

SOIL GEOCHEMISTRY OF THE KEMESS SOUTH PORPHYRY GOLD-COPPER DEPOSIT (94E/2E)

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INTRODUCTION

As part of the British Columbia Geological Survey drift prospecting program, a geochemical orientation survey was conducted at the Kemess South porphyry copper-gold deposit. The goal of the drift prospecting program is to establish drift exploration methodologies appropriate for the province through the examination of glacial and postglacial processes which influence geochemical dispersion.

The Kemess South deposit was chosen for a study of the interaction between an oxidizing orebody and the overlying transported surficial deposits. Soil geochemical response to the deposit is strong; concentrations greater than 500 ppm copper and 150 ppb gold directly overlie the deposit in an area measuring 800 by 300 metres (Coffin and Mertens, 1988). During the 1991 field season, the relationship between the Kemess South deposit and the overlying soils was studied to determine if the geochemical anomalies overlying it are a result of physical or hydromorphic (chemical) transport.

A blanket of enriched (supergene) copper mineralization, overlain in places by a copper-depleted oxidized cap, is developed within the Kemess South deposit. Ney *et al.* (1976) provide a detailed review of the process and occur-

rence of supergene porphyry copper mineralization in the Canadian Cordillera. Within a porphyry copper deposit, the process of supergene enrichment results in a distinct vertical zonation. In the oxidized zone copper minerals are either nonexistent or consist of copper oxides and native copper. Iron oxide minerals are common and include limonite, hematite, jarosite, goethite and a variety of amorphous iron oxides (Anderson, 1982). Underlying the oxidized zone, supergene copper minerals consist mainly of chalcocite and covellite. Pyrite and chalcopyrite are the most common primary sulphides in the hypogene zone.

PROPERTY OVERVIEW

LOCATION AND ACCESS

The Kemess South deposit is located at latitude 57°00'N, longitude 126°45'W (NTS 94E/02W), 7 kilometres east of Thutade Lake and 550 kilometres northwest of Prince George (Figure 3-7-1). Access to the property, by the Omineca Mining Road, is possible from either Mackenzie or Fort St. James. The property may also be reached by air via the Sturdee airstrip, approximately 25 kilometres to the northwest.

LOCAL GEOLOGY AND MINERALIZATION

The Kemess South property is underlain mainly by mafic volcanic rocks of the Upper Triassic Takla Group and poorly exposed sedimentary strata of the Permian Asitka Group (Figure 3-7-2). Stocks, dikes and a sill-like body of porphyritic quartz monzodiorite and tonalite intrude these rocks. Cann and Godwin (1980) have assigned a Lower Jurassic age to similar intrusions on the Kemess North property 5 kilometres to the north. Gold-copper mineralization at Kemess South is hosted by a sill-like body of quartz monzodiorite porphyry, up to 245 metres thick, and sometimes extends a short distance into the underlying Takla volcanics. Drilling has confirmed the deposit extends over an area exceeding 1100 by 600 metres. The main hypogene sulphide minerals, in order of abundance, are pyrite, chalcopyrite, bornite and a trace of molybdenite. They occur as disseminated grains and fracture fillings and within quartz stockwork veins.

A zone of supergene enrichment, ranging up to 66 metres thick, is preserved in the southwestern part of the deposit. It is partly covered by a thin layer of sedimentary and volcanic rocks which resemble the Cretaceous-Tertiary Sstut Group, possibly the basal member of the Eocene Brothers Peak Formation. Within the supergene zone, the quartz monzodiorite is weathered to a brick-red colour, imparted by a ubiquitous mixture of hematite, limonite and indeterminate iron oxide and clay minerals. Where the leached cap

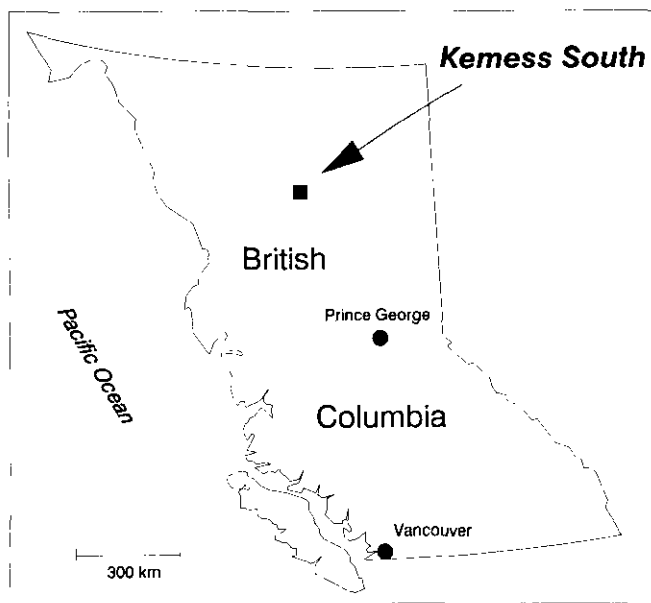


Figure 3-7-1. Location of the Kemess South deposit.

