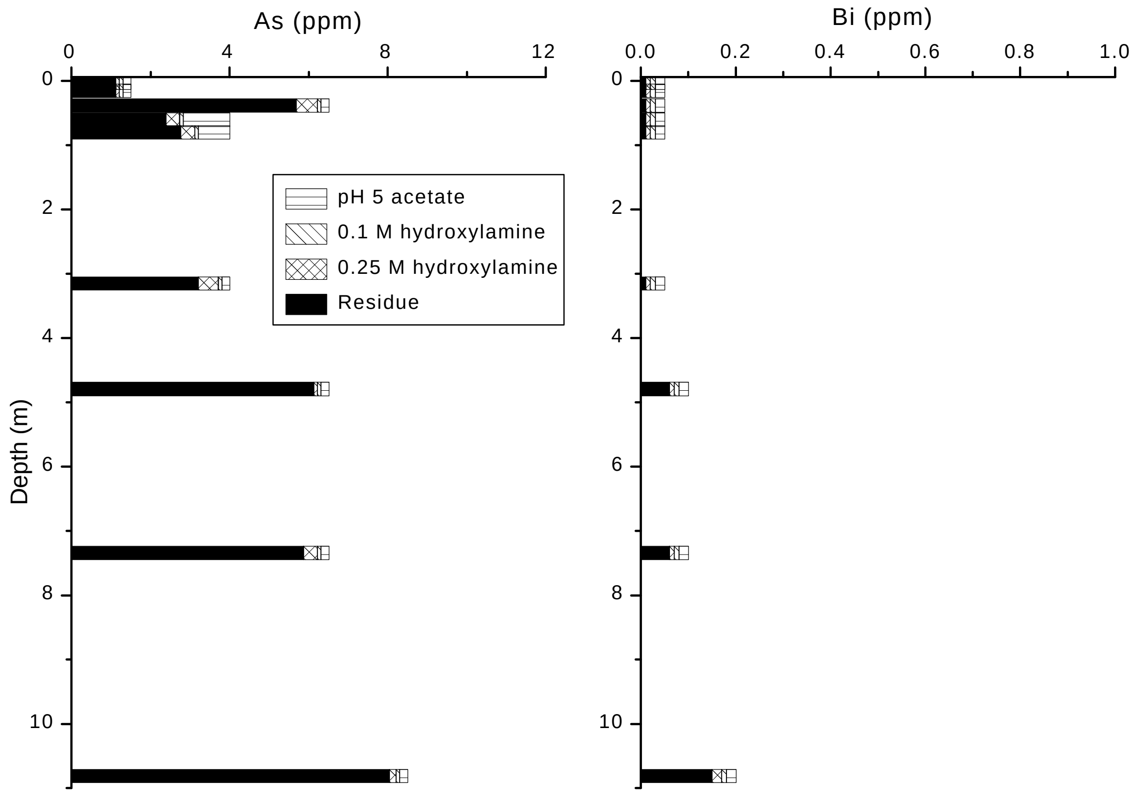


Figure 18: As and Bi data for Profile 1 (Windabout).

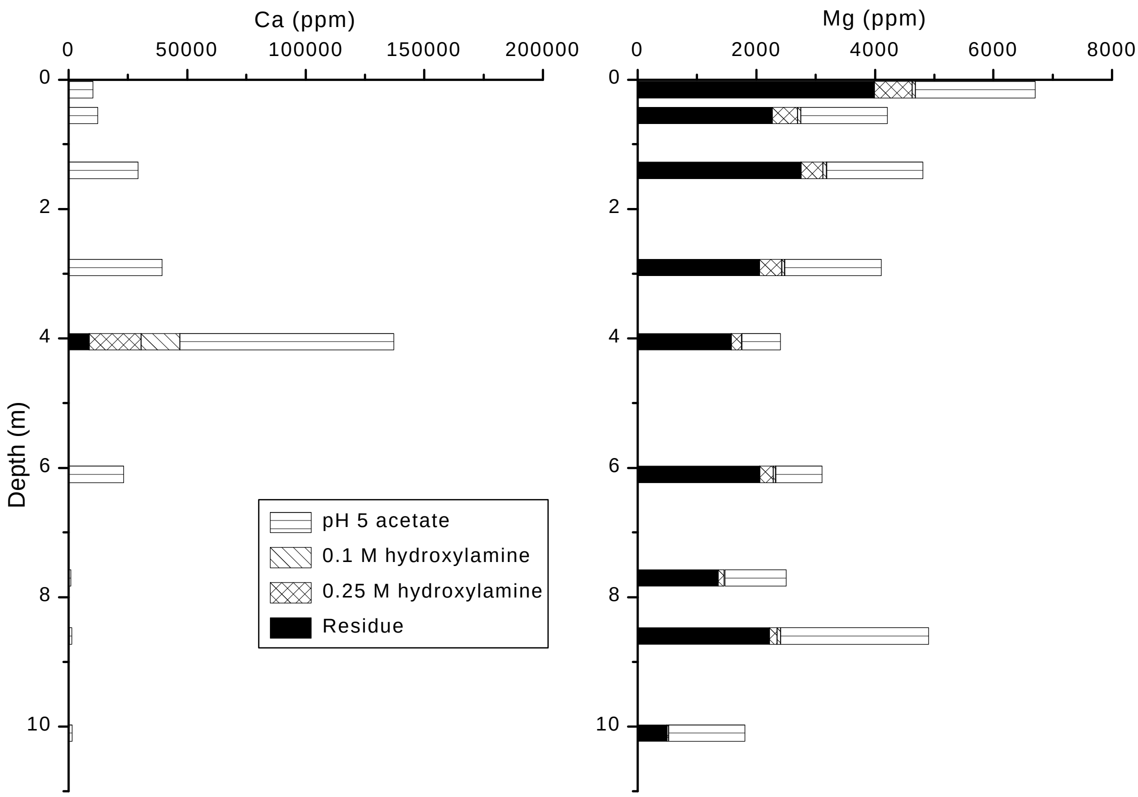


Figure 19: Ca and Mg data for Profile 2 (Area 4).

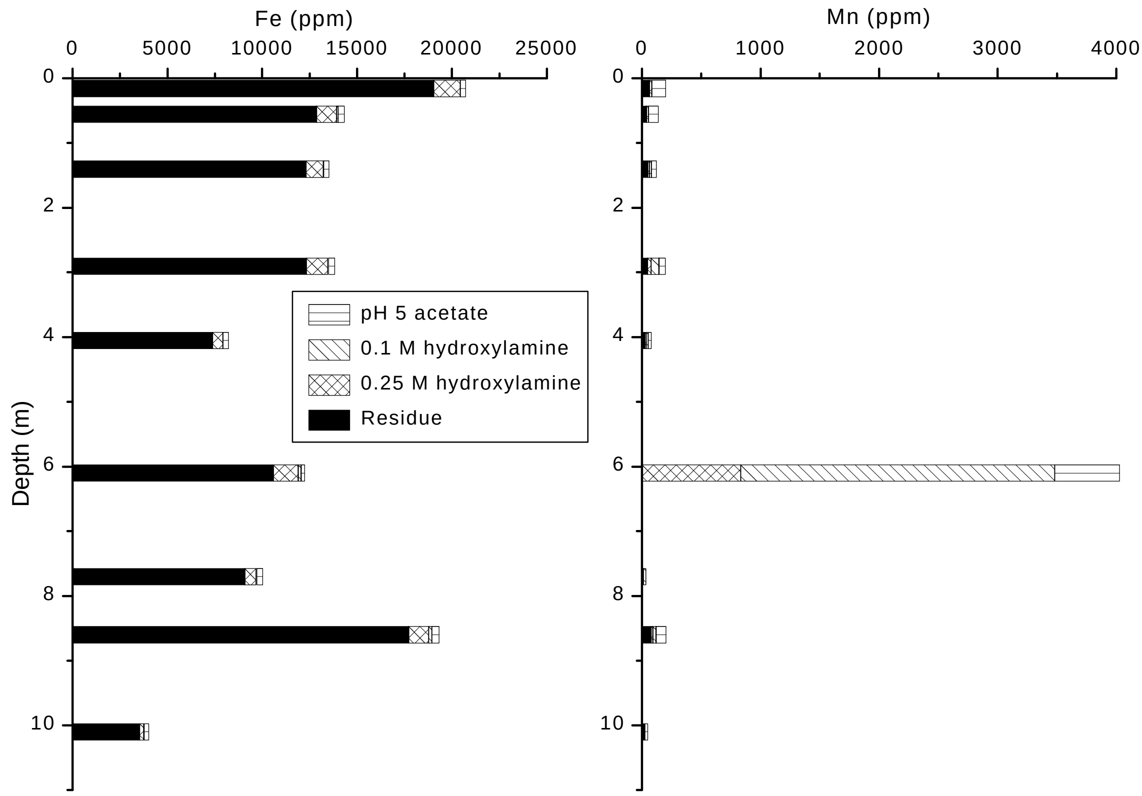


Figure 20: Fe and Mn data for Profile 2 (Area 4).

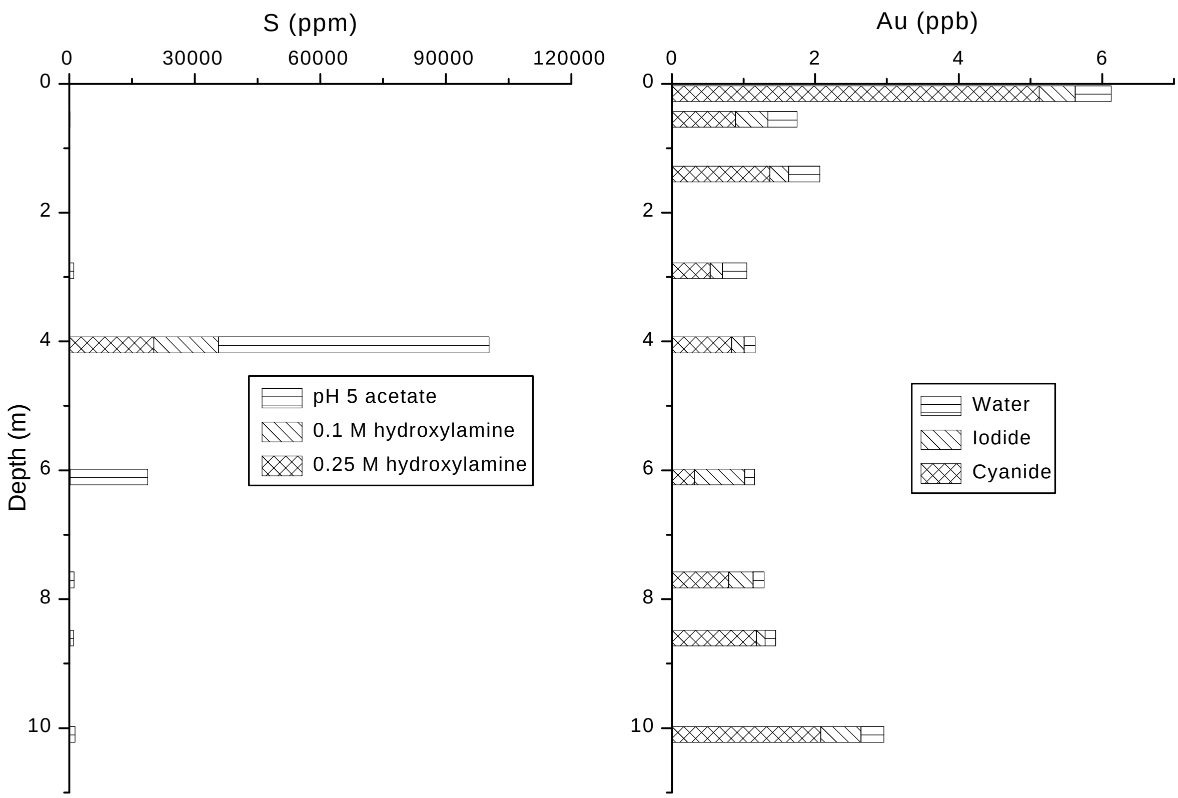


Figure 21: S and Au data for Profile 2 (Area 4).

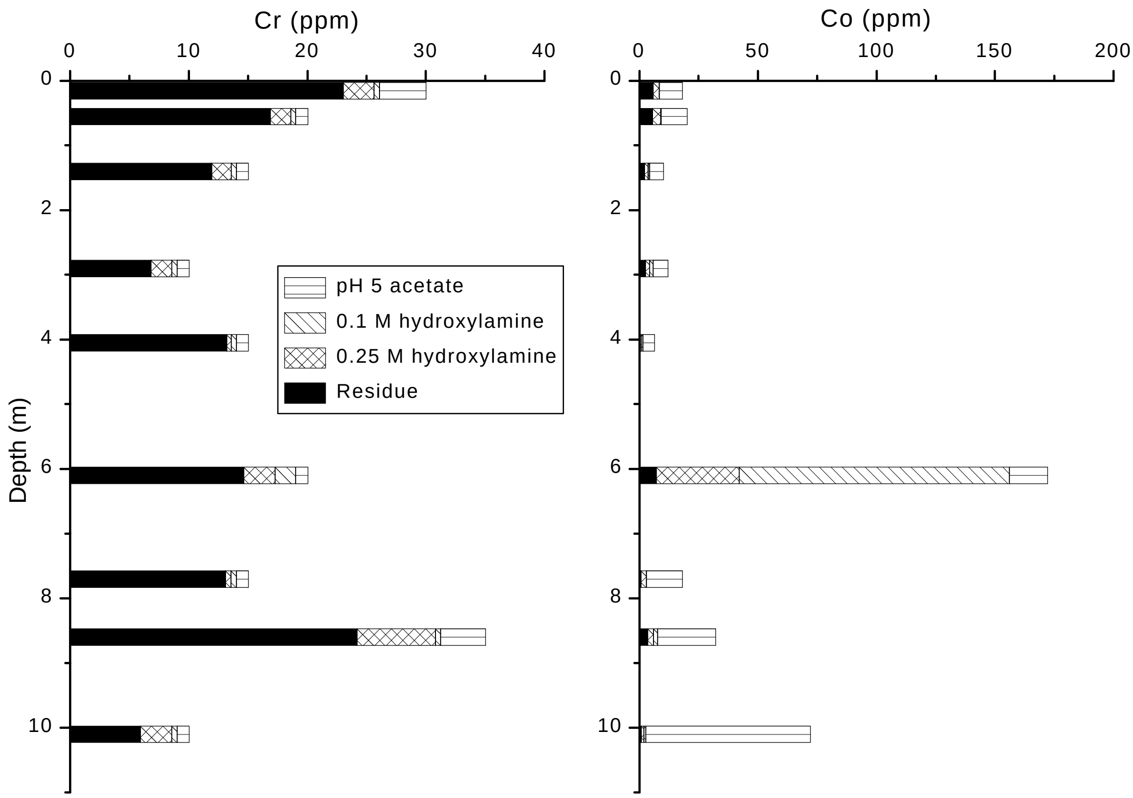


Figure 22: Cr and Co data for Profile 2 (Area 4).

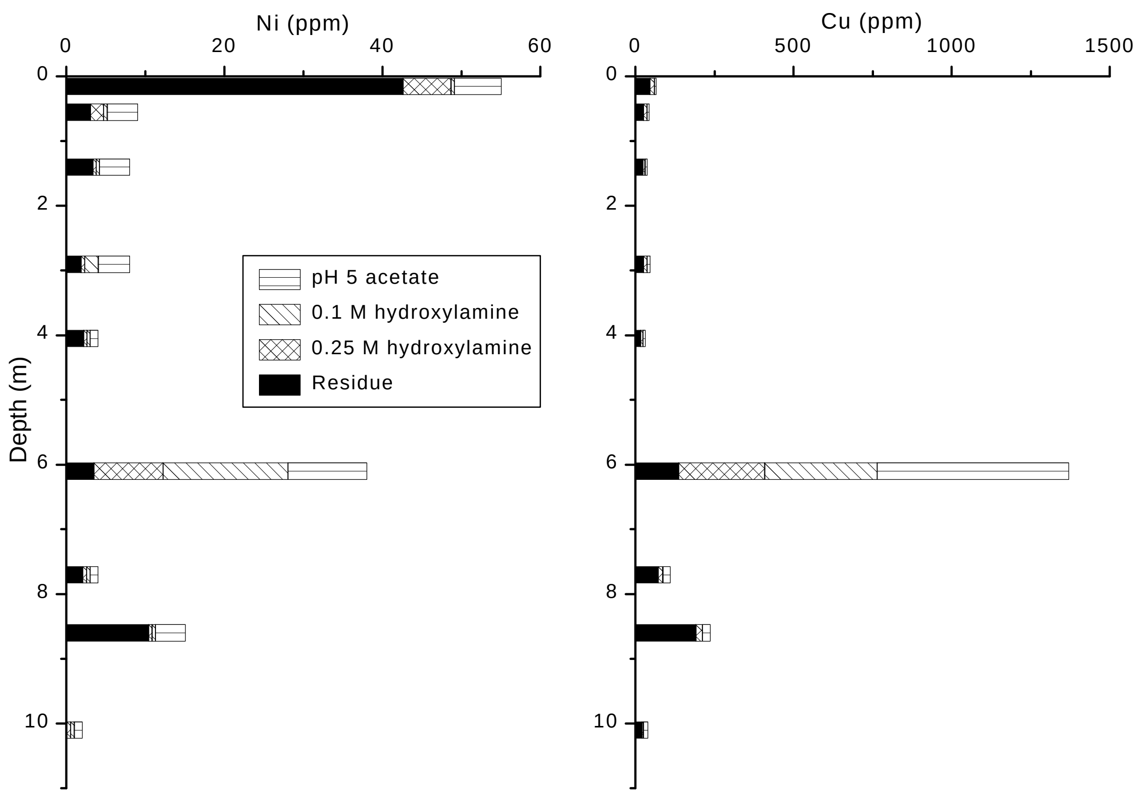


Figure 23: Ni and Cu data for Profile 2 (Area 4).

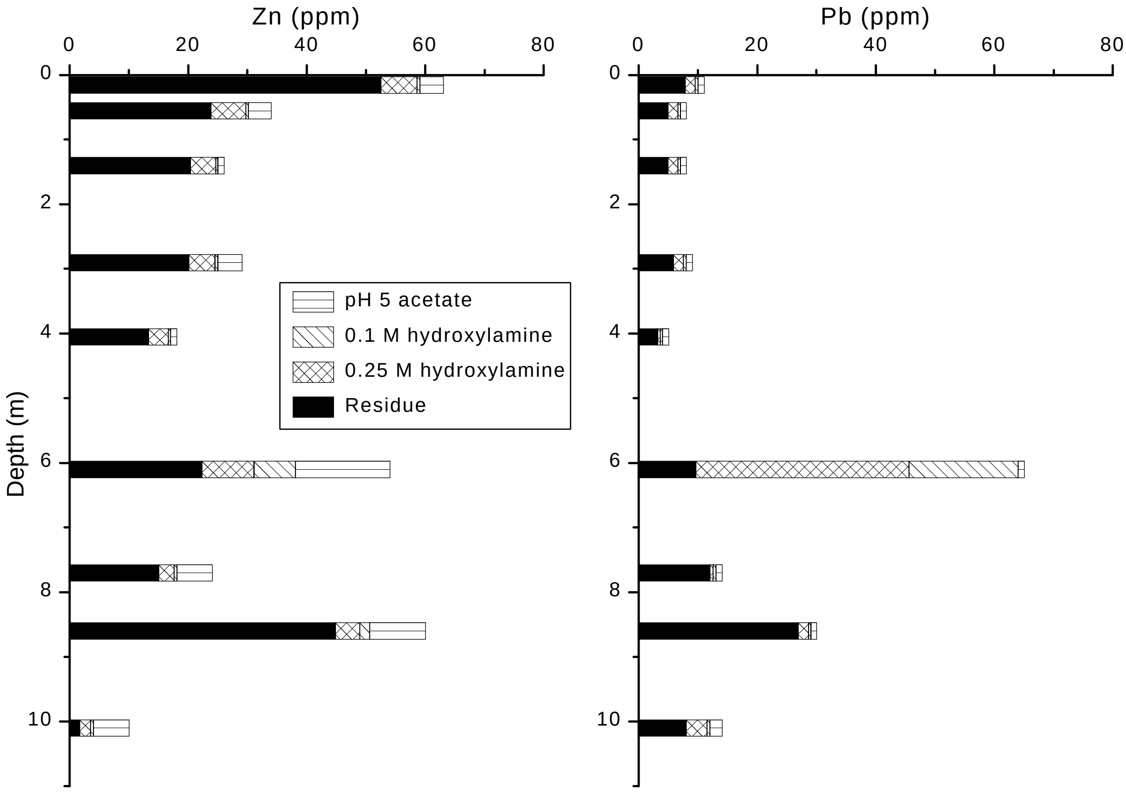


Figure 24: Zn and Pb data for Profile 2 (Area 4).

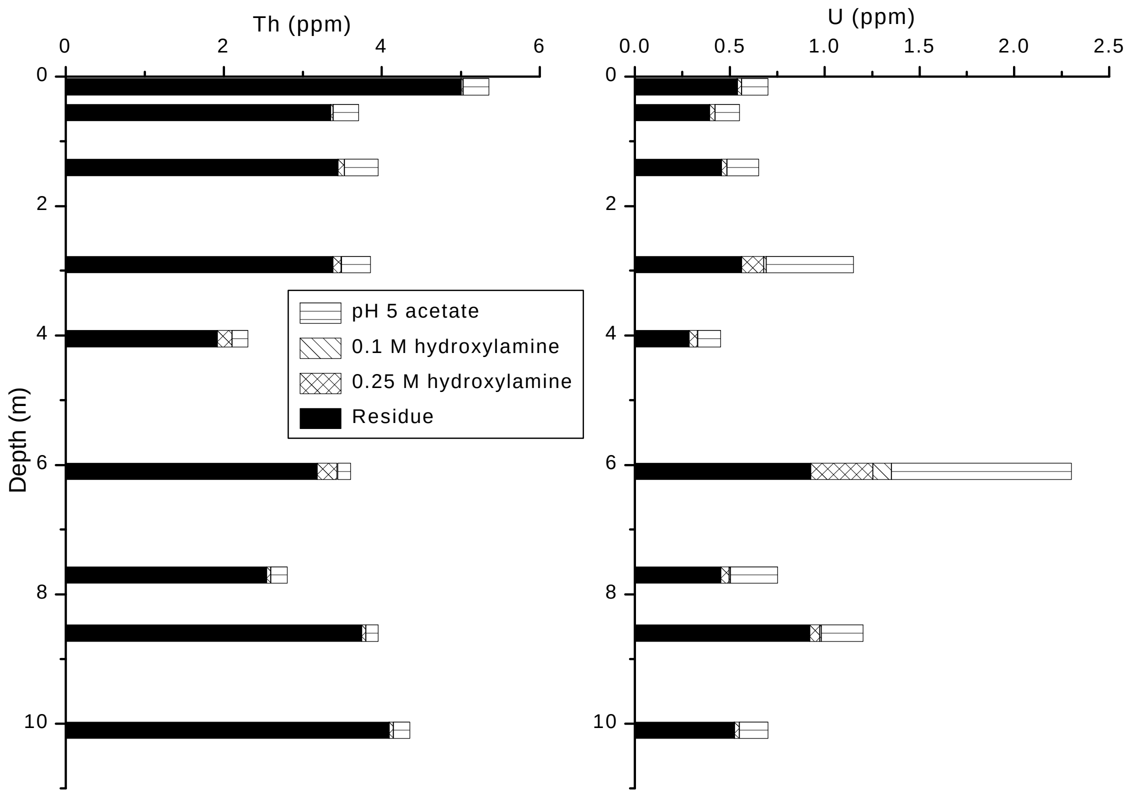


Figure 25: Th and U data for Profile 2 (Area 4).

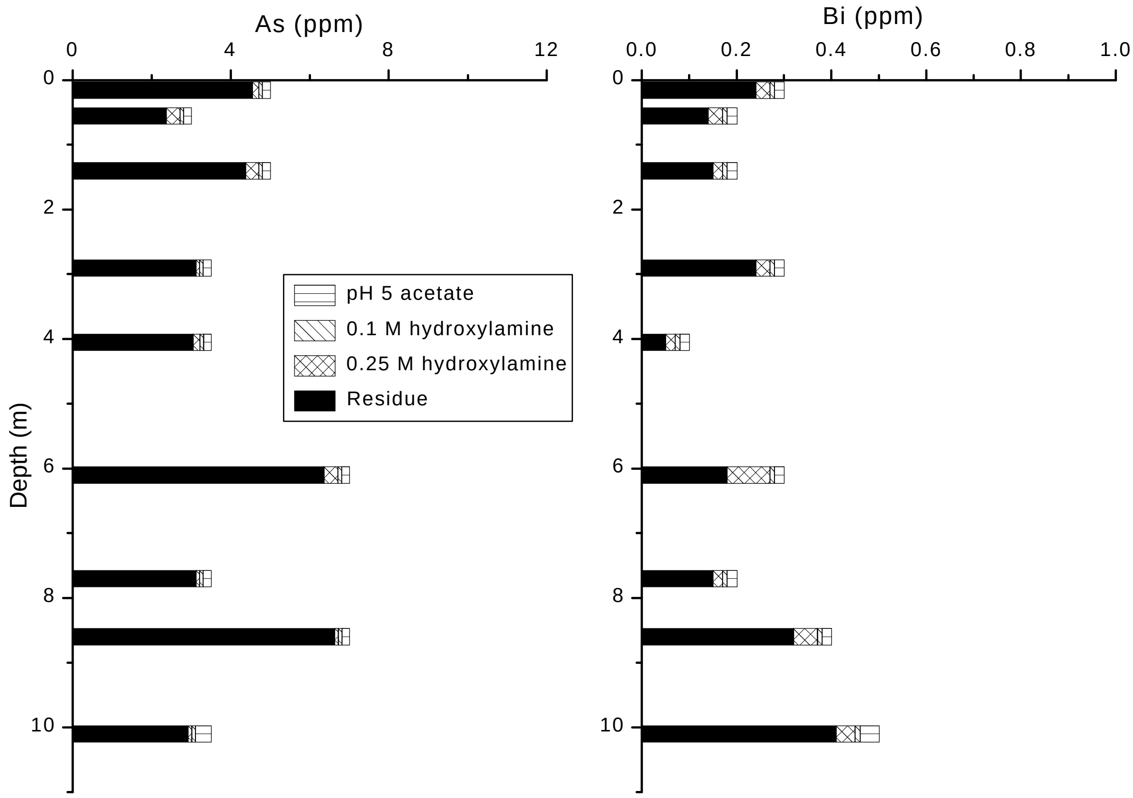


Figure 26: As and Bi data for Profile 2 (Area 4).