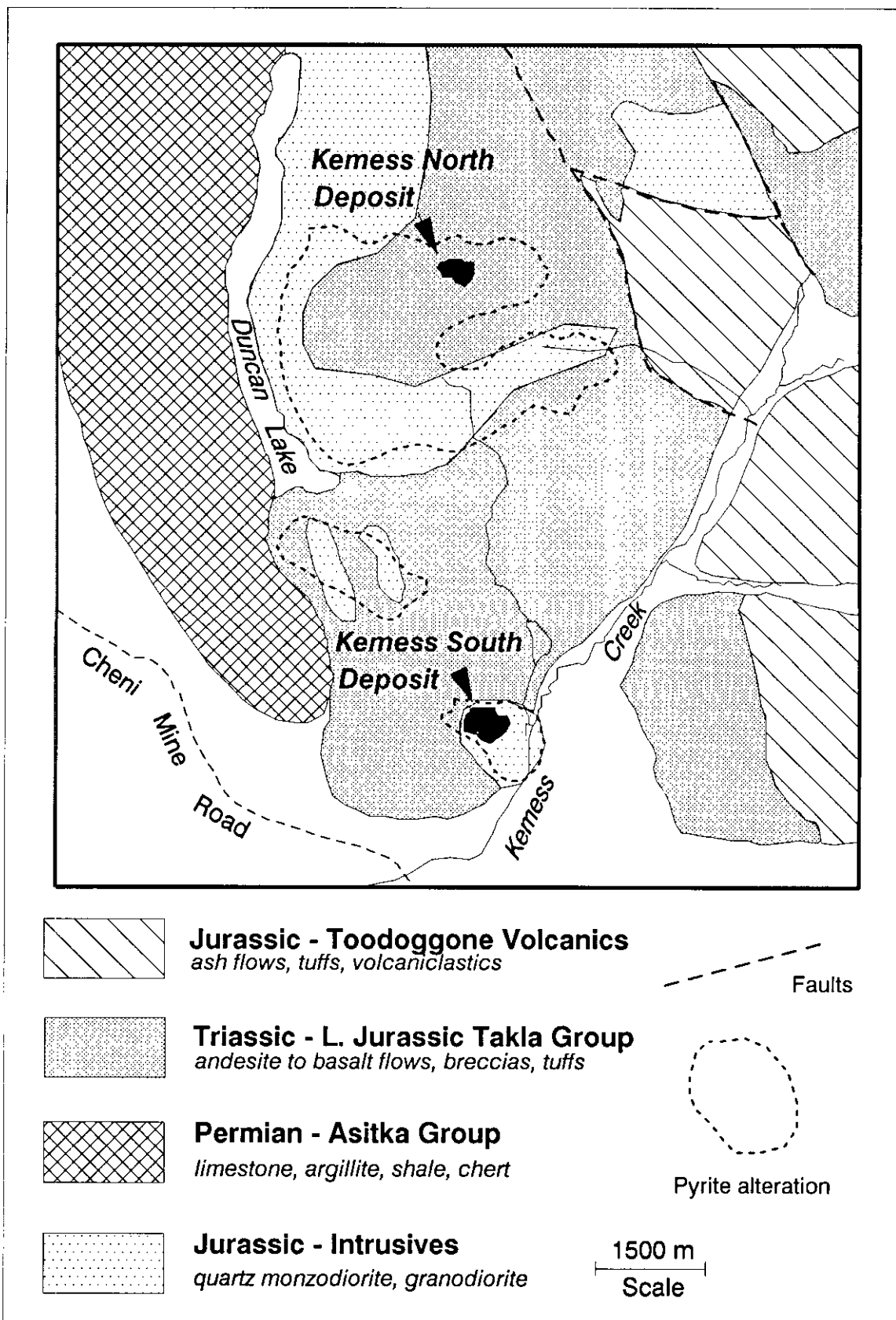


Figure 3-7-2. Geology of the Kemess South area.

of the supergene zone has been preserved, all original textures have been destroyed. However, the quartz stockwork remains readily discernible. Drilling below the leached cap reveals native copper and chalcocite to be the major supergene copper minerals. Copper oxide, carbonate and silicate minerals are minor constituents. Significant concentrations of chalcocite occur in a narrow zone at the transition between supergene and hypogene ore. Locally significant quantities of copper are found within secondary iron minerals. The downward limit of secondary iron minerals marks the abrupt appearance of hypogene sulphides. There is no noticeable change in the concentration of gold in the supergene zone relative to the protore.

Within the mineralized zone the quartz monzodiorite hostrock is replaced by a secondary mineral assemblage of potassium feldspar and intense sericite-chlorite alteration. Most primary mafic silicate minerals have been replaced by biotite and chlorite. Takla volcanic rocks in the footwall are characterized by a propylitic alteration assemblage comprising chlorite, calcite and pyrite. Laterally outwards from the intrusion, propylitic alteration in the Takla volcanics is comprised of epidote and pyrite.

SURFICIAL GEOLOGY

Surficial deposits overlying the Kemess South deposit are of a variable nature and thickness. A veneer of colluvium and till interspersed with pockets of hard-packed till filling lows in the bedrock topography covers the northern, upslope area of the deposit. Towards Attichika Creek the veneer of colluvium and till grades into a thick blanket of till and glaciofluvial sediment which masks the bedrock topography. The Attichika Creek valley is blanketed with extensive deposits of till and glaciofluvial outwash, together with several stagnant ice features. Talus, felsenmeer and bedrock predominate at higher elevations near the deposit. Glacial striae to the south indicate that the direction of regional ice movement during the last (Fraser) glaciation was towards the east and southeast (Lord, 1948). However, glacial features in the vicinity of the property suggest ice flowed in a southerly direction, a result of control by local topography.

PHYSIOGRAPHY AND CLIMATE

The property lies in the Swannell Ranges of the Omineca Mountains. Local relief ranges from 1200 to 1900 metres and is represented by a mixture of steep to precipitous slopes and flat valley bottoms. Located at an elevation of 1300 metres, the deposit subcrops near the base of a moderate to steeply sloping northwest-trending ridge which rises approximately 300 metres above the adjoining Attichika Creek valley. Glaciation has rounded peaks less than 1800 metres in height while bedrock above this height is still comparatively rugged. Humo-ferric podzols are the most prevalent soil type developed above the deposit and in the vicinity. Remnants of late Tertiary erosion surfaces were noted by Holland (1976) in the McConnell and Wrede Ranges to the southeast. Treeline is at approximately 1500 metres.

METHODS

SAMPLE COLLECTION

Twenty-eight 1-kilogram samples of soil saprolite or rock were collected from five profiles ranging from 1 to 3 metres in depth along an east-west traverse across the deposit (Figure 3-7-3). Four of the profiles were developed on mineralized bedrock and one profile sampled a thick unit of till. At each location, B-horizon, till, saprolite or rock were sampled at regular intervals down profile, or on either side of significant physical changes in the profile. Two field duplicates were taken.

SAMPLE PREPARATION

Samples were sent to the Geological Survey Branch Analytical Sciences Laboratory in Victoria for sample preparation. All samples were dried at 50°C. Soil and saprolite samples were dry sieved to -80+230 mesh (-177-63 µm) and -230-mesh (-63 µm) fractions. The -80+230-mesh fraction was wet sieved to remove any adhering fines and then dried at 50°C. Bedrock samples were cleaned with compressed air, crushed and pulverized to -100 mesh (-150 µm). Representative splits of each sample fraction were prepared for analysis. Control reference standards GXR2 and GXR4 were inserted into each sample batch to allow monitoring of quality control.

SAMPLE ANALYSIS

COPPER, MOLYBDENUM, GOLD, IRON AND ALUMINUM

Subsamples of the -80+230 and -230-mesh fractions were submitted to Chemex Labs, Ltd. in North Vancouver and subjected to a total dissolution using a hot, concentrated perchloric-nitric-hydrofluoric acid ($\text{HClO}_4\text{-HNO}_3\text{-HF}$) digestion. Analyses were carried out for copper by atomic absorption spectroscopy (AAS) and for aluminum, iron and molybdenum by inductively coupled plasma-atomic emission spectroscopy (ICP-AES). Gold analyses were conducted on five grams of each -80+230 and -230-mesh sample by instrumental neutron activation analysis (INAA) at Activation Laboratories in Ancaster, Ontario.