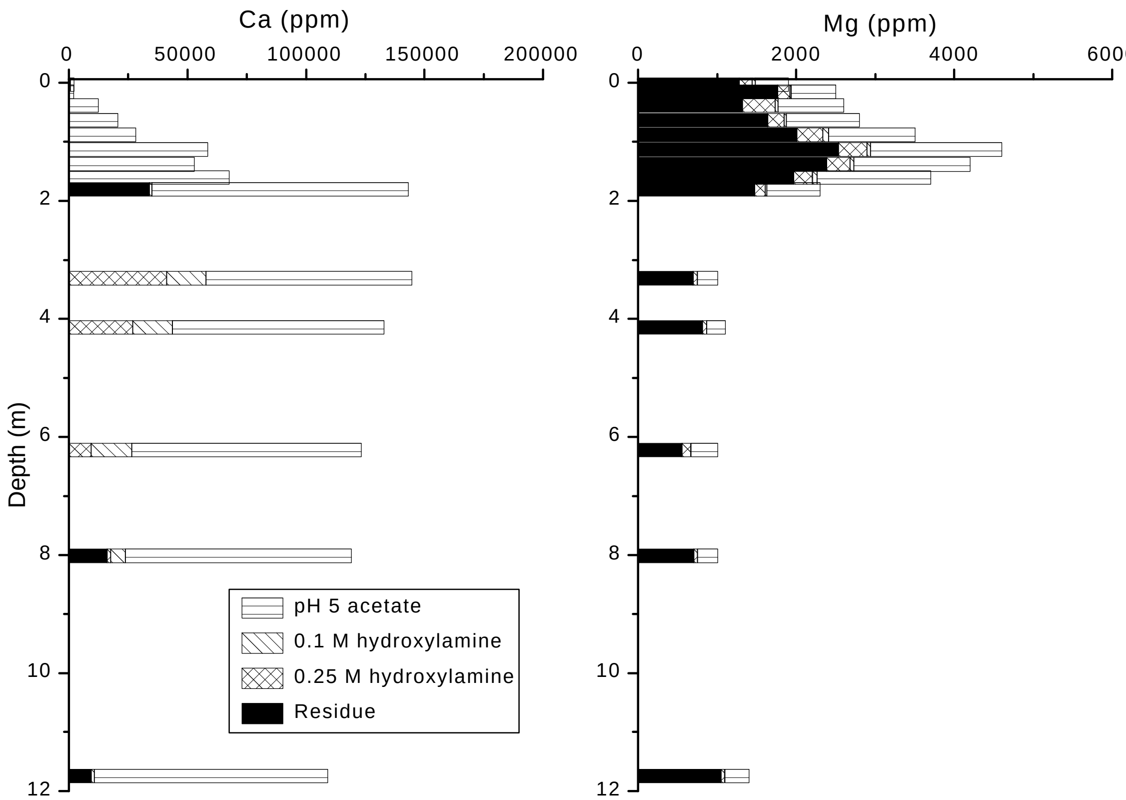


Figure 27: Ca and Mg data for Profile 3 (Windabout).

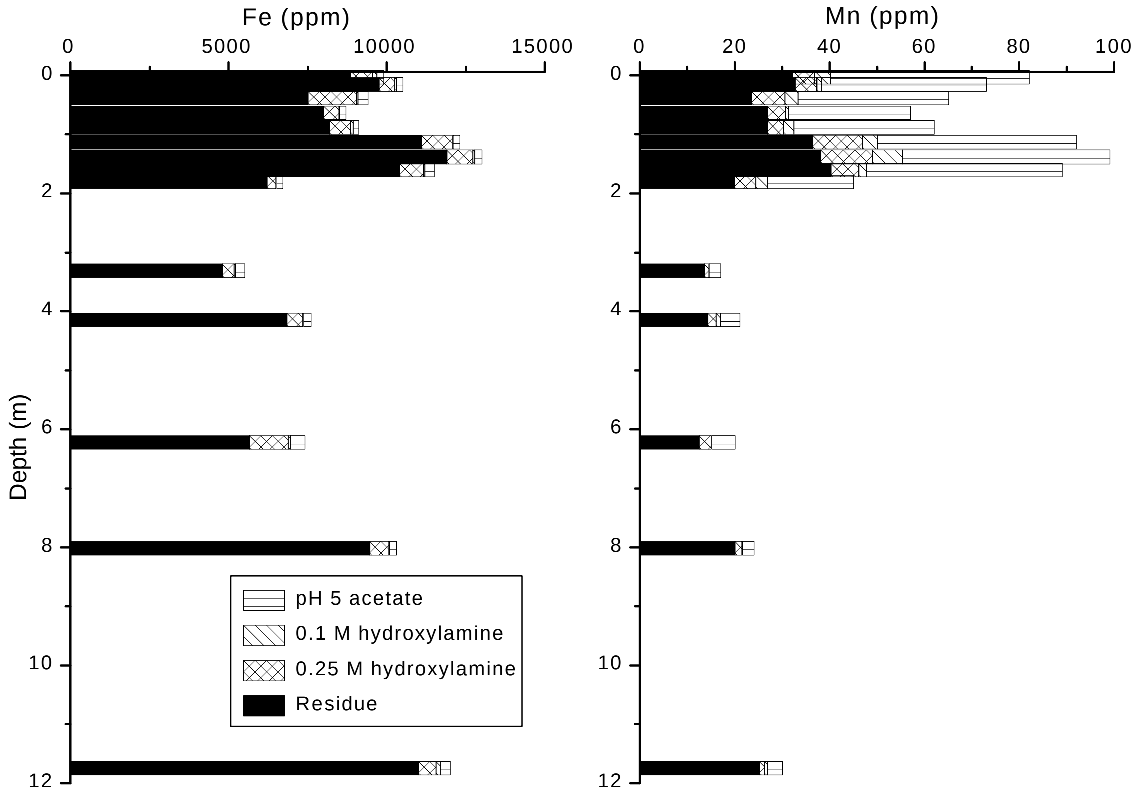


Figure 28: Fe and Mn data for Profile 3 (Windabout).

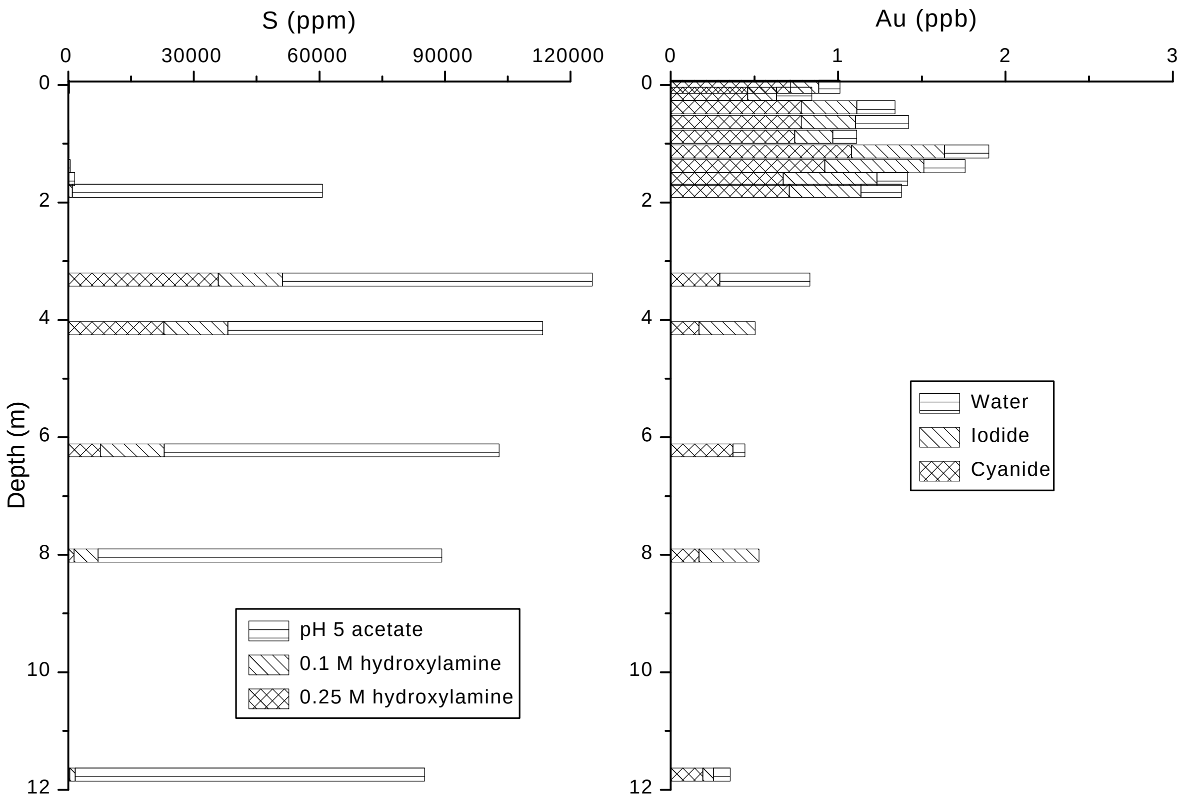


Figure 29: S and Au data for Profile 3 (Windabout).

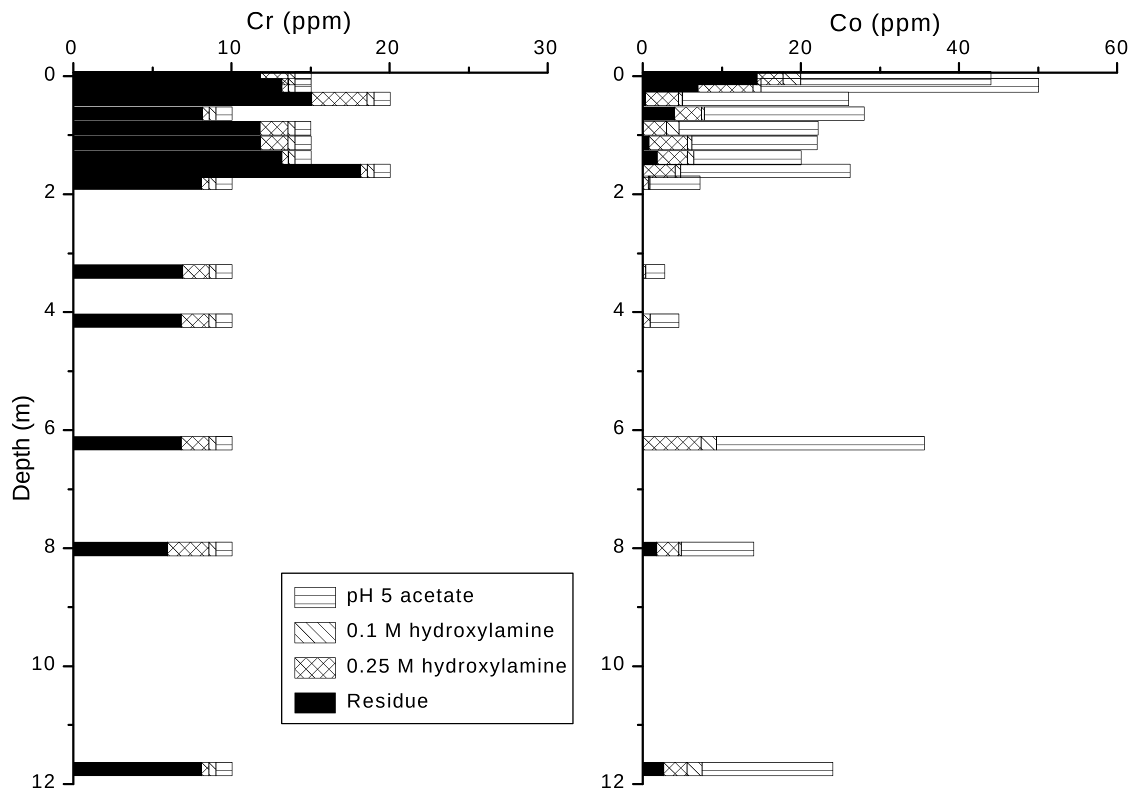


Figure 30: Cr and Co data for Profile 3 (Windabout).

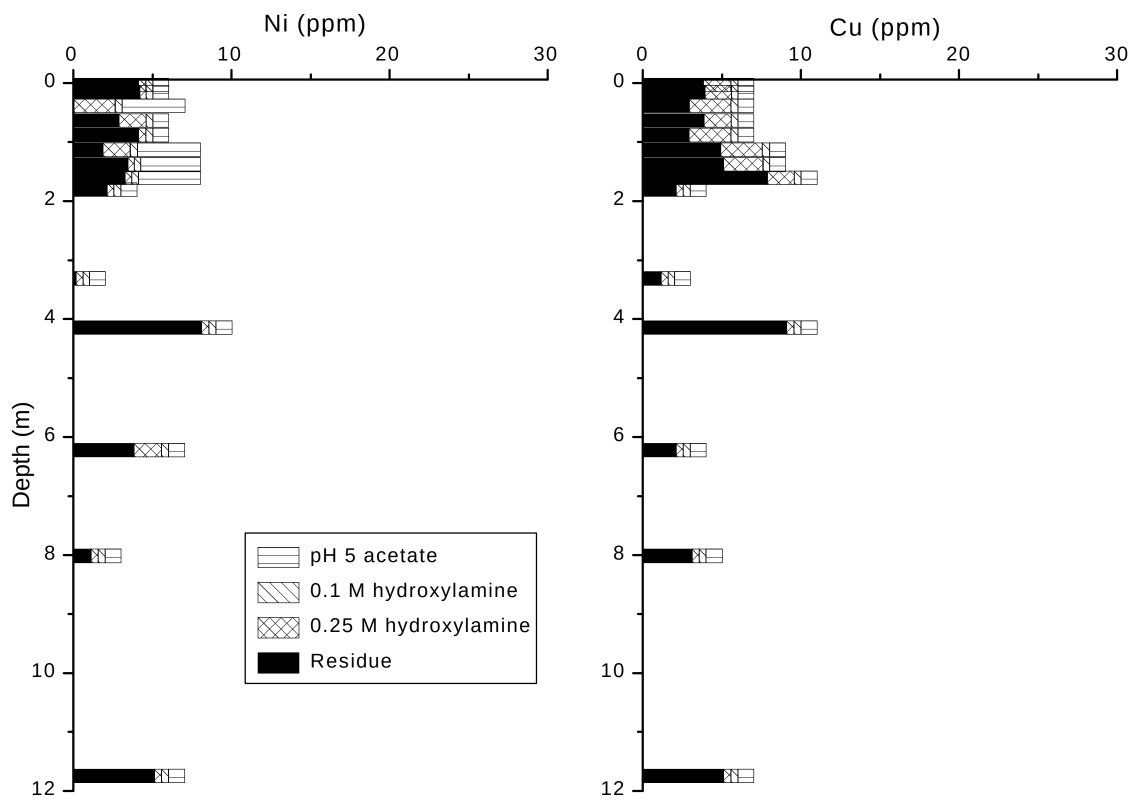


Figure 31: Ni and Cu data for Profile 3 (Windabout).

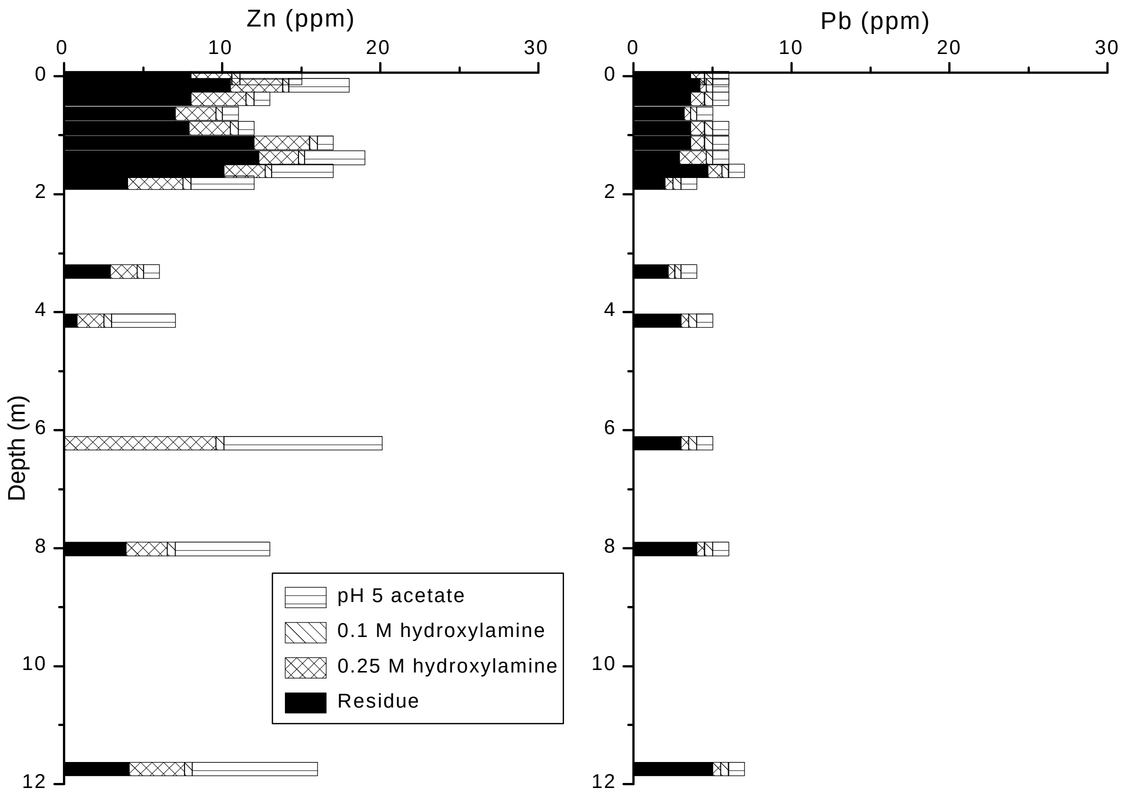


Figure 32: Zn and Pb data for Profile 3 (Windabout).

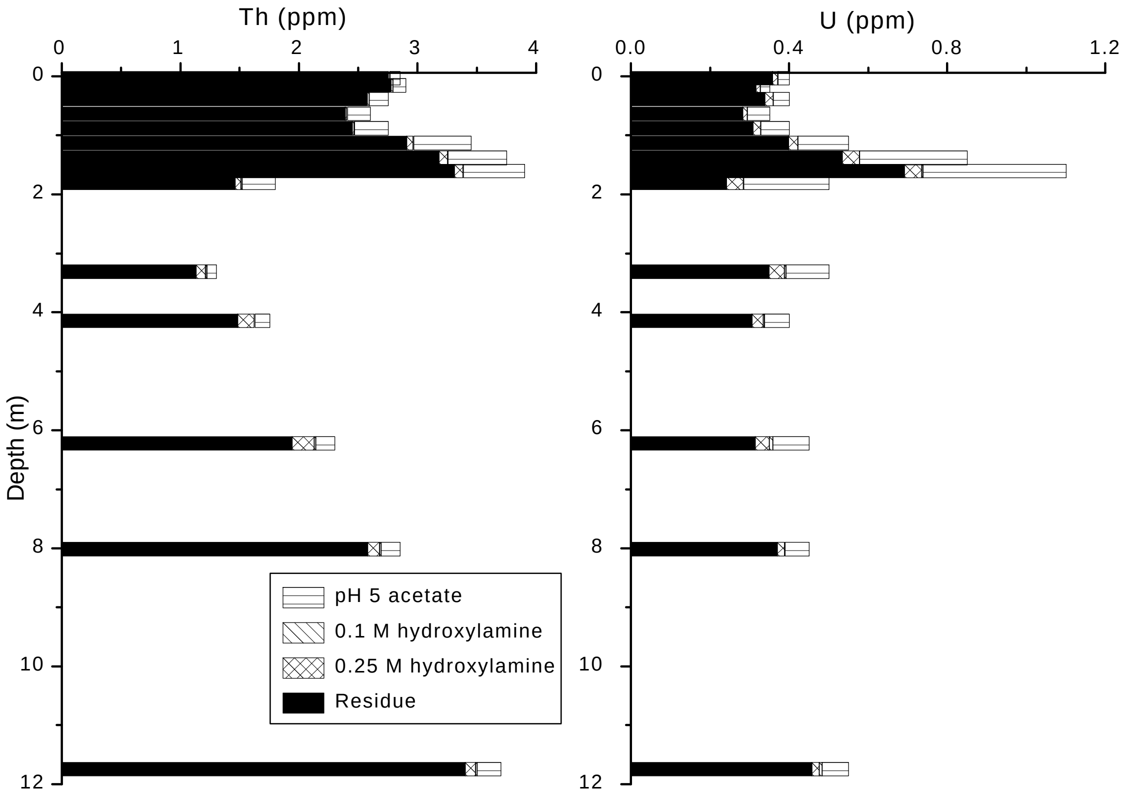


Figure 33: Th and U data for Profile 3 (Windabout).

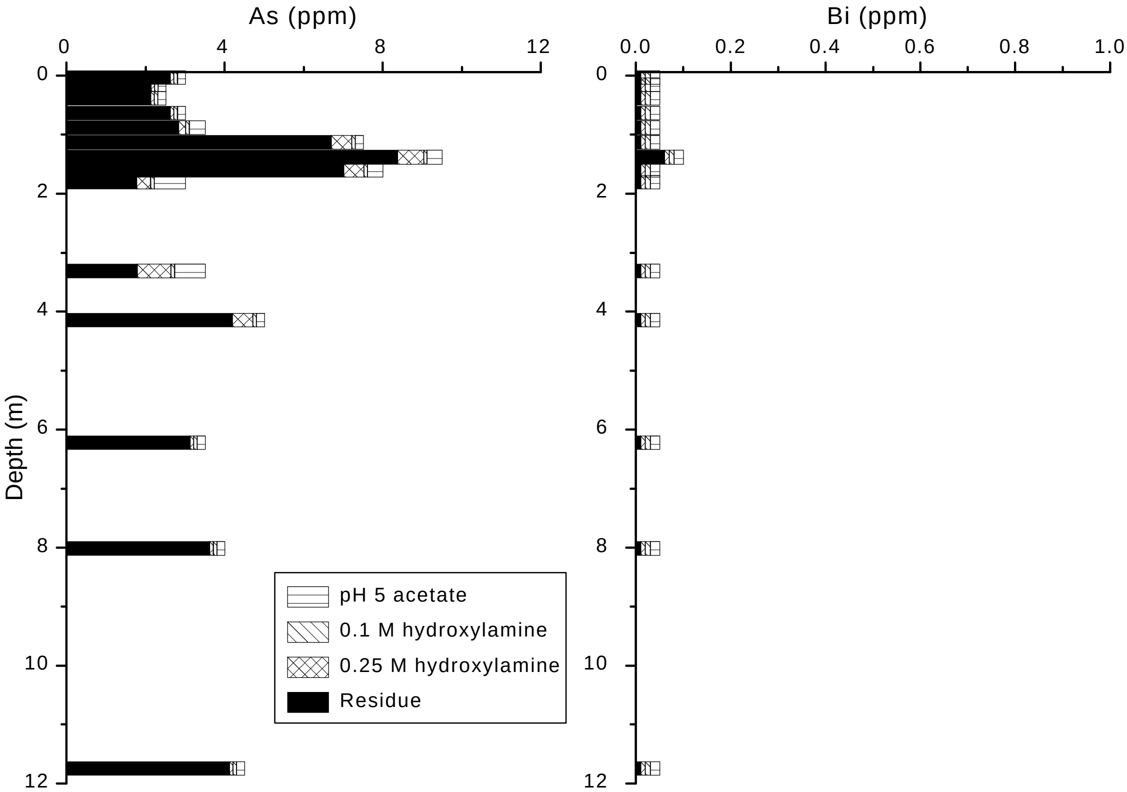


Figure 34: As and Bi data for Profile 3 (Windabout).

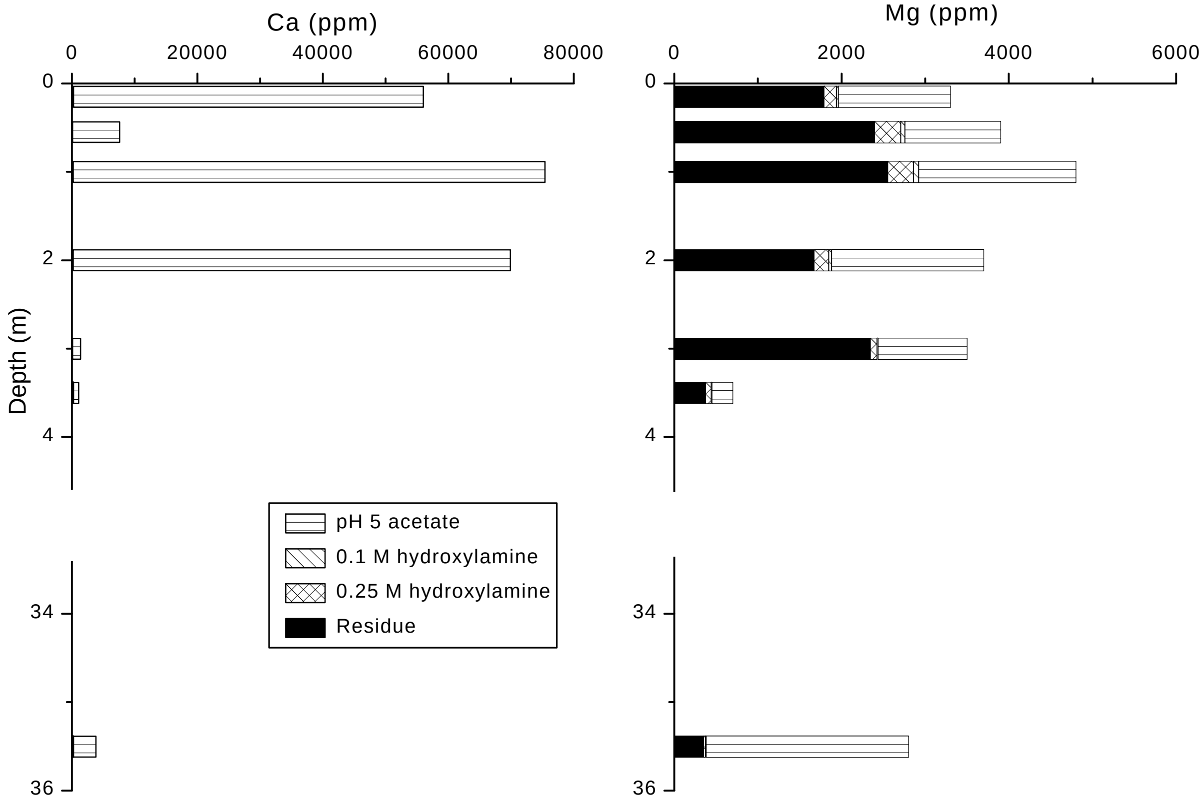


Figure 35: Ca and Mg data for Profile 4 (NW Pit).