SEQUENTIAL PARTIAL EXTRACTIONS FOR COPPER

Sequential partial extractions for copper were performed at the Analytical Sciences Laboratory on 0.5-gram subsamples of the -230-mesh fraction in the following order:

- (1) 1 M ammonium acetate ($\text{CH}_3\text{COONH}_4$) at pH 7.2
- (2) 0.1 M hydrochloric acid (HCl)
- (3) Aqua regia ($3\text{HCl}:1\text{HNO}_3$)

Solutions derived from these extractions were analysed for copper by atomic absorption spectroscopy. Sequential partial extractions provide a method for identifying the residence sites of metals within samples. Each extraction technique liberates metals from particular minerals either by dissolution of the mineral or by the exchange of that metal with another cation. Neutral (pH 7.2) ammonium acetate acts to remove weakly bonded metals in exchange sites. For example, copper cations (Cu^{+2}) weakly held to a mineral will be displaced by free NH_4^{+2} cations in the ammonium

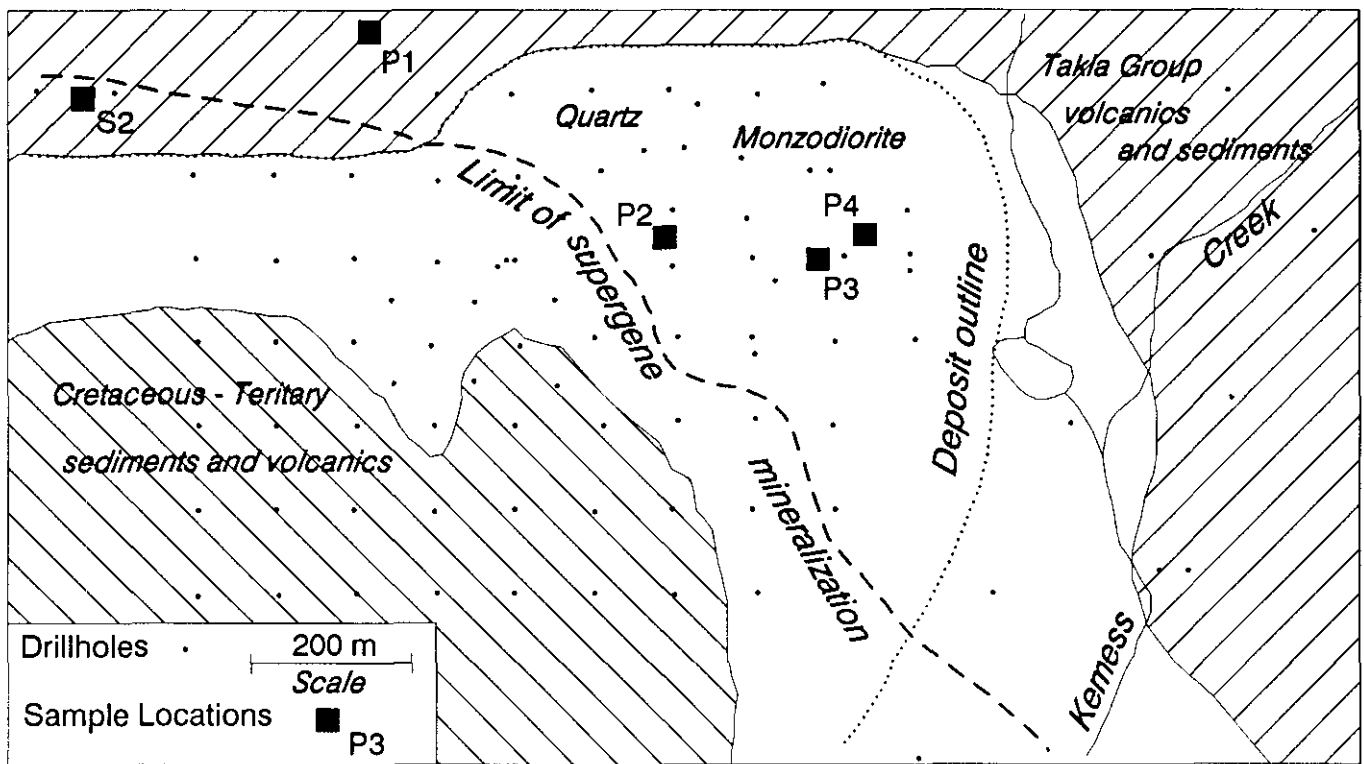


Figure 3-7-3. Geology of the Kemess South deposit.

acetate solution. Dilute hydrochloric acid (0.1 M HCl) will release exchangeable metals and metals associated with clays, manganese oxides and organic matter, and will also partly decompose sulphides and carbonates (Fletcher, 1981). Aqua regia readily dissolves sulphides and iron oxides while leaving silicates relatively unaffected. Results of these extractions were compared with the copper results for the total acid digestion discussed above.

RESULTS

PROFILE DESCRIPTIONS

Diagrams of the five sampled profiles are shown in Figure 3-7-4. Profile S2 is a 3.5-metre section topped by a gleyed organic-rich A-horizon 25 centimetres thick. The B-horizon soil is developed within a layer of colluvium containing angular clasts which extends to a depth of 75 centimetres. Within the B-horizon, a reddish Bf-horizon grades into an underlying dark brown BC-horizon at a depth of 60 centimetres. Underlying the colluvium is a compact, brick-red hematitic saprolite unit containing abundant clay between strongly weathered rock clasts. Minor amounts of malachite-bearing clasts are visible within this unit which grades into the lower unit at a depth of 180 centimetres. This lowermost saprolite is buff coloured and consists of rotted bedrock with clays filling the interstices between rock fragments. It is more compact than the overlying saprolite and contains a higher proportion of malachite-bearing clasts. Locally high concentrations of hematite and jarosite endow a brick-red or pale yellow colour to the unit. Mineralized quartz monzodiorite and a volcanoclastic unit, tenta-

tively identified as belonging to the Toodogone Group (L.J. Diakow, personal communication, 1991), underlies the saprolite. Both rock types contain native copper, chalcocite and malachite.

Profile P1 is a 250-centimetre section. A thin (5–10 cm) A-horizon is underlain by a 40-centimetre B-horizon. The B-horizon grades downwards into a unit of oxidized, tan-coloured till which extends to the bottom of the profile. Clasts within the till consist primarily of subrounded fragments of dark grey chert; approximately 10 per cent of the clasts are iron stained.

The 1-metre section of Profile P2 is composed of 40 centimetres of saprolitic quartz monzodiorite overlain by a 60-centimetre B-horizon and a thin (<5 cm) A-horizon. The contact between the saprolite and B-horizon is gradational over approximately 10 centimetres. Within the B-horizon, a reddish Bf-horizon grades into an underlying, dark brown BC-horizon at a depth of 35 centimetres.

Profile P3 is a 2.5-metre section. A thin (<5 cm) A-horizon is underlain by a 50-centimetre B-horizon. The B-horizon is subdivided into an upper Bf and a lower BC-horizon by a gradational contact at approximately 30 centimetres. Below the B-horizon is a transitional unit 60 centimetres thick consisting of a dark brown, clay-rich sandy material. Both the upper and lower contacts of this unit are gradational over 20-centimetre intervals. Underlying this transitional unit is 70 centimetres of brick-red, clay-rich hematitic saprolite composed of rotted quartz monzodiorite. At 180 centimetres, the hematitic saprolite changes abruptly to a relatively pristine quartz monzodiorite containing pyrite (3%) and chalcopyrite (1%).

Profile P4 is a 2.5-metre section. A thin (<5 cm) A-horizon is underlain by a B-horizon 40-centimetres thick which grades into an 80-centimetre unit of till (C horizon). The till is dark grey and contains subangular to subrounded clasts of which approximately 10 per cent are iron stained. Underlying the till is 110 centimetres of brick-red clay-rich hematitic saprolite, similar to that found in Profile P3. At a depth of 230 centimetres, the saprolite abruptly changes to a relatively pristine quartz monzodiorite containing visible pyrite (3%) and chalcopyrite (1%), similar to that in Profile P3.

ELEMENT DISTRIBUTIONS WITHIN PROFILES

COPPER

Copper concentrations for both size fractions are highest within the saprolite samples from Profile S2, ranging from 10 700 to 36 800 ppm (1.07 to 3.68%; Table 3-7-1 and Figure 3-7-5a). The lowest copper values are found in the till profile P1, with concentrations varying from 53 to 1099 ppm. Profiles P2, P3 and P4, each containing saprolitic or pristine quartz monzodiorite, have copper concentrations ranging from 398 to 3582 ppm with the quartz monzodiorite samples (P3-180, P4-240) reporting the lowest values (572 and 398 ppm, respectively). Systematic variation in copper content with depth is not prevalent; only Profiles S2 and P2 show an increase with depth whereas Profiles P1, P3 and P4 show little variation.