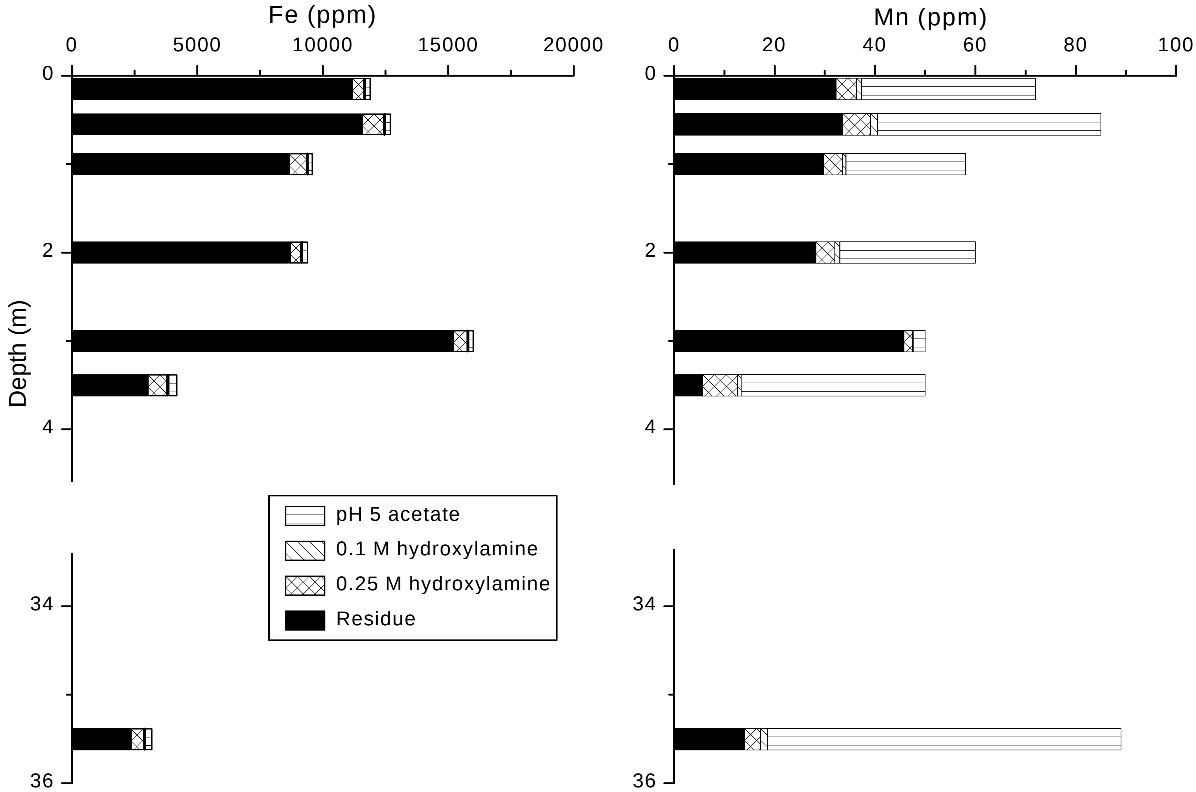


Figure 36: Fe and Mn data for Profile 4 (NW Pit).

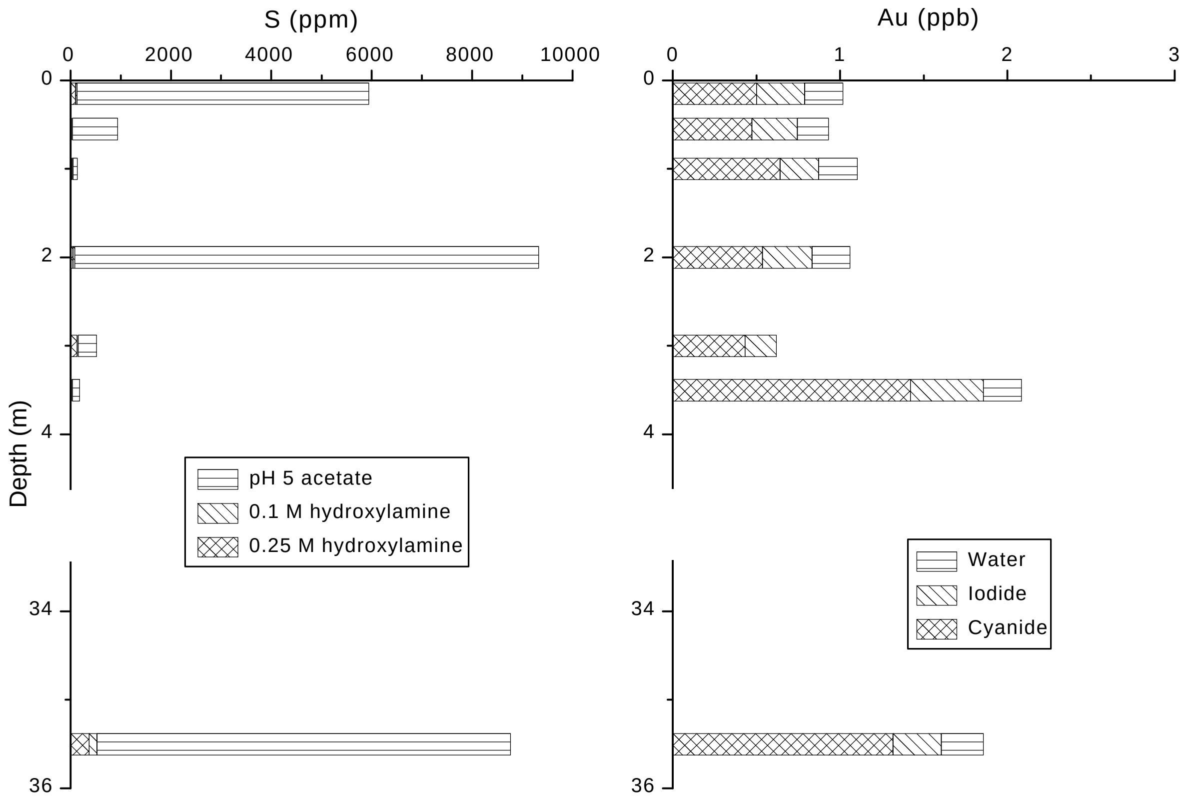


Figure 37: S and Au data for Profile 4 (NW Pit).

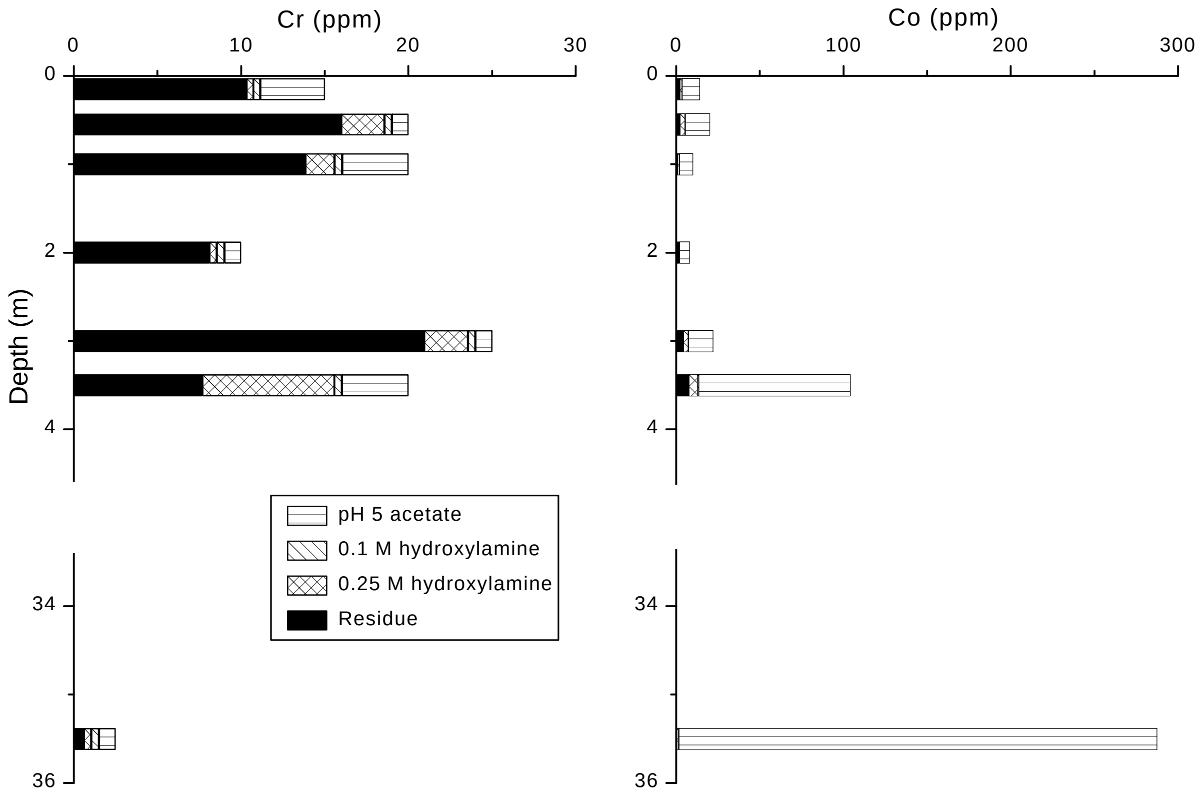


Figure 38: Cr and Co data for Profile 4 (NW Pit).

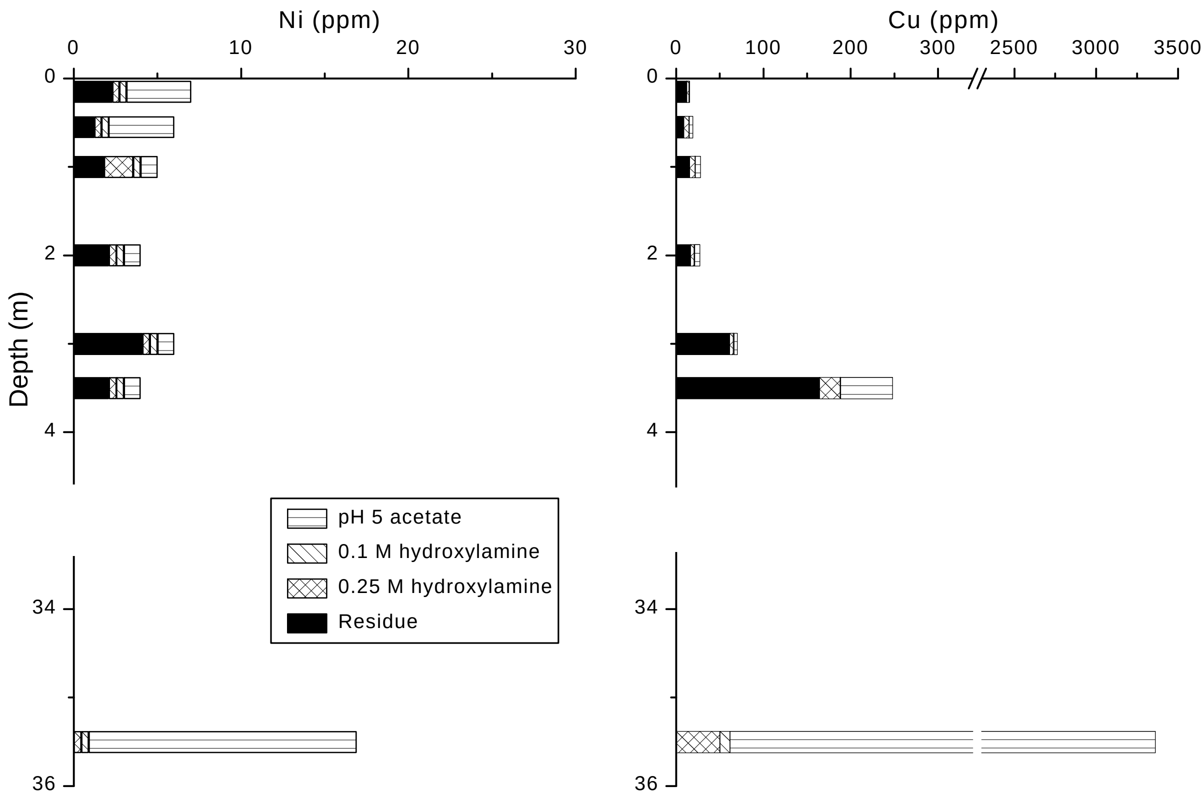


Figure 39: Ni and Cu data for Profile 4 (NW Pit).

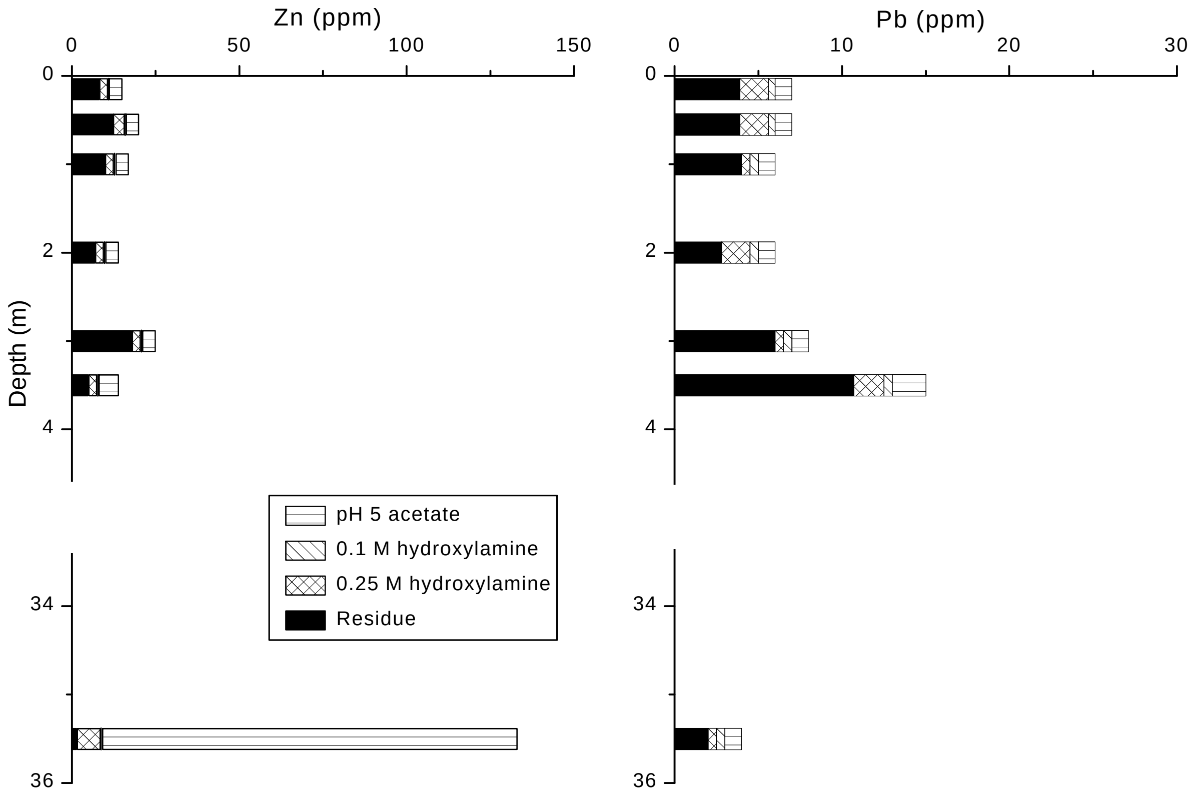


Figure 40: Zn and Pb data for Profile 4 (NW Pit).

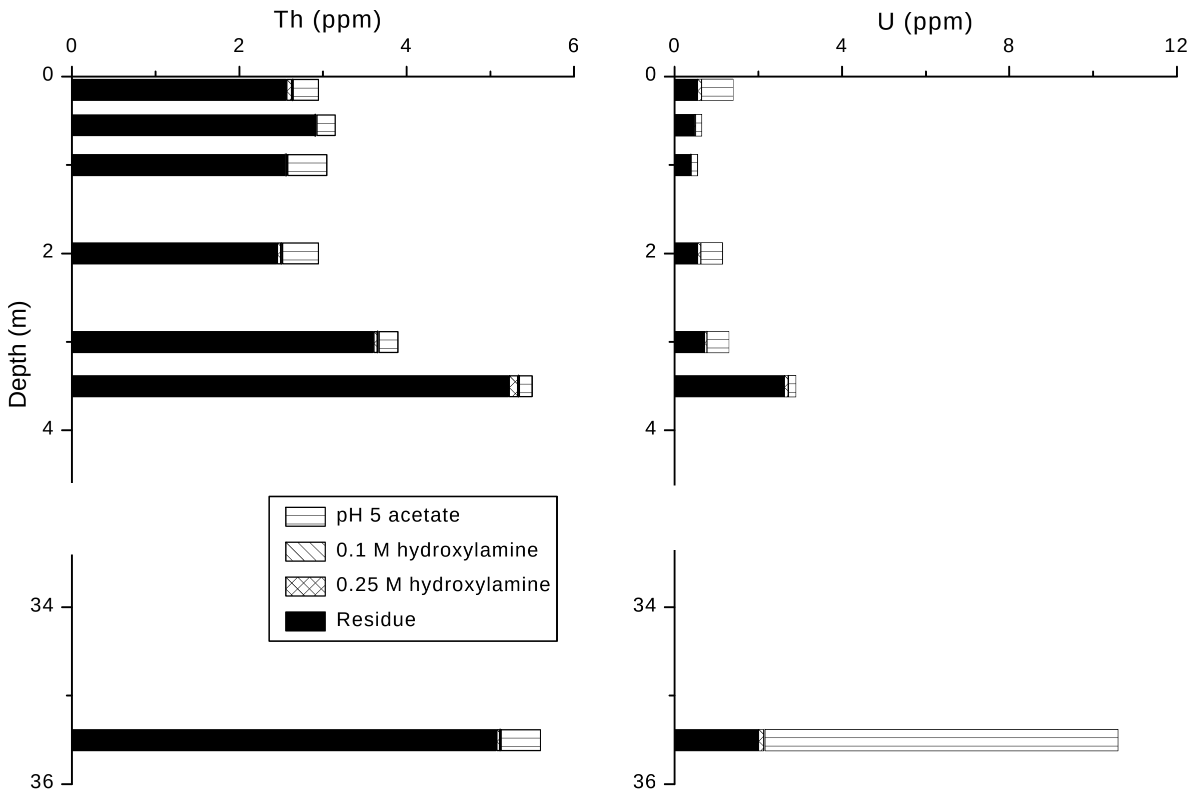


Figure 41: Th and U data for Profile 4 (NW Pit).

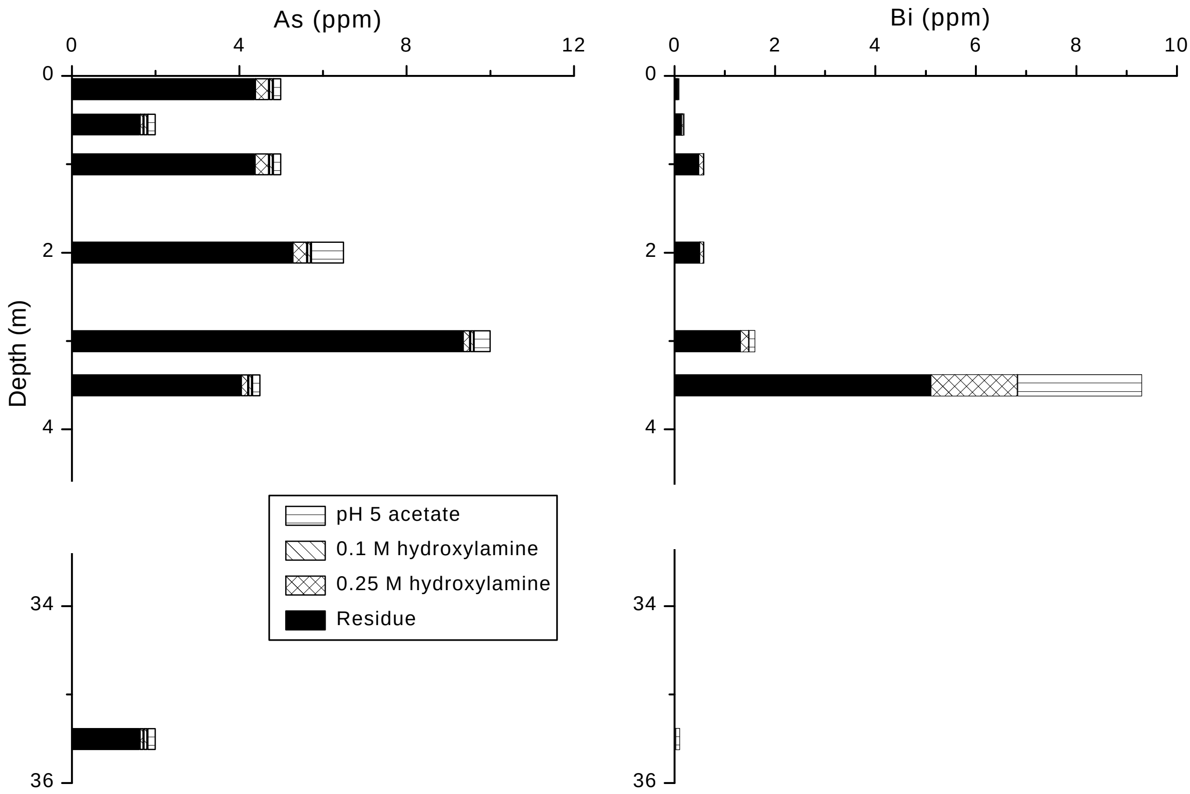


Figure 42: As and Bi data for Profile 4 (NW Pit).

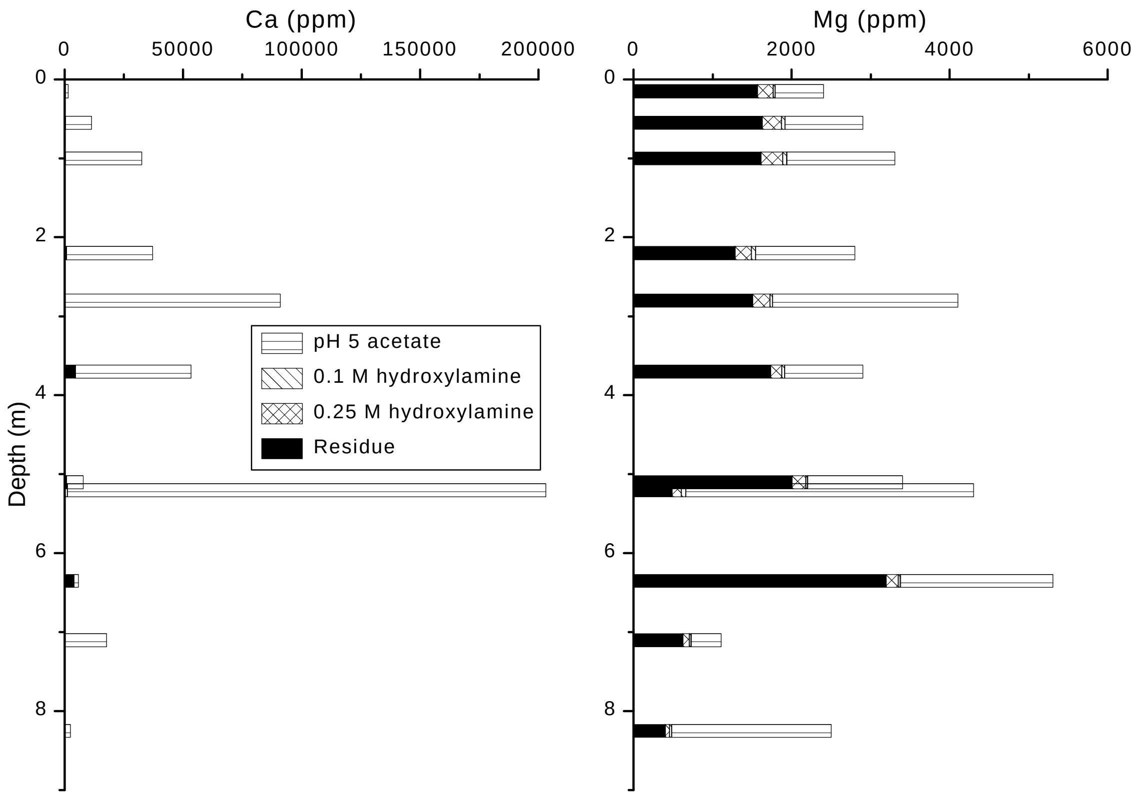


Figure 43: Ca and Mg data for Profile 5 (NE Pit, SE end).

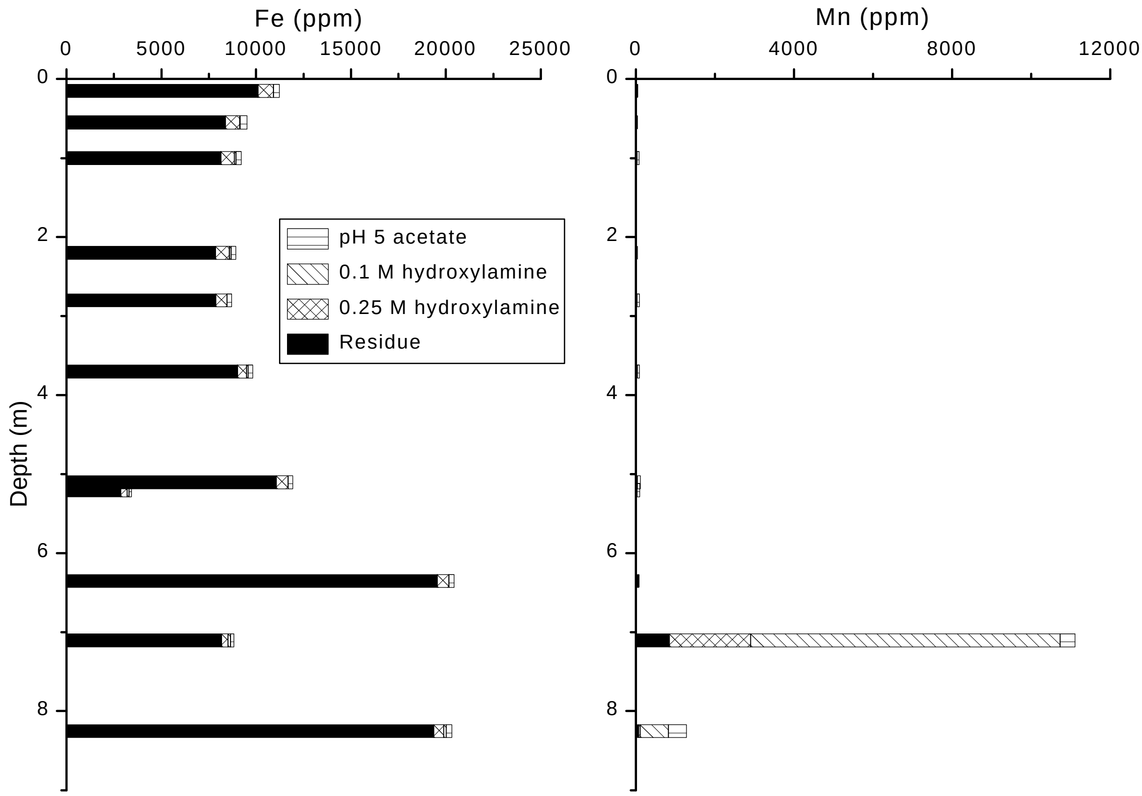


Figure 44: Fe and Mn data for Profile 5 (NE Pit, SE end).

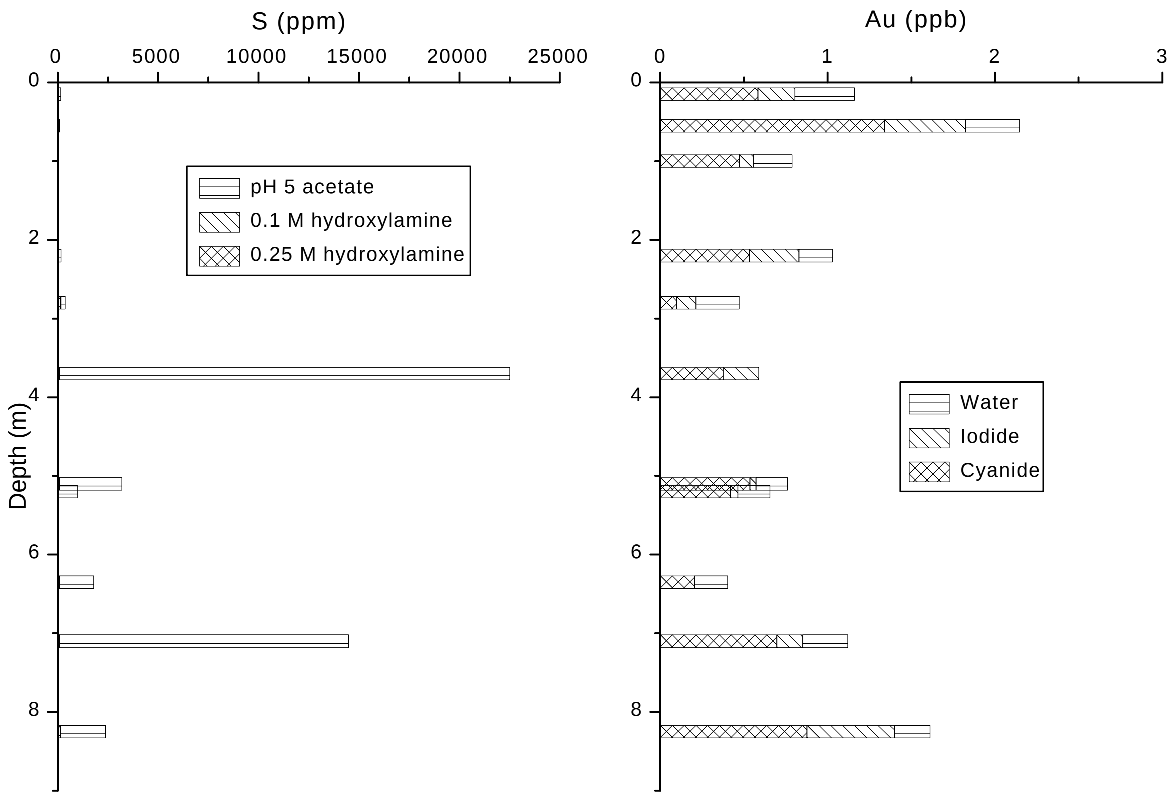


Figure 45: S and Au data for Profile 5 (NE Pit, SE end).

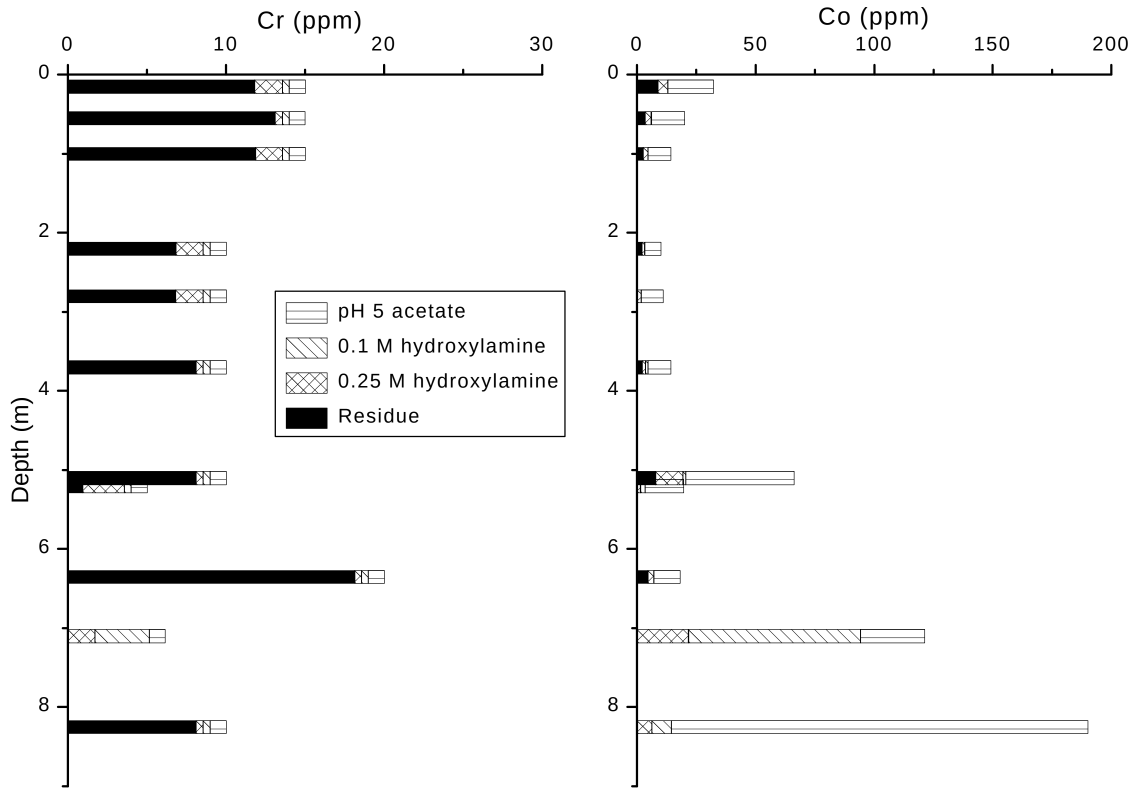


Figure 46: Cr and Co data for Profile 5 (NE Pit, SE end).

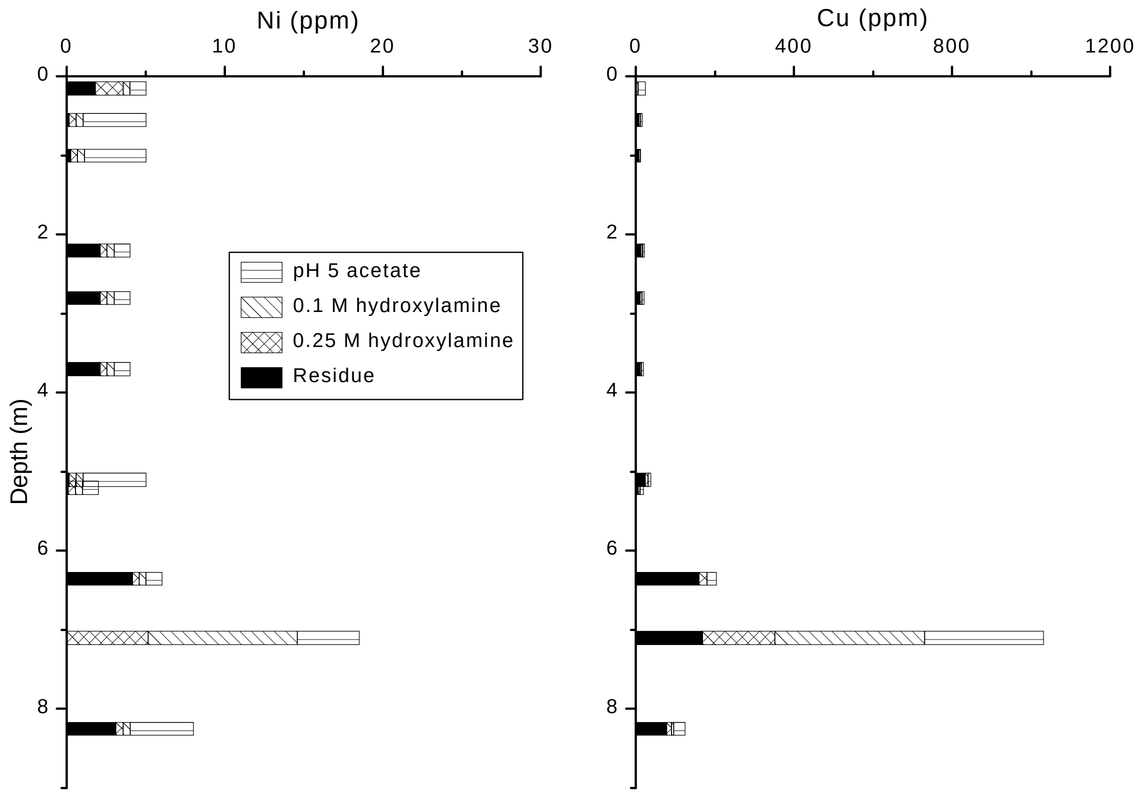


Figure 47: Ni and Cu data for Profile 5 (NE Pit, SE end).

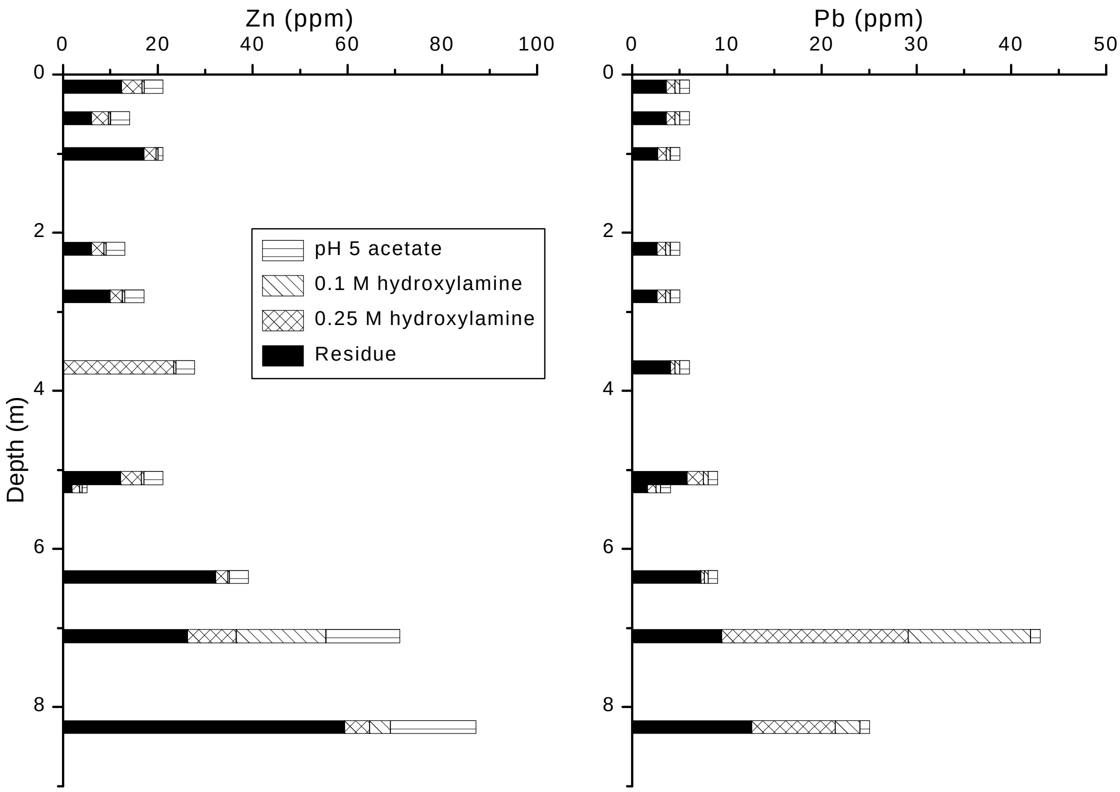


Figure 48: Zn and Pb data for Profile 5 (NE Pit, SE end).

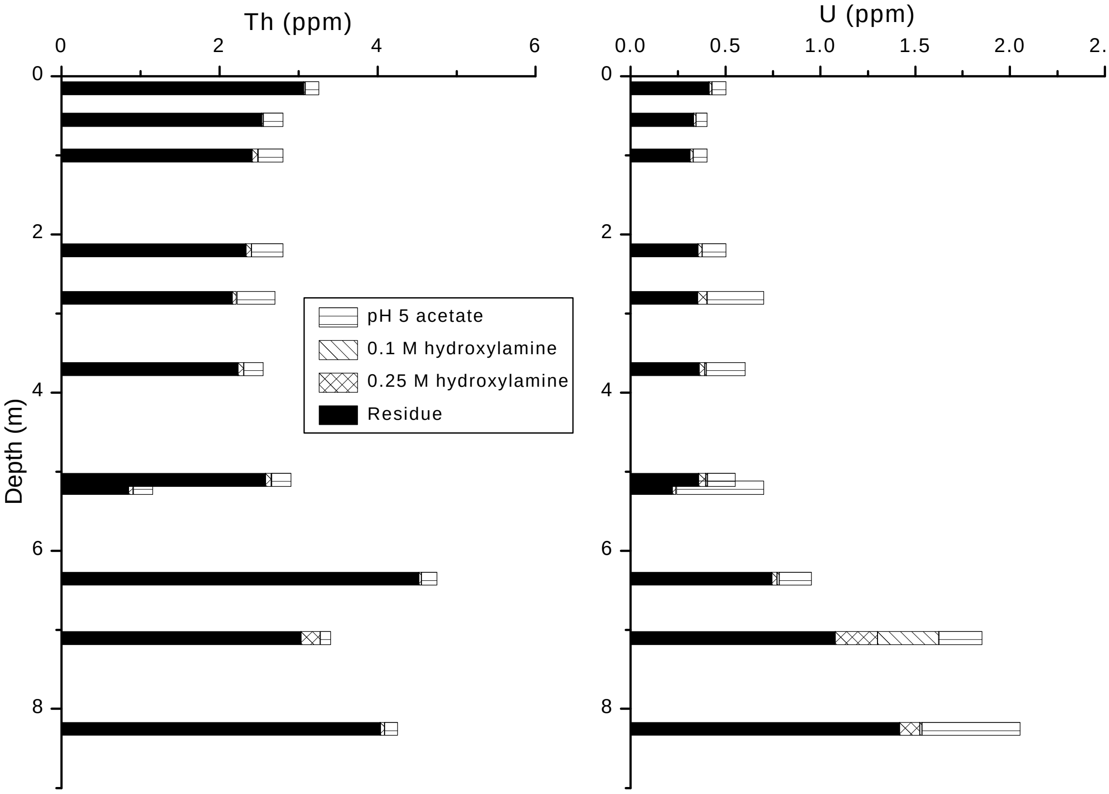


Figure 49: Th and U data for Profile 5 (NE Pit, SE end).

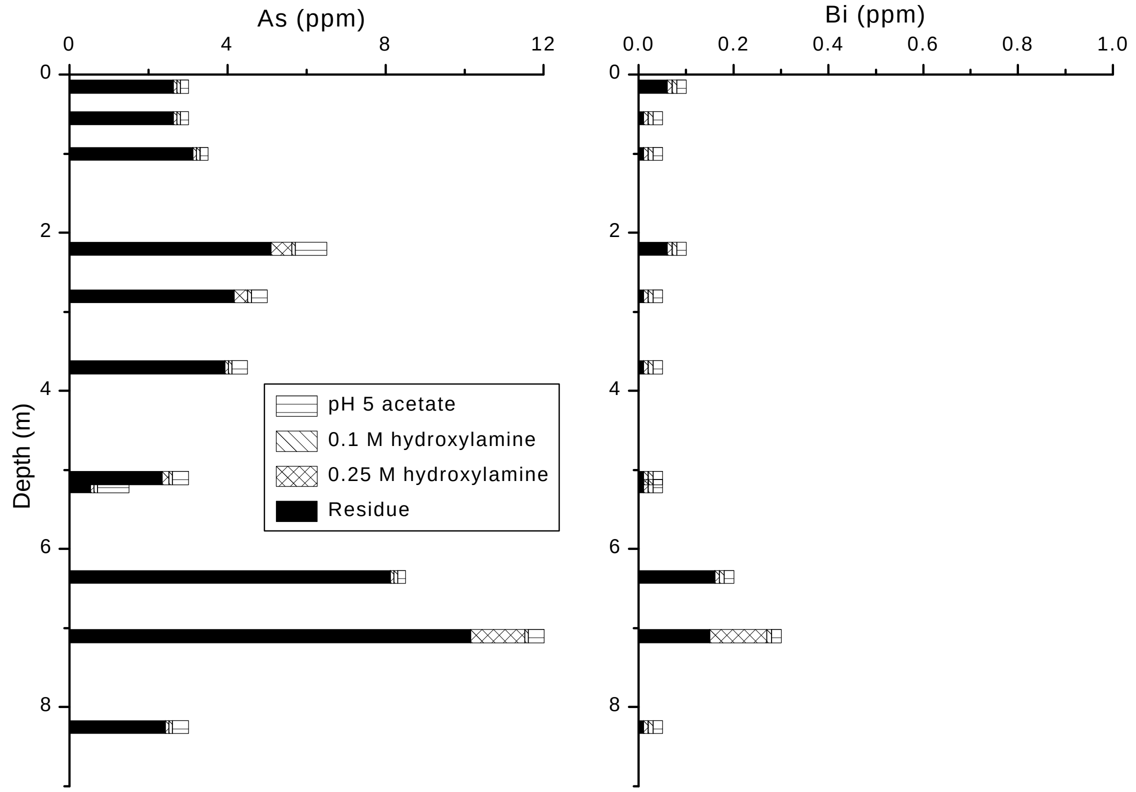


Figure 50: As and Bi data for Profile 5 (NE Pit, SE end).

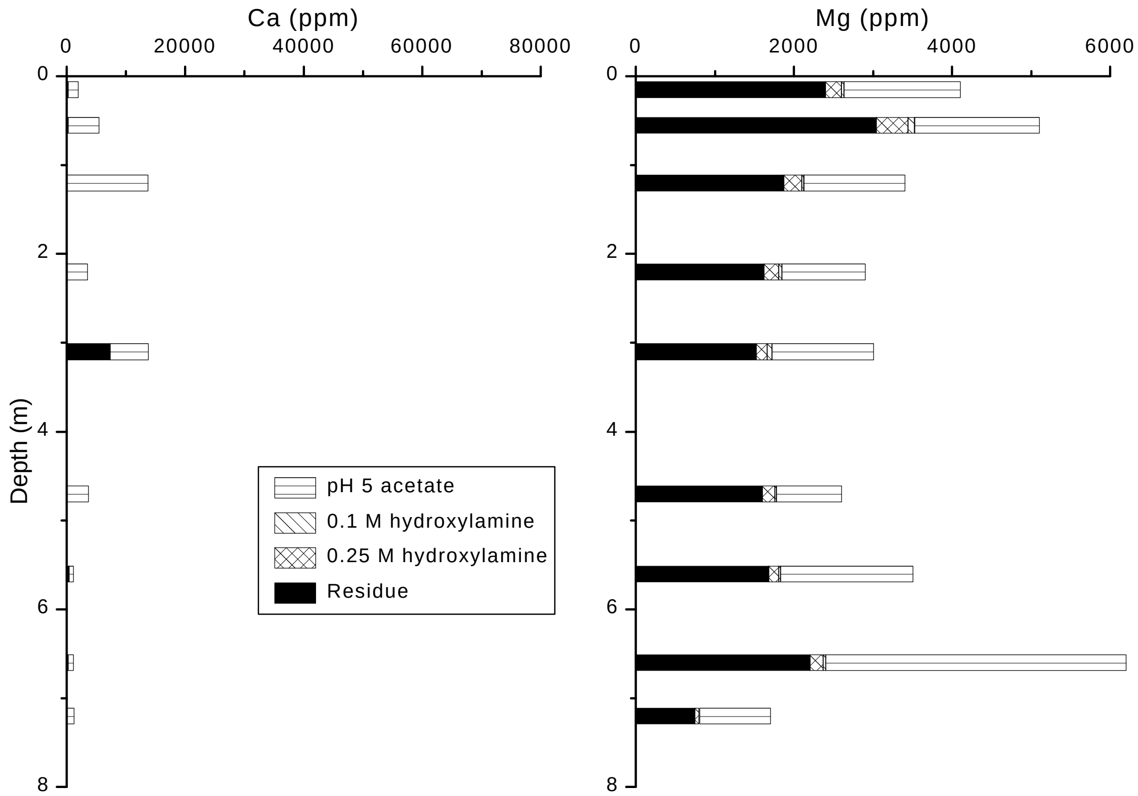


Figure 51: Ca and Mg data for Profile 6 (NE Pit, N end).

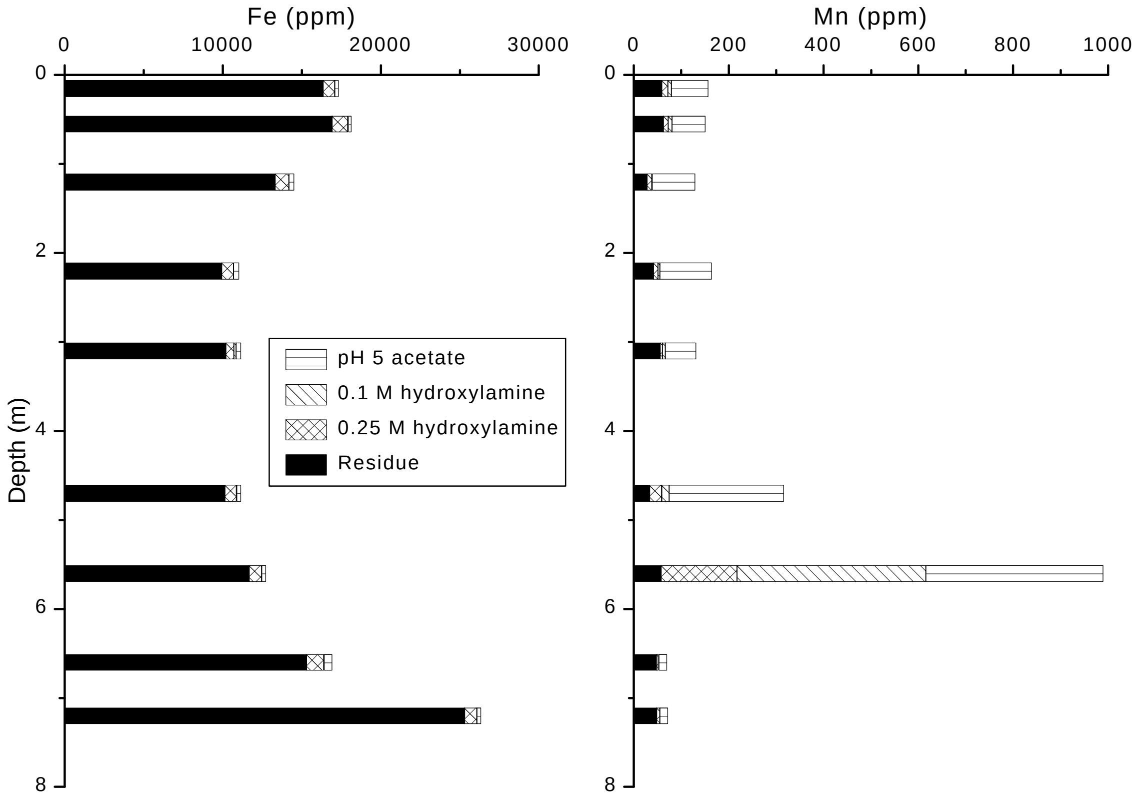


Figure 52: Fe and Mn data for Profile 6 (NE Pit, N end).

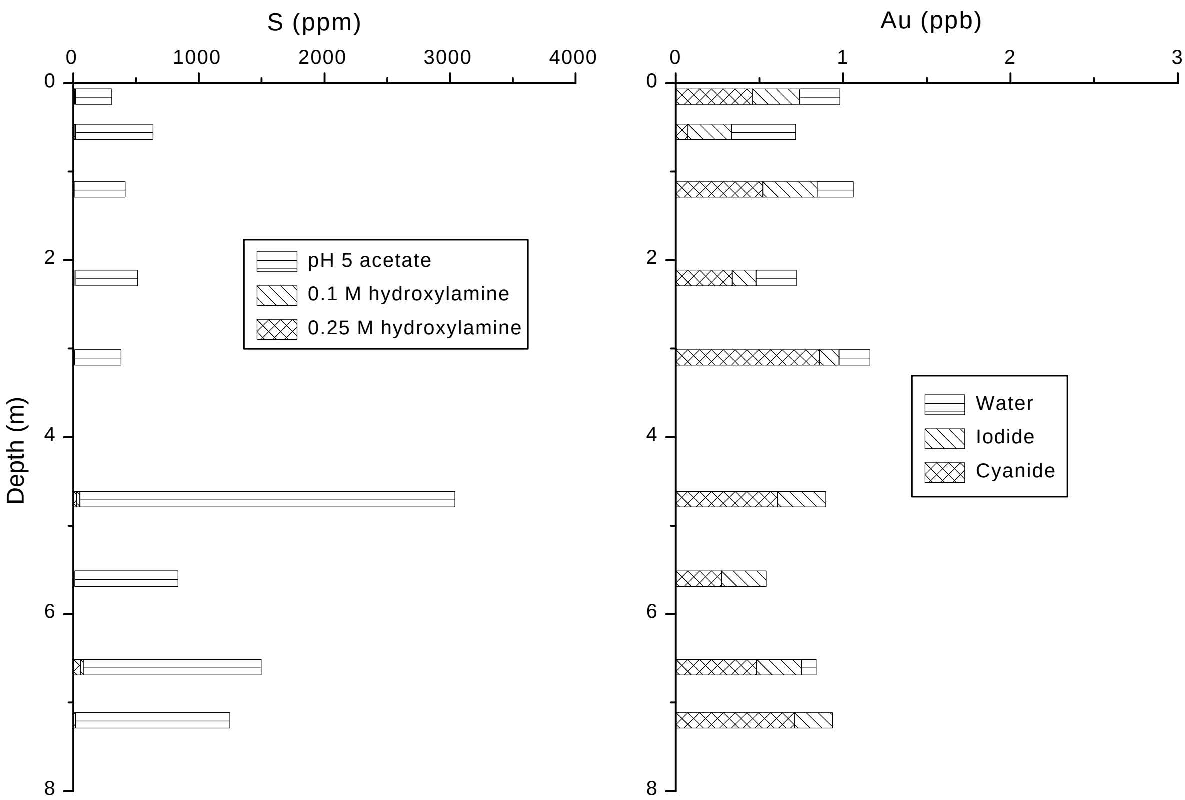


Figure 53: S and Au data for Profile 6 (NE Pit, N end).