GOLD

The highest gold values are found within the -230-mesh fraction of Profile P2, ranging from 1820 to 2880 ppb (Table 3-7-1 and Figure 3-7-5b). Gold contents from both size fractions of the till profile P1 are consistently the lowest, varying from 1 ppb to 930 ppb. Concentrations are uniformly higher within the -230-mesh fractions of Profiles P2, P3 and P4, and generally higher within the -230-mesh fractions of Profile P1 than in their corresponding -80+230-mesh fractions. Except for the B-horizon sample, gold contents are highest within the -80+230-mesh fraction of Profile S2. Duplicate pairs for sample P4-30 show a small degree of variation; 9.6 per cent for gold in the -80+230-mesh fraction and 5.4 per cent for gold in the -230-mesh fraction. No consistent variation with depth was observed for gold within the profiles.

MOLYBDENUM

Molybdenum values are highest within the -230-mesh fraction of Profile P3 and peak (449 ppm) within the coarse-grained, sandy transitional unit between the overlying B-horizon soils and underlying saprolitic quartz monzodiorite (Table 3-7-1 and Figure 3-7-5c). As with gold, molybdenum values are consistently higher within the -230-mesh fraction of Profiles P2, P3 and P4 than in their corresponding -80+230-mesh fractions. Copper and molybdenum behave sympathetically, a feature especially prevalent in Profiles P2, P3 and P4.

IRON

Maximum iron concentrations are found within the -230-mesh fraction of Profile P3; sample P3-150 contains

14.23 per cent iron, whereas the transitional unit reports values of 12.15 and 13.03 per cent iron for samples P3-70 and P3-100, respectively (Table 3-7-1 and Figure 3-7-5d). Profile P1 contains the lowest iron value (2.17%) and displays the least variation between samples. Iron content corresponds to gross variations in copper and molybdenum for both size fractions of Profiles P2, P3 and P4. A similar correlation is not observed in Profiles S2 and P1.

ALUMINUM

Aluminum values are greatest within the -230-mesh fractions of the three lowermost saprolite samples of Profile S2 (up to 12.45%) and the saprolite samples of Profile P3 (up to 10.86%; Table 3-7-1 and Figure 3-7-5e). Unlike iron, variations in aluminum do not appear to correspond to variations in copper and molybdenum for Profiles P2, P3 and P4. However, variations in the aluminum content of the -230-mesh fraction do correspond to variations in copper and molybdenum for the saprolite samples of Profile S2.

PARTIAL EXTRACTIONS FOR COPPER

Results of partial extractions for copper are shown in Table 3-7-2. Figure 3-7-6 presents the percentages of partially extractable copper as a function of the total copper content for each profile. Maximum amounts of ammonium acetate extractable copper are found in samples from Profile S2 whereas Profile P1 generally contains the lowest and most uniform levels of exchangeable copper. Excluding bedrock samples P3-180 and P4-240, the proportion of exchangeable copper increases with depth in Profiles P2, P3 and P4. Copper extractable using 0.1 M hydrochloric acid is also highest in Profile S2; up to 61.75 per cent of the copper present in sample S2-200 is extractable. Samples from Profile P1 contain nearly uniform levels of extractable copper, whereas Profiles P2, P3 and P4 contain increasing amounts of extractable copper with depth. Aqua regia extractable copper accounts for over 80 per cent of the copper in the samples, with the exception of sample P1-30 and, notably, all Profile S2 samples and the saprolite samples from Profiles P3 and P4.

DISCUSSION

Concentrations of copper, molybdenum, gold, iron and aluminum are higher in the -230-mesh fraction than the -80+230-mesh fraction, reflecting the original grain size of sulphides in the deposit, the greater abundance of secondary clays and oxide minerals in the fraction and the hydro-morphic redistribution of metals to these secondary minerals. The sympathetic variation of copper, molybdenum, iron and aluminum within the profiles reflects the incorporation of these elements in secondary minerals developed during weathering. Copper and molybdenum concentrations in the -230-mesh fraction of Profile S2, developed within the supergene zone, appear to correlate more strongly with aluminum than with iron. In contrast, the copper and molybdenum contents of Profiles P2, P3 and P4, developed outside of the zone of supergene enrichment but within oxidized bedrock, correlate with variations in iron.