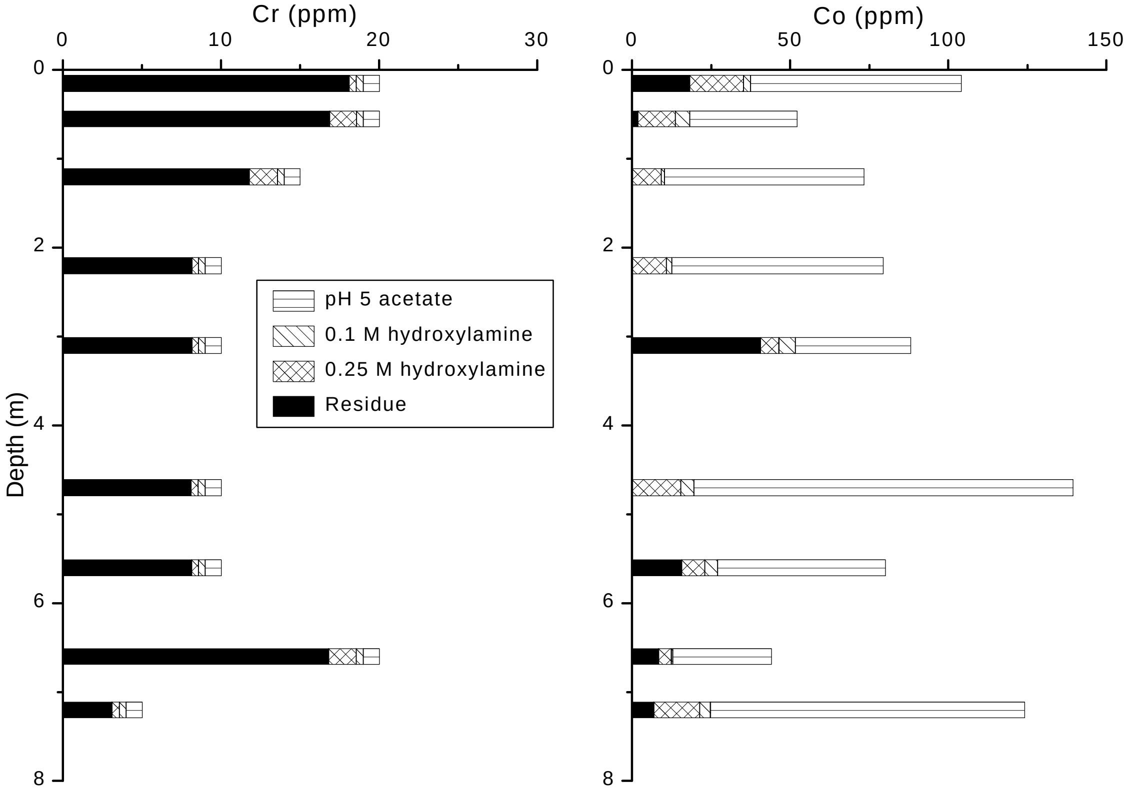


Figure 54: Cr and Co data for Profile 6 (NE Pit, N end).

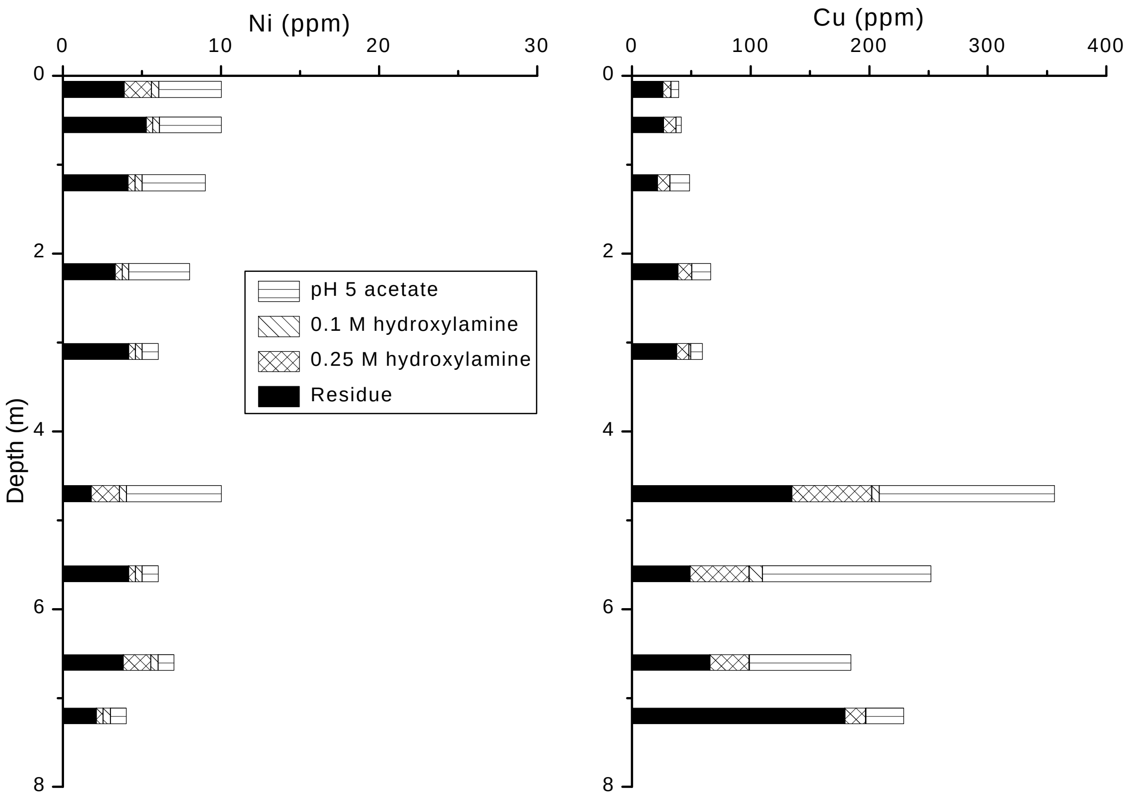


Figure 55: Ni and Cu data for Profile 6 (NE Pit, N end).

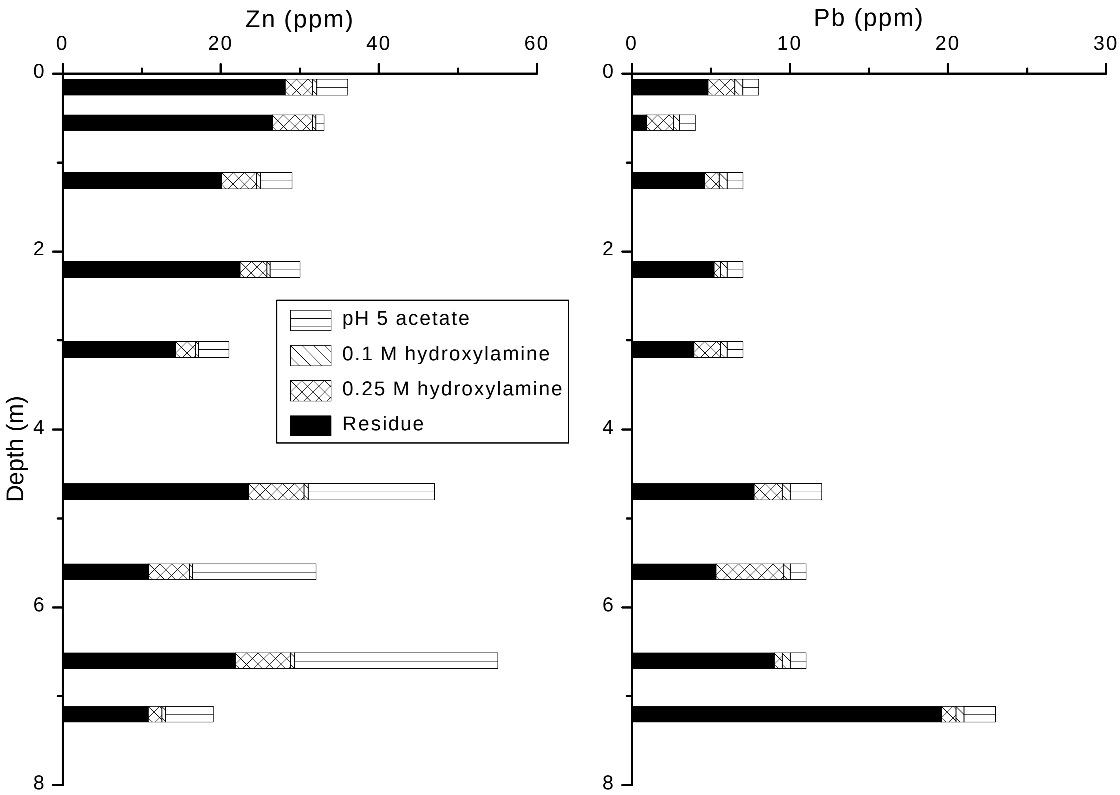


Figure 56: Zn and Pb data for Profile 6 (NE Pit, N end).

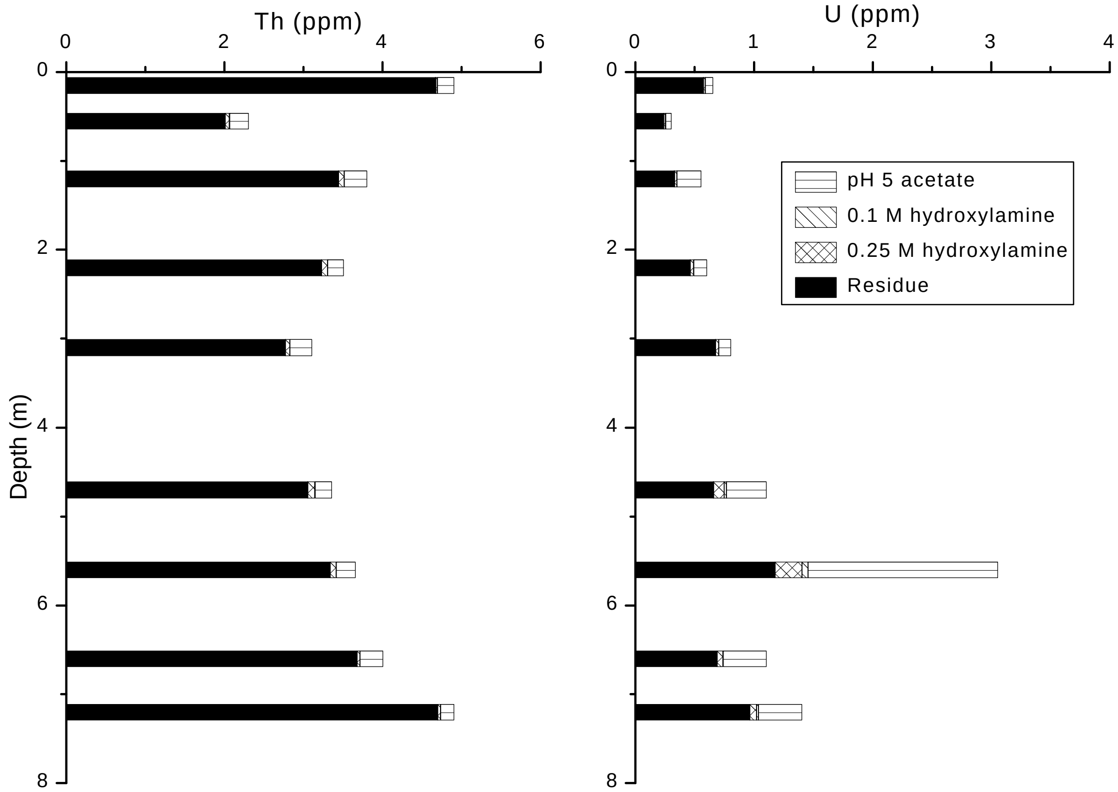


Figure 57: Th and U data for Profile 6 (NE Pit, N end).

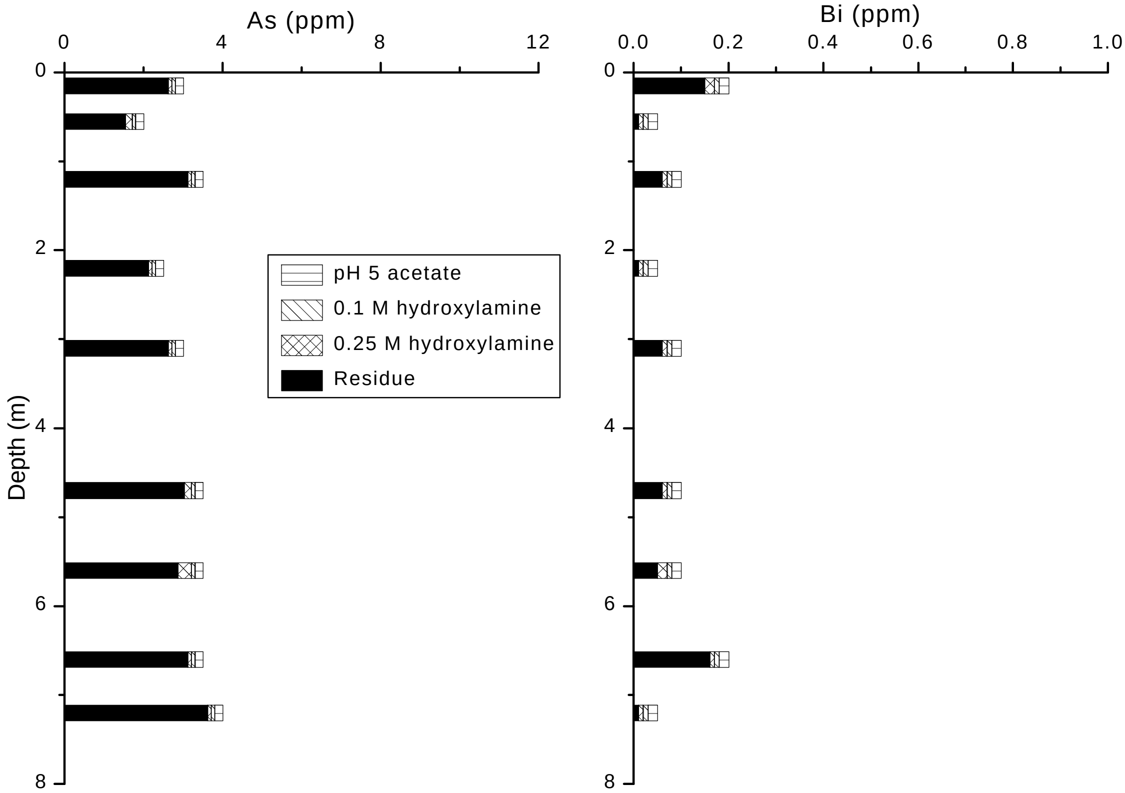


Figure 58: As and Bi data for Profile 6 (NE Pit, N end).

5. DISCUSSION AND RECOMMENDATIONS

The Mt Gunson area is noted for its Cu mineralization and so the behaviour of this element in the upper regolith is of particular interest for exploration. It was found that elevated Cu (and other metal) concentrations were associated with Mn oxides occurring as grains, flakes, fragments and as coatings on sand grains and larger sandstone clasts. Furthermore, most of the Mn was soluble suggesting that the metals have been, and probably still are, mobile within the upper regolith. Manganese staining was common throughout the soils but only in three profiles (2, 5 and 6) did it reach high enough concentrations to be clearly visible from several metres distance on the pit face (Photo 045304). The Cu content of manganiferous material for Profiles 2, 5 and 6 (all from Cattle Grid) are listed in Table 3 with typical background values for Cu, Pb and Zn from a previous study shown in Table 4.

Table 3: Selected metal concentrations for manganiferous samples collected in this study, Cattle Grid, Mt Gunson.

Profile/sample	Mn (ppm)	Cu (ppm)	Pb (ppm)	Co (ppm)	Ni (ppm)	Zn (ppm)
2/SMR6	3990	1370	65	172	38	32
5/SMR32	11100	1030	43	112	16	71
6/SMR41	989	252	11	80	6	32

The concentration of Cu, and to a lesser extent Pb, is significantly higher in the Mn-rich samples compared with the mean concentrations for these elements in un-mineralized material. Manganese oxides are well known scavengers of heavy/base metals such as Co, Ni and Zn and to a lesser extent

Cu and Pb. Analyses of the upper regolith, including calcrete, for elements such as Cu, should be normalized for Mn and Fe to allow for this concentration factor (Figure 59, Figure 60).

Further data is required to test whether target elements such as Cu and Co can be normalized with respect to Mn and Fe and then analysing the residuals. At Windabout, the limited data from this study suggests that for Cu, Zn and Pb at least, no significant concentrations can be found in the upper regolith (Appendix 2, Figure 59, and Figure 60), even though these elements are associated with the Tapley Hill-style of mineralization (Johns, 1974; Rattigan *et al*, 1977); the situation for Co is less clear.

Table 4: Arithmetic mean of metal values in un-mineralized rock units (Rattigan *et al*, 1977).

Unit	**Number of samples**	**Cu (ppm)**	**Pb (ppm)**	**Zn (ppm)**
Sand cover	108	11	28	33
Tregolana shale	202	18	34	66
Whyalla Sandstone	584	12	22	33
Yudnapinna Beds	377	14	25	41
Tapley Hill Formation	264	102	170	259
McLeay Beds	46	17	43	73
Pandurra Formation	71	24	32	35

Gold concentrations in the Quaternary cover at Mt Gunson were found to be low (usually < 2 ppb), and that Ca concentrations are generally lower (< 5%) than in soils found in the Gawler Craton further west where concentrations are of the order of 20 - 30 % (Lintern and Sheard, 1997; unpublished data). No definitive pattern for Au distribution was observed and, in particular, no elevated Au concentrations were found in pedogenic carbonate units, or in gypsum. In the Yilgarn Craton (WA), soil Ca concentrations greater than 1% appear to be an important locus for Au; also, Au concentrations in soils are regionally much greater than 2 ppb in mineralized areas (e.g. Lintern, 1989; Lintern and Butt, 1991, 1992; Lintern and Scott, 1990). As the Mt Gunson area is not noted for its Au mineralization, the results reported here are inconclusive, and it may still be necessary to target the calcrete horizon when exploring for Au in this region. It is recommended that auger drilling (0 - 1 m) be used as a "compromise" sampling technique to best allow for the observed variations in the Au content of the upper regolith and to maximize the chances of sampling calcrete in its various forms in the near-surface environment. Consideration should be given to sieving samples to remove wind blown sand which is regarded as a common diluent in this terrain although there is a danger of removing much of the fine carbonate during such an operation.

6. SUMMARY

1. Manganese and Fe oxides and oxyhydroxides appear to accumulate base and heavy metals such as Cu, Pb, Zn, and Co and need to be considered using data normalization procedures if exploring for these metals using the upper regolith; the difficulty in recognising these materials in drill hole cuttings probably negates their specific use as sampling media.

2. The concentration of Au is generally <2 ppb and is a contributing factor as to why the distribution of Au is highly variable in the upper regolith and does not show a strong association with calcrete. Nevertheless, because of its success in other parts of the Gawler Craton, calcrete sampling sampling is recommended for Au exploration; the use of a power auger to collect the top metre composite is further recommended since this will maximize the probability of collecting carbonate. Care should be taken if attempting to remove wind blown sand by sieving as this process may remove much of the fine carbonate.

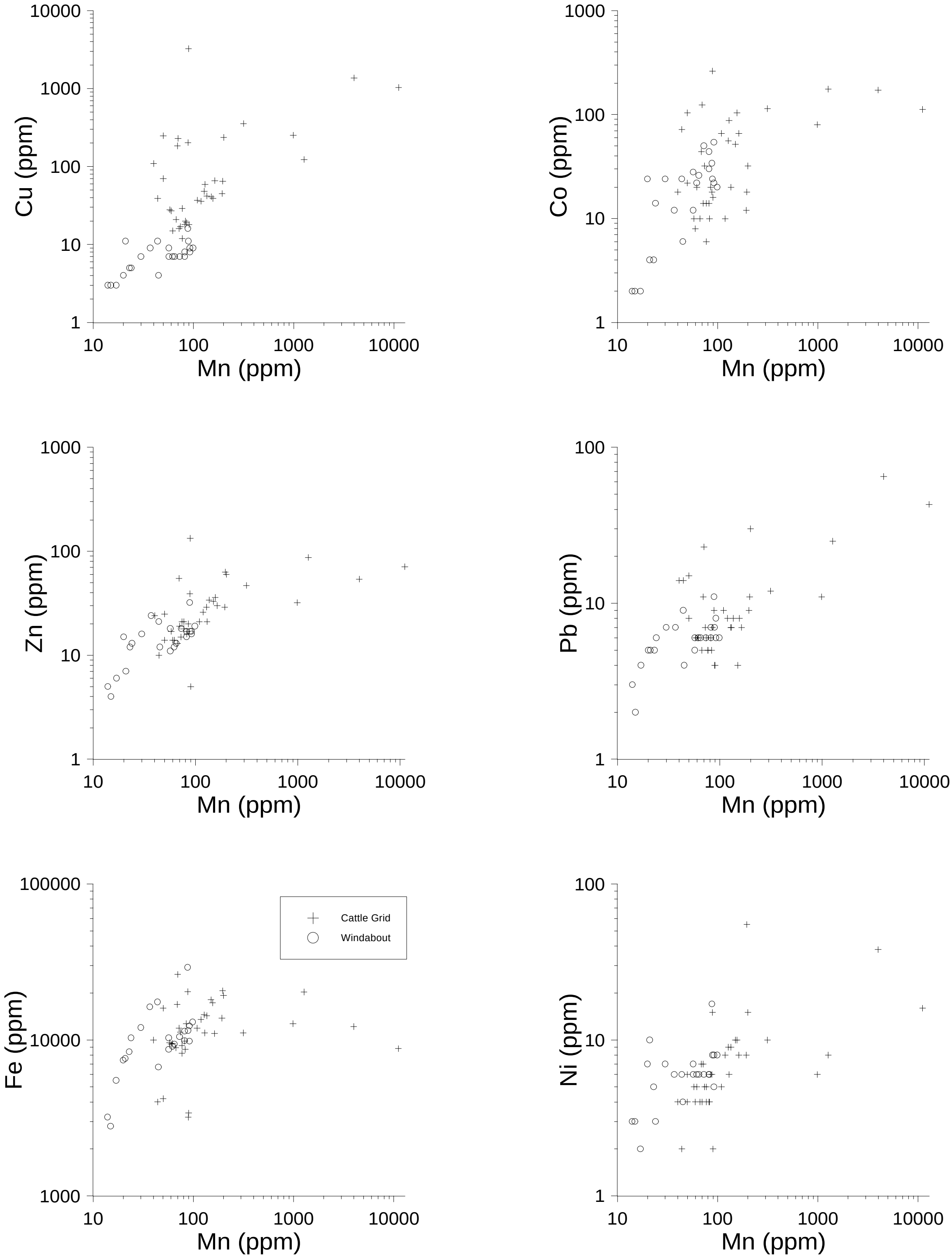


Figure 59: Scatter plots of total Mn versus selected elements for regolith samples at Mt Gunson.

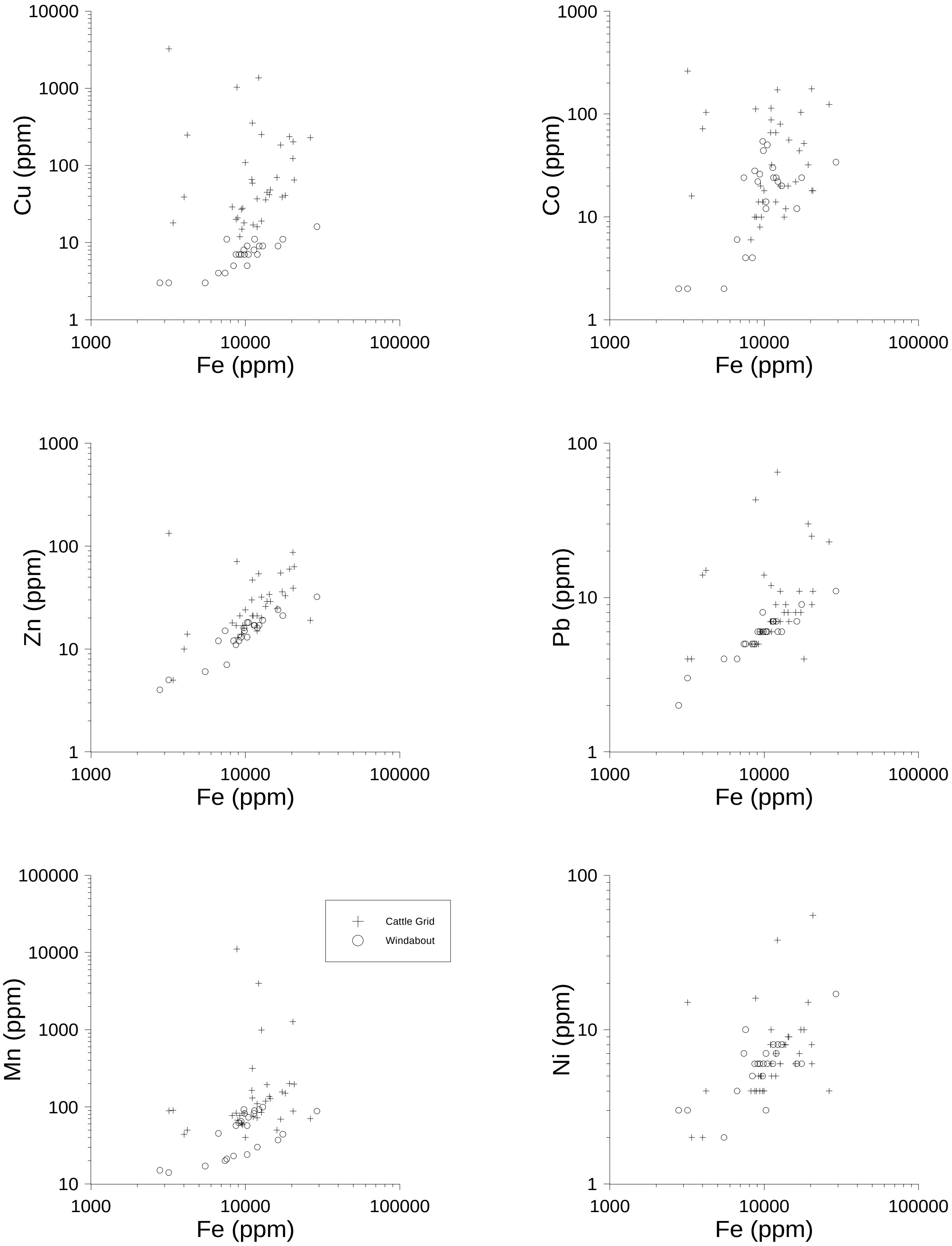


Figure 60: Scatter plots of total Fe versus selected elements for regolith samples at Mt Gunson.

7. ACKNOWLEDGEMENTS

The following people and companies are thanked for their support and expertise in preparation of this report: Stuart Metals NL for allowing access to the site, providing geological plans and geochemical data, and contributing to the cost of the project; Adelaide Chemical Company Ltd for logistics;

H. Paterson and D. Harley from Stuart Metals NL are thanked for useful discussions; A. Caruso and B. Giles from Abseil Access for assisting with the collection of samples; D. Longman for XRD interpretation and assisting with sample preparation; A. Francis and his team are thanked for drafting some of the diagrams; N. Alley, R. Anand, M. Killick and S. Robertson gave advice in the preparation of this report. CRC LEME is supported by the Australian Cooperative Research Centres Program.

8. REFERENCES

Anon, 1997., 1997. *Stuart Metals N.L. Annual Report*. Principal office located at 9 Havelock Street, West Perth, Western Australia.

Chao, T.T., 1984. Use of partial extraction techniques in geochemical exploration. *Journal of Geochemical Exploration*, 20: 101-135.

Gray, D.G and Lintern, M.J., 1993. Further aspects of the chemistry of gold in some Western Australian soils. *CSIRO Australia, Division of Exploration Geoscience* Report No. 391R. 50pp.

Johns, R.K., 1974. Base metal mineralisation in the Pernatty Lagoon region. *South Australia. Geological Survey. Report of Investigations*, 42.

Kelly, K.L. and Judd, D.R., 1976. *Color universal language and dictionary of names*. National Bureau of Standards. United States Commerce Department, Washington, D.C.

Lintern, M.J., 1989. Study of the distribution of gold in soils at Mt. Hope, Western Australia. *CSIRO Australia, Division of Exploration Geoscience Report* No. 24R. 36 pp.

Lintern, M.J., 1997. Calcrete sampling for gold exploration. *Mines and Energy Resources, South Australia*. Journal 5: 5-8.

Lintern, M.J. and Butt, C.R.M., 1991. Distribution of gold and other elements in soils from the Mulline area, Western Australia. *CSIRO Australia, Division of Exploration Geoscience* Report No. 159R. 56 pp.

Lintern, M.J. and Butt, C.R.M., 1992. The Distribution of Gold and other elements in soils and vegetation at Zuleika, Western Australia. *CSIRO Australia, Division of Exploration Geoscience Report* No. 328R. 90 pp.

Lintern, M.J. and Butt, C.R.M., 1993. Pedogenic carbonate - an important sampling medium for gold exploration in semi-arid areas. *CSIRO Australia, Division of Exploration Geoscience*. Exploration Research News Number 7.

Lintern, M.J. and Scott, K.M., 1990. The distribution of gold and other elements in soils and vegetation at Panglo, Western Australia. *CSIRO Australia, Division of Exploration Geoscience* Report No. 129R. 96 pp.

Munsell Color, 1975. *Munsell Soil Color Charts*. Munsell Color, Baltimore, Maryland, U.S.A.

Northcote, K.H., 1979. *A factual key for the recognition of Australian soils*. 4th Edition. Rellim Technical Publications, Adelaide.

O'Driscoll, E.S.T., 1986. Observations of the lineament-ore relation. *In*: Reading, H.G., Watterson, J. and White, S.H., (Editors). Major crustal lineaments and their influence on the geological history of the continental lithosphere. *Royal Society of London. Philosophical Transactions*, 317:195-218.

Preiss, W.V., (Compiler) 1987. The Adelaide Geosyncline: Late Proterozoic stratigraphy, sedimentation, palaeontology and tectonics. *South Australia. Geological Survey. Bulletin,* 53: 384-389.

Preiss, W.V., 1993. Neoproterozoic. *In*: Drexel, J.F., Preiss, W.V. and Parker, A.J., (Editors). The geology of South Australia. Volume 1 The Precambrian. *South Australia. Geological Survey. Bulletin*. 54:171-197.

Rattigan, J.H., Gersteling, R.W., and Tonkin, D.G., 1977. Exploration geochemistry of the Stuart Shelf, South Australia. *Journal of Geochemical Exploration*, 8: 203-217.

Sheard, M.J. and Bowman, G.M., 1996. Soils, stratigraphy and engineering geology of near surface materials of the Adelaide Plains. *South Australia. Department of Mines and Energy. Report Book*, 94/9.

Thomson, B., Forbes, B and Coats, R., 1975. Adelaide Geosyncline and Stuart Shelf – geology. *In*: Knight, C.L., (Editor). *Economic Geology of Australia and Papua New Guinea. Volume 1 Metals*. The Australian Institute of Mining and Metallurgy, Melbourne. pp. 461-466.

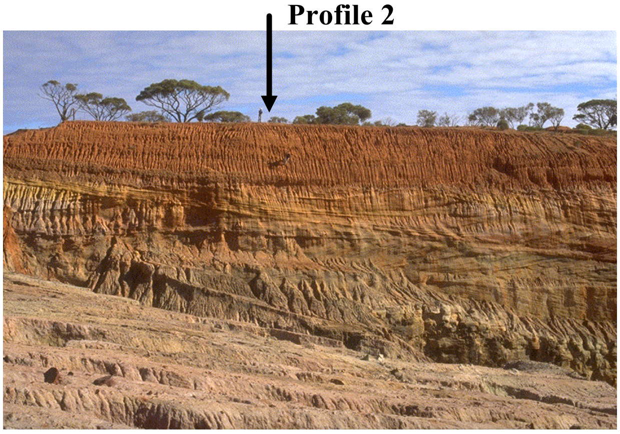
Tonkin, D.G. and Creelman, R.A., 1990. Mount Gunson Copper Deposits. *In*: Hughes, F.E., (Editor). *Geology of the Mineral Deposits of Australia and Papua New Guinea*. The Australasian Institute of Mining and Metallurgy, Melbourne. pp. 1037-1043.

Van Herk, H., Houston, M.L and Dudgeon, R.N., 1975. Planning, development and extraction of the Cattle Grid ore deposit, Mt Gunson. *Proceedings of the Australasian Institute of Mining and Metallurgy Conference*, Adelaide, S.A., June, 1975, pp 113-124.

Williams, G.E. and Tonkin, D.G., 1985. Periglacial structures and palaeoclimatic significance of a late Precambrian block field in the Cattle Grid copper mine, Mount Gunson, South Australia. *Australian Journal of Earth Science*, 32: 287-300.

Wills, K., 1997. Development of calcrete sampling methodology in SA. In “Gold exploration using calcrete geochemistry - background and SA case studies”. *Australian Mineral Foundation Workshop Course 128A/97*. Adelaide.

Profile 2



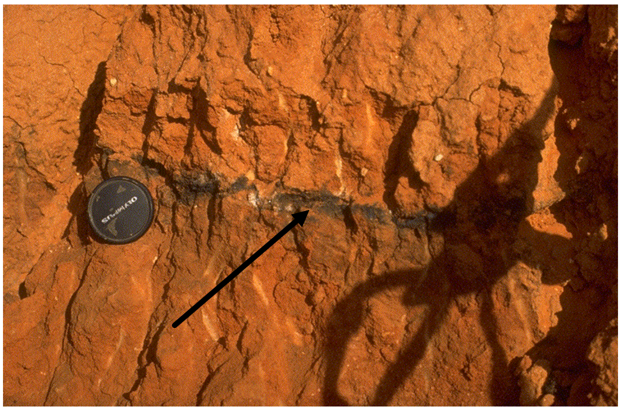
1.
Area 4 pit at Mt Gunson showing the location of Profile 2 and the Quaternary units overlying the cross-bedded Whyalla Sandstone. 703050E 6518759N. *Photo 045300*.

Profile 2

2.
Detail of Area 4 pit at Mt Gunson showing the location of Profile 2 and the Quaternary units overlying the cross-bedded Whyalla Sandstone. The Quaternary units were sampled to the interface with the Whyalla Sandstone. 703050E 6518759N. *Photo 045301*.

3.
Red brown sandy clay with soft concretions of pedogenic carbonate on ped partings. Sample SMR4, 3 m depth, Profile 2, Area 4, Mt Gunson. 703050E 6518759N. Photo 045302.

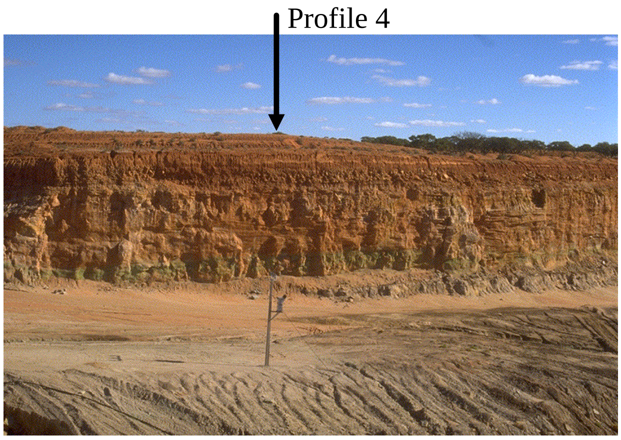
4.
Gypseous red brown sandy clay containing nodules and rhizomorphs of gypsum. Sample SMR5, 4 m depth, Profile 2, Area 4, Mt Gunson. 703050E 6518759N. *Photo 045303*.



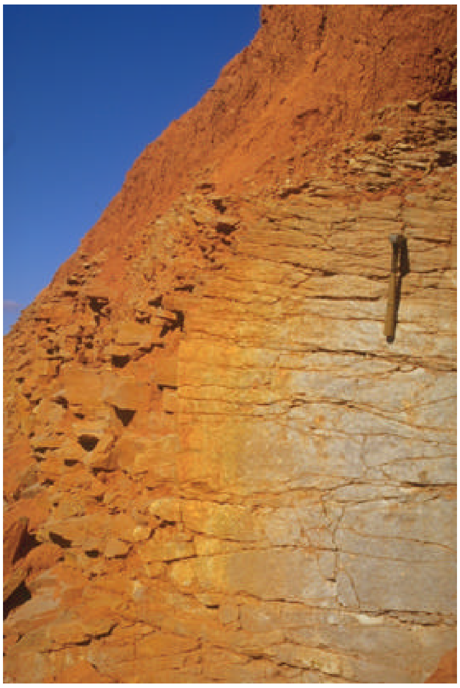
5.
Red brown sandy clay with a 2-3 cm thick band of gypsum and manganese (black). Sample SMR6, 6 m depth, Profile 2, Area 4, Mt Gunson. 703050E 6518759N. *Photo 045304*.

6.
Red brown sandy clay with large sandstone clasts (some > 10 cm) of Whyalla Sandstone. Sample SMR8, 9 m depth, Profile 2, Area 4, Mt Gunson. 703050E 6518759N. *Photo 045305*.

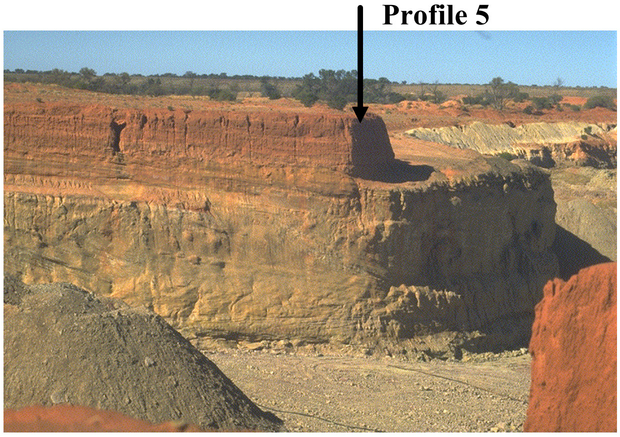
7.
Sandy unit near the interface between the Quaternary units and the Whyalla Sandstone. Sample SMR9, 10 m depth, Profile 2, Area 4, Mt Gunson. 703050E 6518759N. *Photo 045306*.



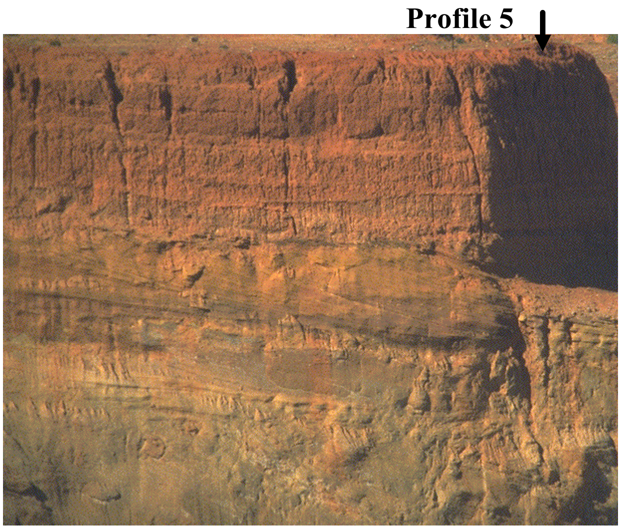
8.
North west pit at Mt Gunson showing approximate location of Profile 4 and the Quaternary units overlying the cross-bedded Whyalla Sandstone. 702670E 6518782N. *Photo 045307*.



9.
Massive sandstone of the Whyalla Sandstone close to the interface with the Quaternary units. North west pit, Mt Gunson, 2 m depth, 702540E 6518850N. *Photo 045308*.

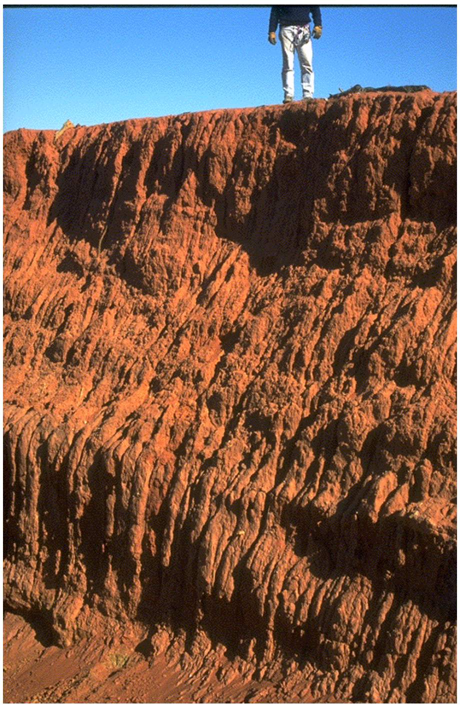


10.
North east pit at Mt Gunson showing approximate location of Profile 5 and the Quaternary units overlying the cross-bedded Whyalla Sandstone and the Pandurra Formation at the base. 703975E 6519105N. *Photo 045309*.

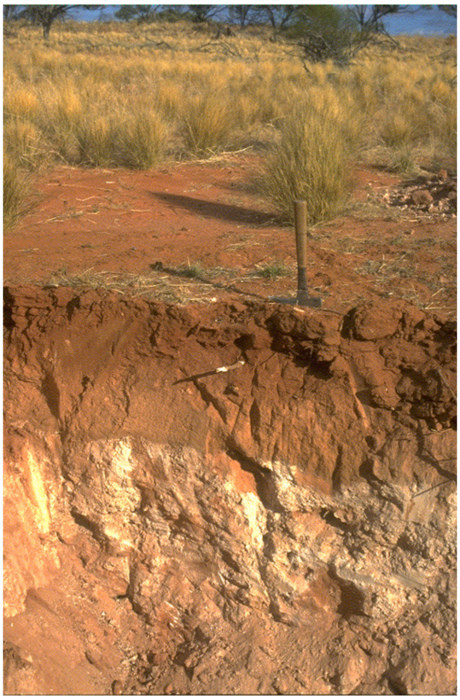


11.
Detail of the North East pit at Mt Gunson showing approximate location of Profile 5 and the Quaternary units overlying the cross-bedded Whyalla Sandstone. 703975E 6519105N. *Photo 045310*.

12.
North east pit at Mt Gunson showing approximate location of Profile 6 and the Quaternary units overlying the cross-bedded Whyalla Sandstone and the Pandurra Formation at the base. 703187E 6518925N. *Photo 045311*.



13.
Detail of the North East pit at Mt Gunson showing location of Profile 6 in the Quaternary units. 703975E 6519105N. *Photo 045312*.



14.
Profile 1 at the Windabout prospect (Mt Gunson) showing red brown sandy clay overlying a pale calcareous and gypseous clayey horizon. 703050E 6518759N. *Photo 045313*.

15.
Profile 3 at the Windabout prospect (Mt Gunson) showing red brown calcareous sandy clay overlying a pale gypseous horizon in the base of the pit. 702395E 6525020N. *Photo 045314*.

10. APPENDICES

10.1 Appendix 1: Pit and Drillhole logs

APPENDIX 1

STUART METALS NL: STUART SHELF - MOUNT GUNSON AREA

REGOLITH INVESTIGATIONS - PIT AND DRILLHOLE LOGS

Symbols and methods used in descriptions

Colours - standard Munsell Color Notation, Soil Color Charts (Munsell Color, 1975).
- word colours follow Kelly & Judd (1976) as modified by Sheard & Bowman (1996).
- (d) = colour description performed on DRY sample.
- (w) = colour description performed on WET sample.

Textures - follow those described in Northcote (1979, pp 26-28).

Mineralogy - Preliminary identification done in the field with a hand lens (M.J. Lintern), follow up detail carried out on both dry samples and wet-sieved samples using a binocular microscope (detailed logging by M.J. Sheard).

Site: Area 4, Profile 2, Pit Face. Photos 045300 and 045301.

Location: Zone 53, 703050 E, 6518759 N

Vertical pit wall, sampled using abseiling technique.

Sample ID	Average depth (m)	Description
SMR1	0.15	UNWASHED: red-brown (d) calcareous clayey sand; texture - clayey sand, moderate brown (w) (5YR 4/5). WASHED: silty fine to medium grained quartz sand, translucent to clear sub angular to sub rounded grains with an orange coating and fracture lining, abundant cream coloured silt sized and mm sized carbonate grains and fragments, rare dark mineral grains, ~2% larger milky to grey quartz grains - rounded coarse sand.
SMR2	0.55	UNWASHED: red-brown (d) calcareous clay; texture - loam, fine sandy, grayish reddish orange (w) (2.5YR 5/7). WASHED: as above with more calcrete fragments and more of the well rounded milky quartz grains (~5% of washed bulk).
SMR3	1.40	UNWASHED: red-brown (d) clay, soft concretions of carbonate along ped partings, points of carbonate in the clay; texture sandy loam, brownish orange (w) (5YR 5/8). WASHED: sand as above, conspicuous white carbonate fragments, larger (>2 mm) rounded milky quartz grains appear to be of fluvial origin.
SMR4 Photo 045302	2.90	UNWASHED: red-brown (d) clay, soft concretions of carbonate along ped partings, points of carbonate in the clay, ?mangans & gypsum; texture sandy loam, brownish orange (w) (5YR 5/8). WASHED: as above with more fine sand and coarse silt present.
SMR5 Photo 045303	4.05	UNWASHED: gypsiferous red (d) clay, nodules and rhizomorphs of gypsum (50-100 mm); texture - clayey sand, brownish orange (w) (5YR 5/8). WASHED: sand as above with less calcrete, layers of crystalline gypsum enclosing sand grains.
SMR6 Photo 045304	6.10	UNWASHED: manganiferous clay (10-20mm thick) & gypsum from horizon above; texture - sandy clay, moderate brown & black (w) (5YR 4/3 & N 2/-). WASHED: fine to coarse silt and fine to medium grained quartz sand with 3-5% 1-3 mm rounded fluvial grains, black Mn oxide grains-flakes-fragments ~10-15% of bulk washed, crystalline gypsum with included Mn oxides & sand grains - band ~ 20 mm thick.
SMR7	7.70	UNWASHED: sandy red-brown (d) clay; texture - clayey sand, grayish reddish orange (w) (2.5YR 5/6) WASHED: quartz sand with some coarse silt as per SMR1, no calcrete, rare grains of buff coloured silcrete with included white quartz sand grains.
SMR8 Photo 045305	8.60	UNWASHED: red sandy clay with large sandstone clasts (>100 mm); texture - sandy light clay, grayish reddish orange (w) (2.5YR 5/6). WASHED: less sand in washed bulk and >60% is not orange stained as sand above is), coarse silt to medium grained sand with larger composite fragments of sandstone - creamy to milky quartz grains, silcrete fragments <2 mm.
SMR9 Photo 045306	10.10	UNWASHED: greeny yellow sandstone and sand, moderate orange yellow (d) (10YR 7/8), dark orange yellow (w) (10YR 6/7). WASHED: fine to medium grained colourless to grey & milky quartz sand with 10-15% silt, rare black grains - rounded to subangular (?Mn oxides), occasional fluvial gravel clasts - well rounded (3-4 mm).

Site: NW Pit, Profile 4, Pit Face. Photo 045307. Location: Zone 53, 702670 E, 6518782 N Vertical pit wall, sampled using abseiling technique		
Sample ID	Average depth (m)	Description
SMR16	0.15	UNWASHED: red-brown (d) sandy clay, carbonate nodules (10-20 mm); texture - sandy clay, brownish orange (w) (2.5YR 5/8). WASHED: reddish stained and/or coated quartz grains - coarse silt to fine - medium grained sand, subangular to rounded grains with some larger 1-3 mm composite fragments (sandstone), creamy calcrete grains as silt to sand and fragments <3 mm (~5-10%). Occasional rounded fluvial quartz gravel to 3 mm, strong acid response.
SMR17	0.55	UNWASHED: red-brown (d) loam, small (<2 mm) calcrete nodules; texture - sandy clay loam, light brown (w) (5YR 5/5). WASHED: sand as above without much fragmental calcrete (<1%), rare black heavy mineral flakes and angular grains <1 mm and some larger angular white to cream quartz grains to 2 mm.
SMR18	1.00	UNWASHED: red-brown (d) sandy clay with large 50-100 mm soft carbonate concretions; texture - loam, light brown (w) (5YR 6/6). WASHED: large amount of silt to fine sand sized carbonate grains and fragments (~25% of bulk), quartz sand as above in SMR16, rare large angular to subrounded quartz grains to 2 mm (1-3%), strong acid response.
SMR19	2.00	UNWASHED: red-brown (d) sandy clay with soft concretions of carbonate on peds; texture - loamy clay, moderate orange (w) (5YR 6/7). WASHED: very little granular material in washed sample, sand and carbonate silt as above, calcrete fragments (5-10 mm), plus vein fragments of crystalline gypsum (10-15 mm), strong acid response.
SMR20	3.00	UNWASHED: red (d) sandy clay, ?non calcareous with hard ?sandstone nodules; texture - sandy clay, strong brown (w) (2.5YR 4/7). WASHED: reddish stained fine to medium grained quartz sand with some coarse silt, rare calcrete grains and some silcrete fragments (1-3 mm) enclosing rounded quartz grains.
SMR21	3.50	BASAL SOIL ZONE: sandstone clasts - some >100 mm, similar to those sampled at SMR8. ROCK: poorly laminated sandstone composed of medium to coarse grained clear to grey subrounded to subangular and angular quartz. Rock is grain supported with pores and voids filled with creamy to grey silica cement and a reddish cement. Weak acid response, 2nd sample has true silcrete cement, rock fractures across grains.
SMR22	35.50	ROCK: hand specimen - malachite stained sandstone. Washed specimen - grey to pinkish-grey quartz sandstone, fine to medium grained, translucent to grey coloured grains and some creamy to white ?feldspar grains, has sulphide smell, some dark yellowish black to grey sulphide grains present.

Site: NW Pit, Profile not geochemically analysed but described, and located adjacent to Profile 4, Pit Face

Location: Zone 53, 702540 E, 6518850 N

Vertical pit wall, sampled using abseiling technique

Sample ID	Average depth (m)	Description
SMR11	0.15	UNWASHED: red-brown (d) sandy clay, calcareous throughout; texture - sandy clay, strong brown (w) (5YR 4/6). WASHED: orange stained aeolian quartz sand - fine to medium grained, with coarse silt, also with medium to coarse grained milky quartz as rounded grains, rare lithic grains and fragments including silcrete (1-3 mm), medium to strong acid response.
SMR12	0.55	UNWASHED: red-brown (d) sandy clay, calcareous throughout; texture - gritty clay, light brown (w) (5YR 5/6). WASHED: sand as above with ubiquitous white calcrete angular fragments 0.5-1.0 mm, strong acid response.
SMR13	1.00	UNWASHED: red-brown (d) sandy clay, calcareous spotting; texture - sandy clay to clayey sand, light brown (w) (5YR 5/6). WASHED: orange stained aeolian quartz sand - fine to medium grained, also with medium to coarse grained angular to subangular milky quartz, calcrete (1-6 mm) and gypcrete (1-5 mm) fragments (encapsulating sand) (1-3 mm), ~1-2% silt and sand sized calcrete grains, strong acid response.
SMR14	1.40	UNWASHED: sandy clay, clay peds, silcreted sandstone fragments; texture - sandy heavy clay, strong brown (w) (2.5YR 4/7). WASHED: equal mix of - orange stained fine to medium grained aeolian quartz sand and medium to coarse grained milky to creamy angular to subangular quartz sand. Large rounded clasts of ferruginous silcrete and sandstone (5-15 mm), gypcrete fragments to 10 mm, no acid response.
SMR15 Photo 045308	2.00	ROCK: silica cemented quartz sandstone, medium to coarse grained translucent to grey quartz, strongly cemented - rock breaks across grains, cement both original digenetic and of later silcrete type (amorphous, khaki colour), no acid response.

Site: NE Pit (SE end), Profile 5, Pit Face. Photos 045309, 045310.

Location: Zone 53, 703975 E, 6519105 N

Vertical pit wall, sampled using abseiling technique

Sample ID	Average depth (m)	Description
SMR23	0.15	UNWASHED: red (d) clayey sand, non calcareous; texture - clayey sand, strong brown (w) (5YR 4/8). WASHED: orange stained rounded to subangular quartz grains, aeolian, medium to coarse silt (~20%) and fine to medium sand, no acid reaction .
SMR24	0.55	UNWASHED: red (d) sandy clay, highly calcareous; texture - clayey sand, light brown (w) (5YR 5/6). WASHED: sand as above, with calcrete grains as coarse silt to fine sand sizes and fragments 1-2 mm, strong acid reaction.
SMR25	1.00	UNWASHED: sandy clay (d) with soft calcareous concretions (up to 50 mm); texture - clayey sand, brownish orange (w) (5YR 5/8). WASHED: sand as above, abundant cream coloured calcrete fragments enclosing quartz sand, strong acid reaction.
SMR26	2.20	UNWASHED: sandy clay (d) with soft calcareous concretions (up to 50 mm); texture - clayey sand, light brown (w) (5YR 6/6). WASHED: sand as above with much less calcrete (< 5%), moderate acid response.
SMR27	2.80	UNWASHED: red-brown (d) clay, highly calcareous, soft and some carbonate indurated nodules (<5 mm); texture - sandy loam, light brown (w) (5YR 6/6). WASHED: sand as above with abundant cream, white and brown calcrete lumps (5-10 mm) and fines as silt and sand grains, strong acid reaction.
SMR28	3.70	UNWASHED: red (d) clay, calcareous and gypsiferous, gypsum nodules (>50 mm), rhizomorphs; texture - clayey sand, brownish orange (w) (2.5YR 5.5/8). WASHED: sand as above with less calcrete, veins of crystalline gypsum enclosing sand grains, these veins ~10-20 mm thick, moderate to strong acid response.
SMR29	5.10	UNWASHED: sandy loam (d) with spotty mangans, some soft carbonate concretions, some gypsum; texture - light sandy clay loam, brownish orange (w) (5YR 5/8). WASHED: sand as above with less gypsum and only minor calcrete, weak acid response.
SMR30	5.20	UNWASHED: nodular calcrete horizon, nodules up to 50-100 mm; texture - clayey sand, light brown (w) (5YR 6/6). WASHED: quartz sand as above with sand sized calcrete grains and calcrete nodules, crystalline gypsum veins.
SMR31	6.35	UNWASHED: red and green-grey (d) sand and clay; texture - sandy clay, brownish orange (w) (5YR 5.5/8). WASHED: mixture of reddish stained quartz grains and colourless clear to milky quartz grains, some gypsum and calcrete fragments 2-4 mm, moderate acid response.

(continued)

SMR32	7.10	UNWASHED: coarse sandy horizon immediately above Whyalla Sandstone. Highly manganiferous, some gypsum, Mn-coated sandstone clasts up to 100 mm; texture - sand, moderate orange yellow (d) (10YR 7/8), strong yellowish brown (w) (10YR 5/7). WASHED:
SMR33	8.25	ROCK: khaki Whyalla Sandstone, bedded, manganiferous banding. WASHED LOOSE COMPONENTS: sand, light yellowish brown (d) (10YR 6/6), strong yellowish brown (w) (10YR 5/7). Medium grained rounded to angular quartz, fragments of silcreted same. Yellow siliceous clay coating of many grains, some dark lithic and pale feldspathic grains and fragments.