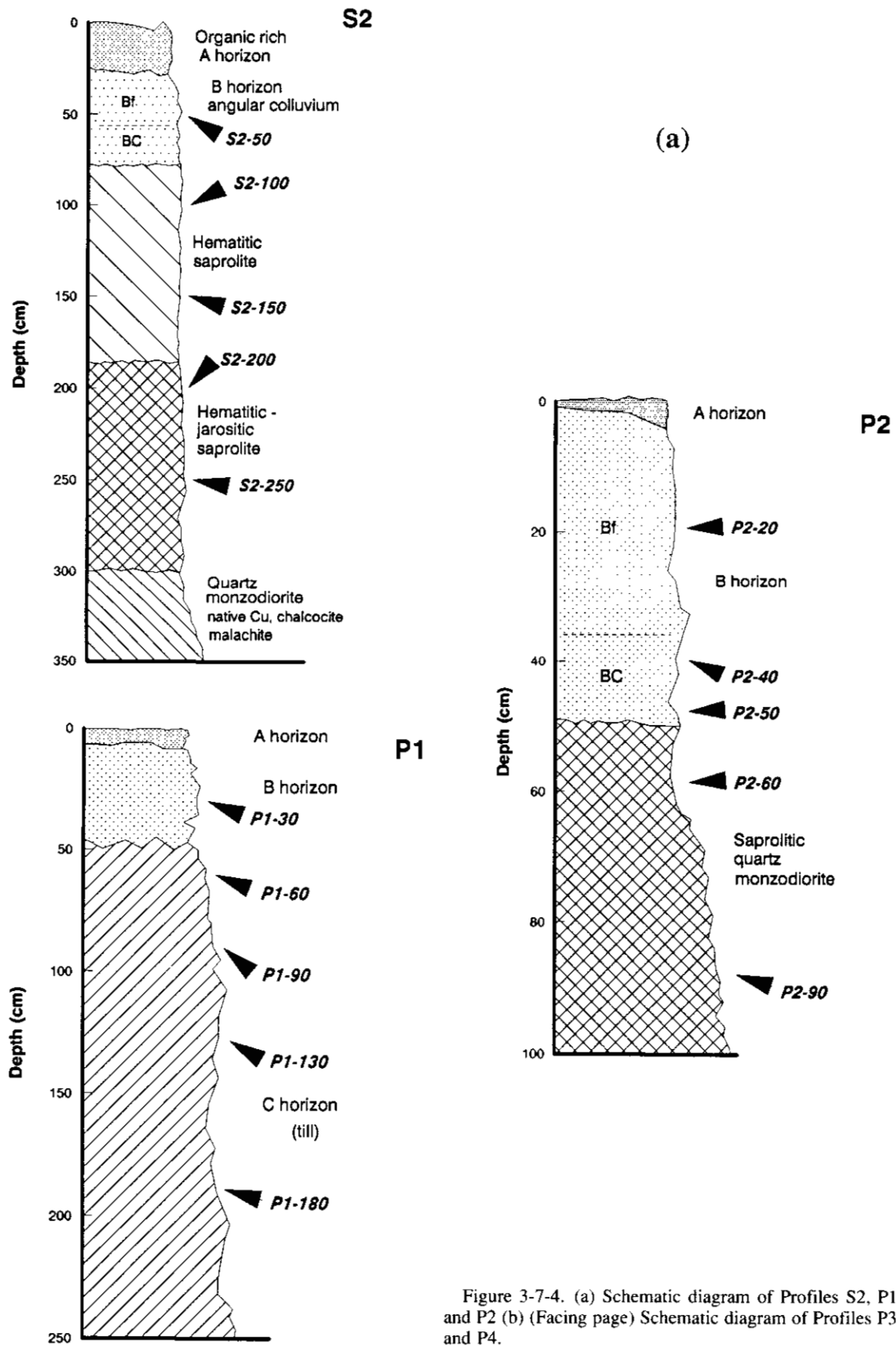
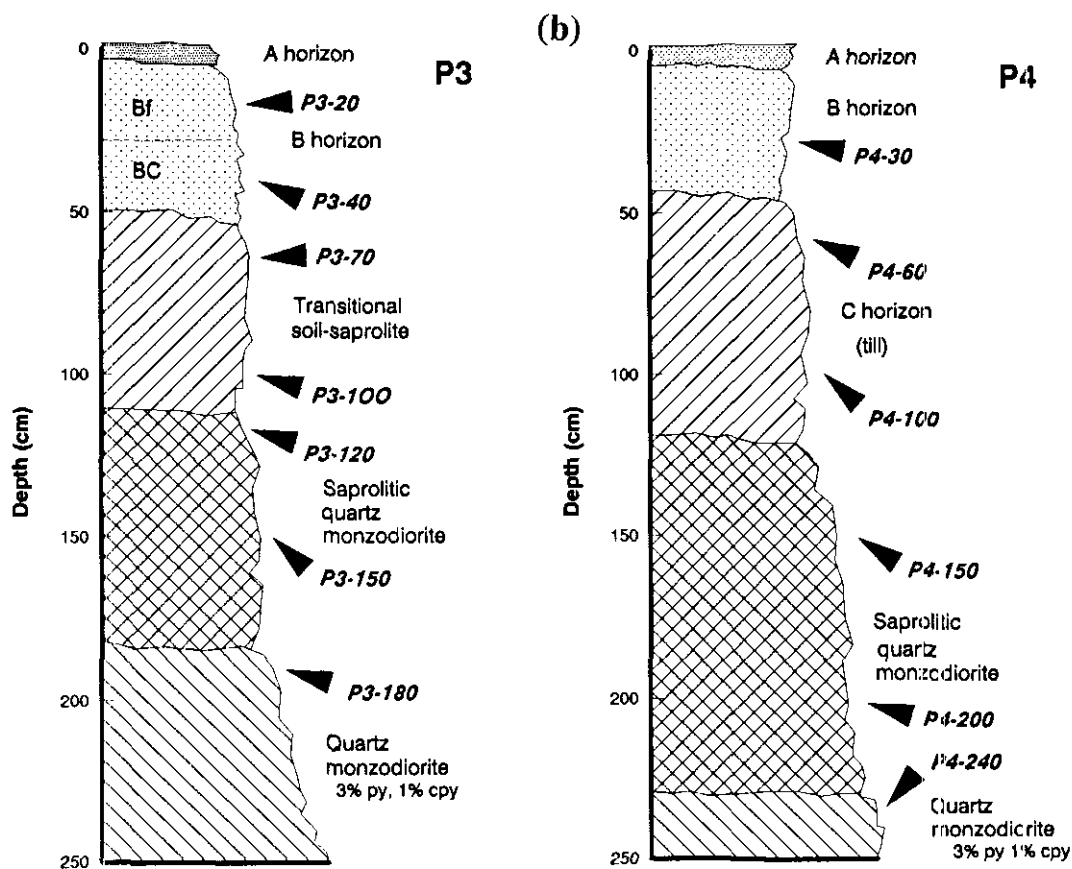