Site: Area 4, Pit Face Location: Zone 53 703187 E, 6518925 N Location Vertical pit wall, sampled using abseiling technique		
Sample ID	Average depth (m)	Description
SMR34	6.2	(Lens shaped sandstone structure in pit face [10 x 3 m], similar material to SMR33) ROCK: weakly cemented, laminated sandstone, lamellae on mm to 10's mm scale, with purple, brownish yellow and grey bands, fine to medium grained quartz sand and silt, poorly sorted subangular to subrounded to rounded frosted greyish grains, 1-2% weathered feldspar grains, some rare dark lithic grains, no acid response. UNWASHED LOOSE COMPONENTS: texture - sand, pale orange yellow (d) (7.5YR 8/4), light brown (w) (7.5YR 6/4) WASHED LOOSE COMPONENTS: fine to medium grained grey to milky rounded quartz sand, some milky to cream coloured feldspar grains and rare dark lithic grains, some fragments of yellow silcrete.

Site: NE Pit (N end), Profile 6, Pit Face. Photos 045311 and 045312. Location: Zone 53, 703794 E, 6519275 N Vertical pit wall, sampled using abseiling technique		
Sample ID	Average depth (m)	Description
SMR35	0.15	UNWASHED: red (d) sandy clay, non calcareous; texture - loamy sand,, moderate reddish brown (w) (2.5YR 4/5). WASHED: reddish coated fine to medium rounded grained quartz aeolian sand, with some rare cream silcrete fragments, no acid response.
SMR36	0.55	UNWASHED: red-brown (d) sandy clay, regular white dots - non calcareous, sample is generally calcareous; texture - loam, strong brown (w) (2.5YR 4/6). WASHED: very little granular material, fine to coarse carbonate silt and fine to medium grained quartz sand - reddish stained as above, strong acid response.
SMR37	1.20	UNWASHED: red (d) sandy clay with dots of soft calcareous concretions; texture - loamy sand, strong brown (w) (2.5YR 4/6). WASHED: medium to coarse silt and reddish stained fine to medium grained rounded quartz sand, aeolian, similar sized carbonate grains and calcrete fragments up to 3 mm, strong acid response.
SMR38	2.20	UNWASHED: red (d) sandy clay, ?Mn spotting, fine white spotting; texture - clayey sand, strong brown (w) (2.5YR 4/6). WASHED: coarse silt to coarse sand, reddish stained aeolian quartz grains and grey to colourless rounded grains derived from a different source, some cream calcrete fragments 1-3 mm, and occasional black mineral grains to 1 mm, weak to moderate acid response.
SMR39	3.10	UNWASHED: red (d) sandy clay with spotty soft calcareous concretions; texture - clayey sand, strong brown (w) (2.5YR 4/8). WASHED: sand as above with larger calcrete fragments (>10 mm) common, strong acid response.
SMR40	4.70	UNWASHED: stone zone consisting of silcrete cobbles and gravel, gypsiferous and manganiferous sandy clay matrix; texture - clayey sand, strong brown (w) (2.5YR 4/8). WASHED: medium to coarse silt and fine to coarse sand with some fine gravel - well rounded quartz grains, fragments of medium to coarse grained quartz sandstone and silcrete, large angular to sub rounded clasts of silcrete (>10 mm), black mineral and lithic clasts - rounded => ?fluvial source to some of the material.
SMR41	5.60	UNWASHED: hard red (d) clay with manganiferous coatings; texture - clayey sand, grayish reddish orange (w) (2.5YR 5/6). WASHED: fine to coarse grained rounded quartz sand - some reddish stained the rest is grey, milky to clear grains, 5-7% rounded to angular black mineral & lithic grains, some fine quartz gravel and silcrete fragments, no acid response.

(continued)

SMR42	6.60	UNWASHED: red and grey (d) mottled clay with small (<1 mm) white spots; texture - sandy clay, light reddish brown (w) (2.5YR 5/5). WASHED: fine to coarse silt and fine to coarse sand, well rounded to subangular clear to milky to cream quartz, some angular fragments of silicified ?saprolite (~2-4 mm) - white ?kaolinitic matrix with fine to medium quartz grains within, rare lithic fragments 1-2 mm, rare dark Fe oxide rounded grains ~1 mm. No acid response.
SMR43	7.20	ROCK: greeny yellow (d) sandstone as soft to friable aggregates (weathered Whyalla Sandstone). LOOSE COMPONENTS UNWASHED: texture - clayey sand, strong yellowish brown (w) (10YR 5/7). LOOSE COMPONENTS WASHED: sand as above (SMR42) with many rock fragments of same sand, bound by a khaki coloured siliceous clayey cement, sand grains are quite rounded, some >2 mm. No acid response.

Site: Windabout 1, Profile 1, Soil Pit Face. Photo 045313.

Location: Zone 53, 703384 E, 6524800 N.

Vertical pit wall, sampled using abseiling technique

Sample ID	Average depth (m)	Description
SMR44	0.03	UNWASHED: red-brown (d) clayey sand, trace of carbonate; texture - clayey sand, strong brown (w) (2.5YR 4/6). WASHED: reddish orange stained quartz silt and sand, medium to coarse silt, fine to medium sand, mostly well rounded aeolian grains, some white to cream angular grains, ~1% angular Fe oxide grains <1 mm, no acid response.
SMR45	0.15	UNWASHED: red (d) clay, calcareous, abundant fine rootlets; texture - clayey sand, strong brown (w) (2.5YR 4/6). WASHED: sand as above with some cream calcrete fragments and no Fe oxide grains, sand only - weak acid response.
SMR46	0.38	UNWASHED: red-brown (d) sandy clay, highly calcareous; texture - loam, light brown (w) (5YR 6/6). WASHED: sand as above with 30-40% cream calcrete grains & fragments, rare charcoal fragments & Fe oxide grains, strong acid response.
SMR47	0.60	UNWASHED: pale near white zone (d), calcareous & gypsiferous; texture - silty sand, light brown (w) (7.5YR 6.5/6). WASHED: sand as above with fragments of silica cemented sandstone with medium to coarse grained quartz, rounded grains of calcified equivalents, some gypsum, rare lithic grains with Mn oxide coatings, moderate acid response.
SMR48	0.80	UNWASHED: pale near white zone (d), calcareous & gypsiferous, some nodular gypsum; texture - gritty silty sand, light yellowish brown (w) (7.5YR 7/4). WASHED: sand as above with large chunks and fragments of calcified siliceous sandstone, gypsum, moderate to strong acid response.

Site: Windabout 3, Profile 3, Soil Pit Face. Photo 045314.

Location: Zone 53, 702395 E, 6525020 N.

Vertical pit wall, sampled using abseiling technique

Sample ID	Average depth (m)	Description
SMR49	0.03	UNWASHED: red-brown (d) sandy clay; texture - clayey sand, strong brown (w) (2.5YR 4/6). WASHED: mostly silt to fine sand - rounded orange stained aeolian quartz grains , ~25% of washed bulk is medium to coarse sand - milky to cream subrounded quartz grains, rare rounded milky quartz grains 2-3 mm, some charcoal fragments, no acid reaction.
SMR50	0.15	UNWASHED: red-brown (d) clay - partly indurated, some fine rootlets; texture - clayey sand, strong brown (w) (2.5YR 4/6). WASHED: sand as above, no acid reaction.
SMR51	0.38	UNWASHED: red-brown (d) clay - partly indurated, calcareous; texture - clayey sand, grayish reddish orange (w) (2.5YR 5/6). WASHED: fine sand as above, more coarse sand (~30%), strong acid response although there is little visible carbonate as grains or fragments => the carbonate is present as grain coatings.
SMR52	0.63	UNWASHED: red-brown (d) clay - partly indurated, calcareous; texture - clayey sand, light brown (w) (5YR 5/6). WASHED: medium to coarse silt and fine to medium grained sand - rounded orange stained quartz, carbonate mostly as silt grains and as rare angular fragments <1 mm, strong acid reaction.
SMR53	0.88	UNWASHED: red-brown (d) clay - partly indurated, calcareous, spotty appearance caused by carbonate; texture - clayey sand, brownish orange (w) (5YR 5/7). WASHED: sand as per SMR52 with 5% white calcrete fragments 1-3 mm and strong acid response.
SMR54	1.13	UNWASHED: red-brown (d) clay - partly indurated, calcareous coatings on peds; texture - clay loam, light brown (w) (5YR 6/6). WASHED: sand as per SMR52 with 20-30% calcrete fragments and sand sized grains - dark cream to khaki coloured, rare calcrete nodules to 5 mm, very strong acid response.
SMR55	1.38	UNWASHED: red-brown (d) clay - partly indurated, calcareous, spotty appearance caused by carbonate; texture - sandy light clay, brownish orange (w) (5YR 5/8). WASHED: sand as per SMR52 with calcrete as silt to sand sized khaki grains and white fragments, strong acid response.
SMR56	1.60	UNWASHED: red-brown (d) clay, gypsiferous and calcareous; texture - gritty clay loam, light brown (w) (7.5YR 6/6). WASHED: as per SMR55 with more white calcrete and frosted milky to cream quartz medium to coarse sand, strong acid response.
SMR57	1.80	UNWASHED: red-brown (d) silty clay, massive hard gypcrete in pit bottom; texture - gritty light clay, moderate yellowish pink (w) (5YR 7/6). WASHED: sand as per SMR56 with gypsum cemented layers/veins 10-20 mm thick composed of 2-3 mm sized gypsum crystals enclosing quartz sand.

STUART METALS NL: Windabout Deposit - Drill Core Log

Site: Windabout, Drillhole CW001D

Location: Zone 53, 703384 E, 6524800 N.

Diamond drillcore, 0-2.7m not sampled - precollar drilling.

Depth (m)	Description
3-4	sand, fine grained orange stained quartz, aeolian, gypcreted (vuggy), no acid reaction.
4-5	clayey sand as above, red-brown (d), no acid reaction.
5-6	clayey sand as above, reddish (d), cross bedded, aeolian, gypsiferous, no acid reaction.
6-7	as above with angular cm sized weathered shale (pale brown - khaki coloured, d), more gypsum as crystalline veins, no acid reaction.
7-8	clayey sand, pale brown (d), crystalline gypcrete veins, no acid reaction.
8-9	gypcreted fine to medium-grained orange stained sand, no acid reaction.
9-10	as per 9-10 m.
10-11	clayey sand, dark red-brown (d), gypsiferous, no acid reaction.
11-12	sandy clay to clayey sand, red-brown (d), no acid reaction.
12-13	as per 11-12 m with zones of red mottled gley clay (greyish) - ?smectitic, no acid reaction.
13-14	gritty brown (d) clay with translucent gypsum veins (5-50 mm), no acid reaction.
14-15	as per 13-14 m with more gypsum veins plus grey-brown (d) clay with Mn oxide ped coatings, no acid reaction.
15-16	as above (14-15 m)
16-17	pale brown (d) clay and silt with gypsum and Mn oxide as black ped coatings, strong acid response.
17-18	silty clay and sand, mottled zone - red-brown and greys (d), transient to next unit below, no acid reaction.
18-19	sandy clay, pale grey to off white with some red mottling (d), kaolinitic to ? smectitic, no acid response.
19-19.6	gley clay, quartz sand and weathered rock, yellow-brownish grey-purple and black (d), Fe and Mn stained mottles, fractures and ped coatings, water-clear gypsum crystals 10 x 25 mm (doubly terminated), weathered rock contact at 19.6, no acid reaction.
19.6-21.5	weathered sandstone, kaolinitic sand, off white (d), no acid reaction.
21.5-22.8	weathered sandstone, silicified fine grained rock and silcreted medium grained quartz sandstone, quartz-rich and clayey, yellow (d) Fe & Mn stained mottles - dark grey-brown (d), fractures and coatings - haematite & goethite, no acid reaction.
22.8-25.8	fine grained laminated shale, cream (d) coloured with red, yellow-brown and purple staining and lamellae coatings, Mn and Fe oxide coatings along fine lamellae partings, no acid reaction. Very pink to purple coloured between 24.1-25.2, & pale pink between 25.2-25.8m
25.8-30	medium-grained quartz sandstone, crudely bedded, pale yellow to pale orange (d), friable to indurated, kaolinitic, ?Mn oxide staining/blotches/mottles and along bedding in sandstone, no acid response. Becoming more indurated (silica cemented) with depth.

STUART METALS NL: Windabout Deposit - Drill Core Log

Site: Windabout, Drillhole CW003D

Location: Zone 53, 702395 E, 6524020 N.

Diamond drillcore, 0-3m not sampled - precollar drilling.

Depth (m)	Description
3.00-5.25	Sand, orange (d) stained quartz medium-grained, aeolian, strongly gypcreted, veined with colourless to grey gypsum, material is vuggy in places, no acid reaction.
5.25-6.35	core loss.
6.35-7.00	Sand, reddish (d) stained quartz medium-grained, aeolian, weak gypsum cement sporadic throughout, no acid response.
7.00-7.50	core loss.
7.50-7.80	Sand, reddish (d) stained quartz medium-grained, aeolian, friable, little to no gypsum.
7.80-8.00	core loss.
8.00-16.00	Sand, reddish (d) stained quartz medium-grained, aeolian, strongly gypcreted throughout, cross cut with veins and zones of colourless to grey gypsum, degree of induration increases with depth, no acid reaction.
16.0-16.3	core loss.
16.3-17.1	Sand, reddish (d) stained quartz medium-grained, aeolian, strongly gypcreted throughout, cross cut with veins and zones of colourless to grey gypsum, degree of induration increases with depth, no acid reaction.
17.1-18.0	core loss.
18.0-19.9	Sand, reddish (d) stained quartz medium-grained, aeolian, strongly gypcreted throughout, cross cut with veins and zones of colourless to grey gypsum, degree of induration increases with depth, no acid reaction
19.9-20.9	core loss.
20.9-21.5	Sandy clay to clayey sand, gley colors with reddish (d) mega mottles, sand grains are medium to coarse grained, no acid reaction.
21.5-23.0	core loss.
23.0-23.7	Sandy clay to clayey sand, gley colors with reddish (d) mega mottles, sand grains are medium to coarse grained, no acid reaction.
23.7-24.4	Gradational zone to unit below, reddish sand as above - grading to weathered shale.
24.4-25.1	Weathered shale, dark reddish to dark maroon/purple (d), bedded to laminated, mottled with pale gray & pink streaks & blotches, Mn oxide coatings on fractures and partings.
25.1-26.1	Clay, ?smectite, gley colors, with some Fe & Mn oxide mottles & patches.
26.1-28.7	Claystone with brecciated sandstone (fine-medium to medium to coarse grained quartz sand) with classic jig-saw fit overall rock texture (?palaeo-land surface), more Fe & Mn oxide staining than above.
28.7-29.0	Sandstone, fractured (incipient breccia) grading to a crudely bedded sandstone - kaolinitic, grayish to pinkish (d), friable and quite weathered.

10.2 Appendix 2: Tabulated geochemical data.

APPENDIX 2

			from	to	average	pH	µS	Ca				Mg				Fe			
Pro	ID	Sample	(m)	(m)	(m)		(1:5)	Total	C	B	A	Total	C	B	A	Total	C	B	A
2	SM1	pit face	0.1	0.2	0.15	7.41	1.8	10100	38	21	10134	6700	642	56	2020	20700	1379	40	258
2	SM2	pit face	0.5	0.6	0.55	7.71	0.9	11800	34	24	12062	4200	424	56	1453	14300	1060	75	308
2	SM3	pit face	1.3	1.5	1.4	7.72	0.4	28300	61	91	29052	4800	367	64	1618	13500	880	69	247
2	SM4	pit face	2.8	3	2.9	7.7	1.0	38000	77	56	39153	4100	375	51	1624	13800	1118	54	309
2	SM5	pit face	3.95	4.15	4.05	7.37	3.6	137000	21996	16207	90209	2400	169	17	639	8200	554	22	256
2	SM6	pit face	6.05	6.15	6.1	7.11	6.8	18700	102	70	22997	3100	224	40	781	12200	1298	143	169
2	SM7	pit face	7.6	7.8	7.7	7.08	2.6	800	7	1.5	637	2500	99	17	1029	10000	588	42	293
2	SM8	pit face	8.5	8.7	8.6	7.37	3.1	1200	10	1.5	882	4900	124	61	2493	19300	1066	177	358
2	SM9	pit face	10	10.2	10.1	7.1	5.8	1300	7	2	1086	1800	21	11	1277	4000	199	49	226
4	SM16	pit face	0.1	0.2	0.15	7.43	3.3	51800	68	142	55866	3300	151	22	1341	11900	481	31	225
4	SM17	pit face	0.5	0.6	0.55	7.83	1.2	7200	21	14	7617	3900	313	50	1145	12700	883	37	232
4	SM18	pit face	0.9	1.1	1	7.83	0.2	73000	31	84	75337	4800	307	61	1881	9600	726	35	200
4	SM19	pit face	1.9	2.1	2	7.87	4.0	69800	35	80	69800	3700	175	35	1821	9400	455	37	224
4	SM20	pit face	2.9	3.1	3	7.62	1.2	1400	10	1.5	1411	3500	80	14	1065	16000	575	38	204
4	SM21	pit face	3.4	3.6	3.5	7.63	0.5	1100	14	2	909	700	67	9	251	4200	794	42	351
4	SM22	pit face	35	36	35.5	5.18	10.6	3900	7	35	3688	2800	21	9	2420	3200	542	42	278
5	SM23	pit face	0.1	0.2	0.15	6.33	0.6	1400	28	7	1144	2400	203	19	615	11200	809	33	272
5	SM24	pit face	0.5	0.6	0.55	7.07	0.6	11200	35	21	10687	2900	244	44	986	9500	749	46	338
5	SM25	pit face	0.9	1.1	1	7.62	0.2	32300	34	38	31950	3300	276	48	1365	9200	710	78	284
5	SM26	pit face	2.1	2.3	2.2	7.85	0.7	37100	31	59	36189	2800	204	57	1257	8900	742	98	218
5	SM27	pit face	2.7	2.9	2.8	7.89	0.7	88600	56	88	90746	4100	220	30	2346	8700	574	20	237
5	SM28	pit face	3.6	3.8	3.7	7.66	5.2	53200	14	45	48656	2900	143	33	992	9800	478	82	232
5	SM29	pit face	5.05	5.15	5.1	7.86	3.3	7700	10	7	6888	3400	171	24	1200	11900	601	30	210
5	SM30	pit face	5.15	5.25	5.2	8.05	0.8	194000	56	965	201860	4300	118	52	3644	3400	340	100	109
5	SM31	pit face	6.3	6.4	6.35	7.8	4.0	5800	14	7	1931	5300	154	26	1926	20400	596	32	232
5	SM32	pit face	7	7.2	7.1	7.51	4.7	15000	21	62	17381	1100	82	22	374	8800	341	133	166
5	SM33	pit face	8.1	8.4	8.25	7.52	12.1	2200	7	7	2036	2500	53	28	2020	20300	523	128	295
6	SM35	pit face	0.1	0.2	0.15	7.53	2.8	1900	10	10	1632	4100	203	31	1471	17300	713	33	201
6	SM36	pit face	0.5	0.6	0.55	7.73	2.6	5400	10	17	5131	5100	403	80	1577	18100	985	67	138
6	SM37	pit face	1.1	1.3	1.2	7.72	2.6	6900	18	11	13653	3400	227	26	1277	14500	840	38	313
6	SM38	pit face	2.1	2.3	2.2	7.68	1.8	2600	14	7	3418	2900	186	39	1056	11000	720	36	307
6	SM39	pit face	3	3.2	3.1	7.93	1.8	13700	13	24	6324	3000	142	59	1280	11100	508	135	268
6	SM40	pit face	4.6	4.8	4.7	7.57	2.9	3200	11	2	3618	2600	160	23	822	11100	698	59	202
6	SM41	pit face	5.5	5.7	5.6	7.37	2.8	1100	10	1.5	749	3500	130	21	1673	12700	762	49	226
6	SM42	pit face	6.5	6.7	6.6	6.57	8.4	1100	10	1.5	854	6200	169	30	3802	16900	1084	40	494
6	SM43	pit face	7.1	7.3	7.2	6.44	3.9	1200	7	14	1120	1700	49	16	891	26300	760	25	226
1	SM44	pit face	0	0.05	0.025	6.9	0.4	2100	45	14	1918	1500	89	14	296	9800	533	70	233
1	SM45	pit face	0.05	0.25	0.15	7.25	0.2	8700	38	21	8788	2000	135	16	361	11400	535	27	165
1	SM46	pit face	0.25	0.5	0.375	7.77	1.0	92100	56	91	98367	2700	184	25	741	10300	538	20	121
1	SM47	pit face	0.5	0.7	0.6	7.86	5.6	138000	43276	18276	108542	1000	79	9	302	2800	159	12	94
1	SM48	pit face	0.7	0.9	0.8	7.8	5.4	147000	40885	18425	98903	1000	107	19	219	3200	191	29	136
1	SM63	DDH	2.7	4	3.35	7.65	1.6	131000	7257	17505	93859	1400	99	15	328	8400	600	59	518
1	SM64	DDH	4.6	5.6	5.1	7.59	0.2	31300	52	97	26182	2300	141	19	542	17500	1053	81	395
1	SM65	DDH	6	9.63	7.815	7.76	0.3	77700	182	674	79602	2600	99	13	467	16300	608	47	277
1	SM66	DDH	11	12	11.5	7.83	0.5	13400	59	56	15342	4600	379	19	534	29200	2018	46	111
3	SM49	pit face	0	0.05	0.025	7.93	0.8	2000	149	83	1426	1900	163	42	417	9900	712	129	219
3	SM50	pit face	0.05	0.25	0.15	7.9	1.3	1800	23	10	1584	2500	154	20	562	10500	509	37	209
3	SM51	pit face	0.25	0.5	0.375	7.75	1.5	11900	52	28	12126	2600	410	37	832	9400	1531	41	323
3	SM52	pit face	0.5	0.75	0.625	7.83	1.8	18900	27	27	20401	2800	209	27	926	8700	471	23	201
3	SM53	pit face	0.75	1	0.875	7.74	6.0	26400	21	39	27892	3500	327	70	1094	9100	672	80	162
3	SM54	pit face	1	1.25	1.125	7.32	5.5	55800	28	73	58264	4600	357	49	1659	12300	975	35	200
3	SM55	pit face	1.25	1.5	1.375	7.3	5.5	49100	36	83	52681	4200	296	50	1470	13000	828	58	218
3	SM56	pit face	1.5	1.7	1.6	7.01	5.3	62700	38	127	67250	3700	234	60	1437	11500	761	44	303
3	SM57	pit face	1.7	1.9	1.8	6.29	5.3	143000	188	979	108076	2300	134	21	673	6700	280	24	186
3	SM58	DDH	3	4	3.5	5.91	5.7	142000	41068	16714	86806	1000	51	10	246	5500	375	45	288
3	SM59	DDH	4	4.75	4.375	6.23	5.6	125000	26683	16847	89180	1100	51	7	230	7600	506	31	230
3	SM60	DDH	6.35	6.8	6.575	6.27	5.4	111000	9233	17169	96755	1000	107	14	327	7400	1219	80	442
3	SM61	DDH	8.28	8.65	8.465	6.3	5.5	119000	1505	6147	95257	1000	44	7	246	10300	596	38	206
3	SM62	DDH	10	14.8	12.4	6.45	4.03	109000	128	1271	98367	1400	40	12	299	12000	559	138	307

A pH 5 acetate
B 0.1 M Hydroxylamine
C 0.25 M Hydroxylamine

DDH Diamond Drill Hole

Smaller font indicates below detection limit.

		Mn				Cr				Co				Ni				Cu			
Pro	ID	Total	C	B	A	Total	C	B	A	Total	C	B	A	Total	C	B	A	Total	C	B	A
2	SM1	196	17.4	2.8	112.8	30	2.6	0.45	3.94	18	2.6	0.17	9.46	55	6.07	0.45	5.91	65	13	0.45	5.91
2	SM2	136	12.9	5.4	78.6	20	1.7	0.42	1	20	3.22	0.51	10.8	9	1.7	0.42	3.85	42	11	0.42	5.78
2	SM3	119	13.5	16.1	40.5	15	1.68	0.42	1	10	1.51	0.67	5.73	8	0.42	0.42	3.82	36	7.57	0.42	5.73
2	SM4	193	30.7	66.2	50.7	10	1.74	0.45	1	12	1.92	1.39	6.33	8	0.45	1.74	3.96	45	12.2	0.45	7.92
2	SM5	77	10.6	14.6	27.1	15	0.41	0.41	1	6	0.83	0.5	4.89	4	0.41	0.41	1	29	6.62	0.41	5.64
2	SM6	3990	831.2	2648.1	546	20	2.63	1.75	1	172	34.9	114	15.9	38	8.77	15.8	9.96	1370	272	356	605.8
2	SM7	40	5.9	14.2	10.2	15	0.45	0.45	1	18	2.08	0.35	14.9	4	0.45	0.45	1	109	13.8	2.6	21.63
2	SM8	200	16.2	26.9	81.4	35	6.63	0.41	3.77	32	2.32	1.66	24.5	15	0.41	0.41	3.77	236	19.1	1.66	24.49
2	SM9	44	1.4	1.1	19.2	10	2.64	0.45	1	72	1.05	0.7	69.5	2	0.45	0.45	1	39	4.39	0.45	13.98
4	SM16	72	4.1	1	34.7	15	0.42	0.42	3.85	14	1.36	0.09	10.4	7	0.42	0.42	3.85	16	2.54	0.42	1
4	SM17	85	5.5	1.4	44.5	20	2.58	0.43	1	20	2.92	0.34	14.5	6	0.43	0.43	3.91	19	6.02	0.43	3.91
4	SM18	58	3.8	0.7	23.8	20	1.74	0.45	3.97	10	1.05	0.09	7.93	5	1.74	0.45	1	28	6.11	0.45	5.95
4	SM19	60	3.8	1	27	10	0.45	0.45	1	8	0.7	0.09	5.95	4	0.45	0.45	1	27	4.36	0.45	5.95
4	SM20	50	1.7	0.15	2.4	25	2.62	0.45	1	22	2.79	0.17	14.7	6	0.45	0.45	1	70	4.36	0.45	3.96
4	SM21	50	7	0.7	36.7	20	7.89	0.45	3.98	104	5.08	0.88	90.5	4	0.45	0.45	1	248	23.7	0.45	59.77
4	SM22	89	3.2	1.4	70.4	2.5	0.45	0.45	1	262	1.23	0.53	286	15	0.45	0.45	16	3240	50.2	11.44	3300
5	SM23	74	5.9	4.2	31.5	15	1.74	0.45	1	32	3.99	0.35	18.9	5	1.74	0.45	1	17	5.21	0.45	17.74
5	SM24	62	4.2	1	26.1	15	0.45	0.45	1	20	2.44	0.35	13.9	5	0.45	0.45	3.96	15	3.48	0.45	3.96
5	SM25	77	5.8	3.4	36.6	15	1.71	0.43	1	14	1.71	0.34	9.35	5	0.43	0.43	3.9	12	3.43	0.43	1
5	SM26	67	4.1	4.8	31.4	10	1.73	0.45	1	10	0.86	0.52	6.68	4	0.45	0.45	1	21	5.19	0.45	3.93
5	SM27	83	9.5	5.3	42.2	10	1.75	0.45	1	10	1.58	0.18	9.15	4	0.45	0.45	1	20	5.25	0.45	3.98
5	SM28	82	4.8	8.6	40.8	10	0.45	0.45	1	14	1.38	1.04	9.42	4	0.45	0.45	1	18	3.45	0.45	3.92
5	SM29	109	8.4	2.4	67.3	10	0.45	0.45	1	66	11.5	1.22	45.5	5	0.45	0.45	3.96	37	6.97	0.45	5.94
5	SM30	90	4.9	27.9	57	5	2.61	0.45	1	16	1.39	1.92	16.2	2	0.45	0.45	1	18	4.35	0.45	7.92
5	SM31	88	3.8	2.1	17.9	20	0.43	0.43	1	18	2.4	0.09	10.9	6	0.43	0.43	1	203	19.7	0.43	23.36
5	SM32	11100	2057.7	7836.3	365.5	2.5	1.71	3.43	1	112	21.6	72.5	26.9	16	5.14	9.43	3.9	1030	184	379	300.1
5	SM33	1270	45.7	709.6	451.1	10	0.45	0.45	1	176	6.15	8.26	176	8	0.45	0.45	3.99	123	12.3	5.27	27.94
6	SM35	156	13.5	7.3	77.3	20	0.45	0.45	1	104	17	2.25	66.6	10	1.73	0.45	3.94	39	6.94	0.45	5.91
6	SM36	150	10.3	7.9	70	20	1.71	0.43	1	52	11.8	4.62	33.8	10	0.43	0.43	3.89	41	10.3	0.43	3.89
6	SM37	128	9.8	2.5	88.6	15	1.76	0.45	1	56	9.13	1.05	63.1	9	0.45	0.45	3.99	48	10.5	0.45	15.97
6	SM38	163	10.5	3.7	108.3	10	0.42	0.42	1	66	10.8	1.69	66.8	8	0.42	0.42	3.84	66	11.8	0.42	15.36
6	SM39	130	4.4	5.7	64.4	10	0.42	0.42	1	88	5.73	5.23	36.4	6	0.42	0.42	1	59	10.1	1.69	9.58
6	SM40	315	25.7	15.5	241.2	10	0.45	0.45	1	114	15.3	4.22	120	10	1.76	0.45	5.99	356	67.7	6.15	147.8
6	SM41	989	159.6	398.1	373.6	10	0.43	0.43	1	80	7.21	4.12	53	6	0.43	0.43	1	252	49.8	11.15	142.3
6	SM42	69	4.2	2.4	15.8	20	1.74	0.45	1	44	4	0.35	31.2	7	1.74	0.45	1	184	33.1	0.45	85.01
6	SM43	70	5.6	1.4	15.1	5	0.45	0.45	1	124	14.5	3.32	99.3	4	0.45	0.45	1	229	17.5	0.45	31.78
1	SM44	92	5.6	2.1	52.1	15	0.45	0.45	1	54	4.17	1.74	44.6	5	0.45	0.45	1	8	1.74	0.45	1
1	SM45	82	5.5	1	40.8	20	0.45	0.45	1	30	4.14	0.69	26.3	6	0.45	0.45	1	8	1.73	0.45	1
1	SM46	57	3.5	0.2	18.3	10	0.45	0.45	1	12	1.93	0.18	10.4	7	0.45	0.45	1	9	1.75	0.45	1
1	SM47	15	0.7	0.15	4.7	5	0.45	0.45	1	2	0.17	0.09	2.35	3	0.45	0.45	1	3	0.45	0.45	1
1	SM48	14	0.2	0.2	3.2	5	1.75	0.45	1	2	0.18	0.09	1.99	3	0.45	0.45	1	3	0.45	0.45	1
1	SM63	23	1.7	0.15	3.1	5	1.7	0.42	1	4	0.34	0.09	2.7	5	0.42	0.42	1	5	0.42	0.42	1
1	SM64	44	2.8	0.15	3.2	15	1.74	0.45	1	24	4.87	0.87	17.8	6	0.45	0.45	1	11	2.61	0.45	1
1	SM65	37	2	0.15	2.3	10	1.68	0.42	1	12	1.85	0.17	6.89	6	0.42	0.42	1	9	1.68	0.42	1
1	SM66	88	6.6	0.15	4	25	4.35	0.45	1	34	11.7	0.7	13.8	17	2.61	0.45	1	16	3.48	0.45	1
3	SM49	82	4.5	3.5	41.8	15	1.73	0.45	1	44	3.29	2.25	24	6	0.45	0.45	1	7	1.73	0.45	1
3	SM50	73	4.6	1	34.7	15	0.41	0.41	1	50	6.97	1	35.1	6	0.41	0.41	1	7	1.66	0.41	1
3	SM51	65	7	2.8	31.7	20	3.49	0.45	1	26	4.18	0.52	21	6	2.62	0.45	3.96	7	2.62	0.45	1
3	SM52	57	3.8	0.7	25.7	10	0.43	0.43	1	28	3.43	0.34	20.3	6	1.71	0.43	1	7	1.71	0.43	1
3	SM53	62	3.5	2.1	29.6	15	1.76	0.45	1	22	2.99	1.58	17.6	6	0.45	0.45	1	7	2.64	0.45	1
3	SM54	92	10.5	3.1	42	15	1.74	0.45	1	22	4.88	0.52	15.9	8	1.74	0.45	3.96	9	2.62	0.45	1
3	SM55	99	10.9	6.3	43.7	15	0.41	0.41	1	20	3.81	0.83	13.6	8	0.41	0.41	3.76	9	2.48	0.41	1
3	SM56	89	5.8	1.7	41.2	20	0.43	0.43	1	24	4.1	0.68	21.4	8	0.43	0.43	3.89	11	1.71	0.43	1
3	SM57	45	4.5	2.4	18.2	10	0.45	0.45	1	6	0.7	0.17	6.33	4	0.45	0.45	1	4	0.45	0.45	1
3	SM58	17	1	0.15	2.3	10	1.69	0.42	1	2	0.34	0.09	2.3	2	0.42	0.42	1	3	0.42	0.42	1
3	SM59	21	1.7	1	4	10	1.74	0.45	1	4	0.87	0.09	3.57	10	0.45	0.45	1	11	0.45	0.45	1
3	SM60	20	2.5	0.2	4.8	10	1.75	0.45	1	24	7.36	1.93	26.3	7	1.75	0.45	1	4	0.45	0.45	1
3	SM61	24	1.4	0.15	2.4	10	2.62	0.45	1	14	2.79	0.35	9.13	3	0.45	0.45	1	5	0.45	0.45	1
3	SM62	30	1	0.7	3.1	10	0.45	0.45	1	24	2.94	1.9	16.5	7	0.45	0.45	1	7	0.45	0.45	1

A pH 5 acetate
B 0.1 M Hydroxylamine
C 0.25 M Hydroxylamine

Smaller font indicates below detection limit.

		Zn				Pb				As				Bi				Ce		
Pro	ID	Total	C	B	A	Total	C	B	A	Total	C	B	A	Total	C	B	A	C	B	A
2	SM1	63	6.1	0.5	3.9	11	1.7	0.5	1	5	0.17	0.09	0.2	0.3	0.03	0.01	0.02	3.47	0.45	5.91
2	SM2	34	5.9	0.4	3.9	8	1.7	0.4	1	3	0.34	0.09	0.2	0.2	0.03	0.01	0.02	3.39	0.42	3.85
2	SM3	26	4.2	0.4	1	8	1.7	0.4	1	5	0.34	0.09	0.2	0.2	0.02	0.01	0.02	2.52	0.42	3.82
2	SM4	29	4.4	0.5	4	9	1.7	0.5	1	3.5	0.09	0.09	0.2	0.3	0.03	0.01	0.02	4.35	0.45	1.98
2	SM5	18	3.3	0.4	1	5	0.4	0.4	1	3.5	0.17	0.09	0.19	0.1	0.02	0.01	0.02	1.65	0.41	1
2	SM6	54	8.8	7	15.9	65	36	18.4	1	7	0.35	0.09	0.2	0.3	0.09	0.01	0.02	128	10.5	7.97
2	SM7	24	2.6	0.5	5.9	14	0.5	0.5	1	3.5	0.09	0.09	0.2	0.2	0.02	0.01	0.02	0.45	0.45	1
2	SM8	60	4.1	1.7	9.4	30	1.7	0.4	1	7	0.09	0.09	0.19	0.4	0.05	0.01	0.02	2.49	0.41	1
2	SM9	10	1.8	0.5	6	14	3.5	0.5	2	3.5	0.09	0.09	0.4	0.5	0.04	0.01	0.04	0.45	0.45	1
4	SM16	15	2.5	0.4	3.9	7	1.7	0.4	1	5	0.34	0.09	0.2	0.1	0.01	0.01	0.02	2.54	0.42	5.78
4	SM17	20	3.4	0.4	3.9	7	1.7	0.4	1	2	0.09	0.09	0.2	0.2	0.03	0.01	0.02	2.58	0.43	3.91
4	SM18	17	2.6	0.5	4	6	0.5	0.5	1	5	0.35	0.09	0.2	0.6	0.09	0.01	0.02	0.87	0.45	3.97
4	SM19	14	2.6	0.5	4	6	1.7	0.5	1	6.5	0.35	0.09	0.79	0.6	0.07	0.01	0.02	1.74	0.45	3.97
4	SM20	25	2.6	0.5	4	8	0.5	0.5	1	10	0.17	0.09	0.4	1.6	0.16	0.01	0.12	0.45	0.45	1
4	SM21	14	2.6	0.5	6	15	1.8	0.5	2	4.5	0.18	0.09	0.2	9.3	1.72	0.01	2.47	1.75	0.45	1
4	SM22	133	7	0.5	124	4	0.5	0.5	1	2	0.09	0.09	0.2	0.1	0.01	0.01	0.08	0.45	0.45	2
5	SM23	21	4.3	0.5	3.9	6	0.9	0.5	1	3	0.09	0.09	0.2	0.1	0.01	0.01	0.02	2.6	0.45	1.97
5	SM24	14	3.5	0.5	4	6	0.9	0.5	1	3	0.09	0.09	0.2	0.05	0.01	0.01	0.02	1.74	0.45	1.98
5	SM25	21	2.6	0.4	1	5	0.9	0.4	1	3.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	2.57	0.43	1.95
5	SM26	13	2.6	0.5	3.9	5	0.9	0.5	1	6.5	0.52	0.09	0.79	0.1	0.01	0.01	0.02	1.73	0.45	1.96
5	SM27	17	2.6	0.5	4	5	0.9	0.5	1	5	0.35	0.09	0.4	0.05	0.01	0.01	0.02	2.63	0.45	3.98
5	SM28	16	23.3	0.5	3.9	6	0.5	0.5	1	4.5	0.09	0.09	0.39	0.05	0.01	0.01	0.02	2.59	0.86	1.96
5	SM29	21	4.4	0.5	4	9	1.7	0.5	1	3	0.17	0.09	0.4	0.05	0.01	0.01	0.02	7.84	1.74	5.94
5	SM30	5	1.7	0.5	1	4	0.9	0.5	1	1.5	0.09	0.09	0.79	0.05	0.01	0.01	0.02	1.74	0.45	3.96
5	SM31	39	2.6	0.4	3.9	9	0.4	0.4	1	8.5	0.09	0.09	0.2	0.2	0.01	0.01	0.02	0.43	0.43	1
5	SM32	71	10.3	18.9	15.6	43	19.7	12.9	1	12	1.37	0.09	0.39	0.3	0.12	0.01	0.02	6.86	11.2	3.9
5	SM33	87	5.3	4.4	18	25	8.8	2.6	1	3	0.09	0.09	0.4	0.05	0.01	0.01	0.02	0.88	0.45	2
6	SM35	36	3.5	0.5	3.9	8	1.7	0.5	1	3	0.09	0.09	0.2	0.2	0.02	0.01	0.02	2.6	0.45	3.94
6	SM36	33	5.1	0.4	1	4	1.7	0.4	1	2	0.17	0.09	0.2	0.05	0.01	0.01	0.02	4.28	0.43	3.89
6	SM37	29	4.4	0.5	4	7	0.9	0.5	1	3.5	0.09	0.09	0.2	0.1	0.01	0.01	0.02	2.63	0.45	2
6	SM38	30	3.4	0.4	3.8	7	0.4	0.4	1	2.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	1.69	0.42	1.92
6	SM39	21	2.5	0.4	3.8	7	1.7	0.4	1	3	0.09	0.09	0.2	0.1	0.01	0.01	0.02	1.69	0.42	1.92
6	SM40	47	7	0.5	16	12	1.8	0.5	2	3.5	0.18	0.09	0.2	0.1	0.01	0.01	0.02	6.15	0.45	2
6	SM41	32	5.1	0.4	15.6	11	4.3	0.4	1	3.5	0.34	0.09	0.2	0.1	0.02	0.01	0.02	1.72	0.43	1.95
6	SM42	55	7	0.5	25.7	11	0.5	0.5	1	3.5	0.09	0.09	0.2	0.2	0.01	0.01	0.02	0.45	0.45	1
6	SM43	19	1.7	0.5	6	23	0.9	0.5	2	4	0.09	0.09	0.2	0.05	0.01	0.01	0.02	0.45	0.45	1
1	SM44	16	6.1	0.5	3.9	8	0.9	0.5	1	1.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	1.74	0.45	1
1	SM45	17	3.5	0.5	3.9	7	0.9	0.5	1	1.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	1.73	0.45	1.96
1	SM46	18	5.3	0.5	4	6	0.5	0.5	1	6.5	0.53	0.09	0.2	0.05	0.01	0.01	0.02	0.88	0.45	3.98
1	SM47	4	1.7	0.5	3.9	2	0.5	0.5	1	4	0.34	0.09	1.18	0.05	0.01	0.01	0.02	0.45	0.45	1
1	SM48	5	1.8	0.5	1	3	0.5	0.5	2	4	0.35	0.09	0.8	0.05	0.01	0.01	0.02	0.45	0.45	1
1	SM63	12	2.5	0.4	3.9	5	0.4	0.4	1	4	0.51	0.09	0.2	0.05	0.01	0.01	0.02	0.42	0.42	1
1	SM64	21	5.2	0.5	4	9	0.5	0.5	1	6.5	0.09	0.09	0.2	0.1	0.01	0.01	0.02	0.45	0.45	1
1	SM65	24	5.9	0.4	5.7	7	0.4	0.4	1	6.5	0.34	0.09	0.2	0.1	0.01	0.01	0.02	1.68	0.42	1
1	SM66	32	4.3	0.5	1	11	0.9	0.5	1	8.5	0.17	0.09	0.2	0.2	0.02	0.01	0.02	1.74	0.45	1
3	SM49	15	2.6	0.5	3.9	6	0.9	0.5	1	3	0.09	0.09	0.2	0.05	0.01	0.01	0.02	2.6	0.45	1
3	SM50	18	3.3	0.4	3.8	6	0.4	0.4	1	2.5	0.09	0.09	0.19	0.05	0.01	0.01	0.02	1.66	0.41	1.89
3	SM51	13	3.5	0.5	1	6	0.9	0.5	1	2.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	2.62	0.45	1.98
3	SM52	11	2.6	0.4	1	5	0.4	0.4	1	3	0.09	0.09	0.2	0.05	0.01	0.01	0.02	1.71	0.43	1.95
3	SM53	12	2.6	0.5	1	6	0.9	0.5	1	3.5	0.18	0.09	0.4	0.05	0.01	0.01	0.02	1.76	0.45	4
3	SM54	17	3.5	0.5	1	6	0.9	0.5	1	7.5	0.52	0.09	0.2	0.05	0.01	0.01	0.02	3.49	0.45	3.96
3	SM55	19	2.5	0.4	3.8	6	1.7	0.4	1	9.5	0.66	0.09	0.38	0.1	0.01	0.01	0.02	3.31	0.41	3.76
3	SM56	17	2.6	0.4	3.9	7	0.9	0.4	1	8	0.51	0.09	0.39	0.05	0.01	0.01	0.02	2.57	0.43	5.83
3	SM57	12	3.5	0.5	4	4	0.5	0.5	1	3	0.35	0.09	0.79	0.05	0.01	0.01	0.02	1.74	0.45	1.98
3	SM58	6	1.7	0.4	1	4	0.4	0.4	1	3.5	0.85	0.09	0.77	0.05	0.01	0.01	0.02	0.42	0.42	1
3	SM59	7	1.7	0.5	4	5	0.5	0.5	1	5	0.52	0.09	0.2	0.05	0.01	0.01	0.02	0.45	0.45	1
3	SM60	15	9.6	0.5	10	5	0.5	0.5	1	3.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	0.45	0.45	1
3	SM61	13	2.6	0.5	6	6	0.5	0.5	1	4	0.09	0.09	0.2	0.05	0.01	0.01	0.02	0.45	0.45	1
3	SM62	16	3.5	0.5	7.9	7	0.5	0.5	1	4.5	0.09	0.09	0.2	0.05	0.01	0.01	0.02	0.45	0.45	1

A pH 5 acetate
B 0.1 M Hydroxylamine
C 0.25 M Hydroxylamine

Smaller font indicates below detection limit.

		S			Th				U				Ag				Au		
Pro	ID	C	B	A	Total	C	B	A	Total	C	B	A	Total	C	B	A	Water	Iodide	I + CN
2	SM1	12	7	185	5.35	0.02	0.01	0.32	0.7	0.02	0.001	0.14	0.25	0.09	0.09	0.2	0.50	1.01	6.13
2	SM2	12	15	166	3.7	0.03	0.01	0.31	0.55	0.03	0.001	0.13	0.25	0.09	0.09	0.2	0.41	0.86	1.75
2	SM3	10	49	46	3.95	0.08	0.01	0.42	0.65	0.03	0	0.16	0.25	0.09	0.09	0.2	0.44	0.70	2.06
2	SM4	12	14	1053	3.85	0.1	0.01	0.36	1.15	0.12	0.01	0.46	0.25	0.09	0.09	0.2	0.34	0.51	1.04
2	SM5	20180	15450	64662	2.3	0.18	0.01	0.19	0.45	0.04	0.01	0.12	0.25	0.09	0.09	0.2	0.16	0.33	1.16
2	SM6	98	95	18566	3.6	0.25	0.01	0.16	2.3	0.33	0.1	0.95	0.25	0.09	0.09	0.2	0.14	0.84	1.15
2	SM7	21	12	1120	2.8	0.05	0.01	0.2	0.75	0.04	0.01	0.25	0.25	0.09	0.09	0.2	0.16	0.50	1.29
2	SM8	119	28	844	3.95	0.05	0.01	0.15	1.2	0.05	0.01	0.22	0.25	0.09	0.09	0.2	0.15	0.27	1.45
2	SM9	5	5	1353	4.35	0.05	0.01	0.2	0.7	0.03	0	0.15	0.25	0.09	0.09	0.2	0.32	0.88	2.96
4	SM16	95	29	5819	2.95	0.07	0.01	0.31	1.4	0.1	0.01	0.75	0.25	0.09	0.09	0.2	0.23	0.52	1.02
4	SM17	19	14	902	3.15	0.01	0.01	0.23	0.65	0.03	0.001	0.15	0.25	0.09	0.09	0.2	0.19	0.46	0.93
4	SM18	30	16	87	3.05	0.02	0.01	0.48	0.55	0.02	0.001	0.16	0.25	0.09	0.09	0.2	0.23	0.46	1.10
4	SM19	45	37	9246	2.95	0.05	0.01	0.44	1.15	0.07	0.01	0.52	0.25	0.09	0.09	0.2	0.23	0.52	1.06
4	SM20	125	26	368	3.9	0.05	0.01	0.24	1.3	0.06	0.01	0.52	0.25	0.09	0.09	0.2	0.02	0.19	0.62
4	SM21	16	18	143	5.5	0.11	0.01	0.16	2.9	0.09	0.01	0.18	0.25	0.09	0.09	0.2	0.23	0.66	2.08
4	SM22	366	160	8240	5.6	0.04	0.01	0.48	10.6	0.12	0.03	8.44	0.25	0.09	0.09	0.2	0.25	0.54	1.86
5	SM23	9	3	138	3.25	0.02	0.01	0.16	0.5	0.02	0.001	0.07	0.25	0.09	0.09	0.2	0.36	0.58	1.16
5	SM24	3	5	83	2.8	0.02	0.01	0.24	0.4	0.01	0.001	0.06	0.25	0.09	0.09	0.2	0.32	0.81	2.15
5	SM25	3	12	35	2.8	0.07	0.01	0.31	0.4	0.02	0.001	0.07	0.25	0.09	0.09	0.2	0.23	0.32	0.79
5	SM26	17	28	114	2.8	0.07	0.01	0.39	0.5	0.02	0	0.12	0.25	0.09	0.09	0.2	0.20	0.50	1.03
5	SM27	135	19	215	2.7	0.05	0.01	0.48	0.7	0.05	0.01	0.3	0.25	0.09	0.09	0.2	0.26	0.38	0.47
5	SM28	28	41	22431	2.55	0.07	0.01	0.24	0.6	0.03	0.01	0.2	0.25	0.09	0.09	0.2	0.02	0.21	0.59
5	SM29	42	26	3129	2.9	0.07	0.01	0.24	0.55	0.04	0.01	0.15	0.25	0.09	0.09	0.2	0.19	0.22	0.76
5	SM30	14	17	950	1.15	0.05	0.01	0.24	0.7	0.02	0.01	0.46	0.25	0.09	0.09	0.2	0.19	0.24	0.66
5	SM31	48	24	1716	4.75	0.03	0.01	0.19	0.95	0.03	0.01	0.17	0.25	0.09	0.09	0.2	0.20	0.14	0.40
5	SM32	55	26	14386	3.4	0.24	0.01	0.12	1.85	0.22	0.32	0.23	0.25	0.09	0.09	0.2	0.27	0.42	1.12
5	SM33	114	25	2248	4.25	0.05	0.01	0.16	2.05	0.11	0.01	0.52	0.25	0.09	0.09	0.2	0.21	0.74	1.61
6	SM35	7	7	292	4.9	0.02	0.01	0.2	0.65	0.01	0.001	0.06	0.25	0.09	0.09	0.2	0.24	0.52	0.98
6	SM36	5	12	617	2.3	0.05	0.01	0.23	0.3	0.02	0.001	0.05	0.25	0.09	0.09	0.2	0.384	0.644	0.716
6	SM37	2	4	407	3.8	0.07	0.01	0.28	0.55	0.02	0.001	0.2	0.25	0.09	0.09	0.2	0.216	0.54	1.06
6	SM38	8	10	495	3.5	0.07	0.01	0.19	0.6	0.02	0.01	0.11	0.25	0.09	0.09	0.2	0.24	0.384	0.72
6	SM39	5	7	368	3.1	0.05	0.01	0.27	0.8	0.03	0.01	0.1	0.25	0.09	0.09	0.2	0.184	0.3	1.16
6	SM40	25	25	2990	3.35	0.09	0.01	0.2	1.1	0.09	0.02	0.34	0.25	0.09	0.09	0.2	0.06	0.288	0.896
6	SM41	5	5	823	3.65	0.07	0.01	0.23	3.05	0.23	0.05	1.6	0.25	0.09	0.09	0.2	0.06	0.268	0.54
6	SM42	54	23	1419	4	0.03	0.01	0.28	1.1	0.05	0.01	0.36	0.25	0.09	0.09	0.2	0.088	0.356	0.84
6	SM43	2	12	1233	4.9	0.03	0.01	0.16	1.4	0.06	0.02	0.37	0.25	0.09	0.09	0.2	0.04	0.228	0.936
1	SM44	28	10	114	2.55	0.01	0.01	0.08	0.35	0.01	0.001	0.03	0.25	0.09	0.09	0.2	0.02	0.28	0.636
1	SM45	16	5	82	3	0.01	0.01	0.12	0.35	0.01	0.001	0.03	0.25	0.09	0.09	0.2	0.104	0.168	0.48
1	SM46	109	25	1167	3.15	0.01	0.01	0.2	0.45	0.01	0.001	0.07	0.25	0.09	0.09	0.2	0.304	0.984	2.444
1	SM47	36925	15961	66275	0.75	0.02	0.01	0.08	0.15	0.01	0.001	0.03	0.25	0.09	0.09	0.2	0.356	0.62	1.284
1	SM48	34884	16040	66932	0.8	0.07	0.01	0.04	0.25	0.01	0.001	0.03	0.25	0.09	0.09	0.2	0.384	0.78	1.58
1	SM63	5997	15901	80695	2.6	0.15	0.01	0.12	0.45	0.02	0.01	0.08	0.25	0.09	0.09	0.2	0.02	0.04	0.32
1	SM64	40	80	20870	5.05	0.12	0.01	0.2	0.85	0.04	0.01	0.16	0.25	0.09	0.09	0.2	0.11	0.44	1.83
1	SM65	74	697	64245	5.25	0.12	0.01	0.27	1	0.05	0.01	0.18	0.25	0.09	0.09	0.2	0.06	0.25	0.70
1	SM66	24	57	10356	7.95	0.21	0.01	0.32	1.95	0.19	0.03	0.55	0.25	0.09	0.09	0.2	0.44	0.76	2.00
3	SM49	100	55	319	2.85	0.01	0.01	0.08	0.4	0.01	0.001	0.03	0.25	0.09	0.09	0.2	0.13	0.30	1.01
3	SM50	3	5	53	2.9	0.01	0.01	0.11	0.35	0.01	0.001	0.02	0.25	0.09	0.09	0.19	0.21	0.38	0.84
3	SM51	9	3	71	2.75	0.01	0.01	0.16	0.4	0.02	0.001	0.04	0.25	0.09	0.09	0.2	0.23	0.56	1.34
3	SM52	15	12	128	2.6	0.01	0.01	0.19	0.35	0.01	0.001	0.06	0.25	0.09	0.09	0.2	0.32	0.64	1.42
3	SM53	12	21	216	2.75	0.01	0.01	0.28	0.4	0.02	0.001	0.07	0.25	0.09	0.09	0.2	0.14	0.37	1.11
3	SM54	26	19	226	3.45	0.05	0.01	0.48	0.55	0.02	0.001	0.13	0.25	0.09	0.09	0.2	0.26	0.82	1.90
3	SM55	46	25	421	3.75	0.07	0.01	0.49	0.85	0.04	0	0.27	0.25	0.09	0.09	0.2	0.25	0.84	1.76
3	SM56	91	27	1402	3.9	0.07	0.01	0.51	1.1	0.04	0	0.36	0.25	0.09	0.09	0.2	0.18	0.74	1.42
3	SM57	58	883	59802	1.8	0.05	0.01	0.28	0.5	0.04	0	0.21	0.25	0.09	0.09	0.2	0.24	0.67	1.38
3	SM58	35808	15337	74088	1.3	0.08	0.01	0.08	0.5	0.04	0.01	0.11	0.25	0.09	0.09	0.2	0.54	0.36	0.65
3	SM59	22828	15282	75248	1.75	0.14	0.01	0.12	0.4	0.03	0	0.06	0.25	0.09	0.09	0.2	0.02	0.34	0.50
3	SM60	7643	15216	80080	2.3	0.19	0.01	0.16	0.45	0.04	0.01	0.09	0.25	0.09	0.09	0.2	0.07	0.10	0.44
3	SM61	1383	5744	82143	2.85	0.1	0.01	0.16	0.45	0.02	0	0.06	0.25	0.09	0.09	0.2	0.02	0.36	0.53
3	SM62	345	1296	83465	3.7	0.09	0.01	0.2	0.55	0.02	0.01	0.07	0.25	0.09	0.09	0.2	0.10	0.16	0.36

A pH 5 acetate
B 0.1 M Hydroxylamine
C 0.25 M Hydroxylamine

Smaller font indicates below detection limit.