Figure 3-7-4. (a) Schematic diagram of Profiles S2, P1 and P2 (b) (Facing page) Schematic diagram of Profiles P3 and P4.



Partial extraction results indicate mineralogical differences between the supergene profile S2, the saprolite profiles P2, P3 and P4 and the till profile P1. Further, variation in the percentage of partially extractable copper with depth reveals changes in the mineralogy of the profile. With the exception of the supergene profile samples S2-150 and S2-200, aqua regia extracts most of the contained copper. Coupled with the lack of sulphides in the profiles (excluding bedrock samples P3-180 and P4-240), this implies that the principal residence site for copper is within iron oxides. Profile P1 contains similar proportions of exchangeable copper (ammonium acetate extractable) and weak hydrochloric acid extractable copper at all depths, reflecting the uniform nature of the till. The consistent increase in exchangeable copper and weak hydrochloric acid extractable copper with depth in Profiles P2, P3 and P4 indicates that the proportion of secondary copper-bearing minerals increases down profile and drops off sharply once competent bedrock is reached. Profile S2 contains the highest levels of exchangeable copper and weak hydrochloric acid extractable copper; the presence of abundant clays, iron oxides, jarosite and malachite suggests that these secondary minerals are also residence sites of copper.

Significant levels of exchangeable copper (3.54%) and weak hydrochloric acid extractable copper (21.67%) in the B-horizon of Profile S2 indicate the presence of copper either within or adsorbed onto secondary minerals, implying that hydromorphic transport of copper has occurred or is

ongoing. Profiles P1, P2, P3 and P4, with B-horizons containing less than 1 per cent exchangeable copper and less than 10 per cent copper extractable by weak hydrochloric acid, appear to have a lesser component of hydromorphically transported copper. However, the similarity of copper contents of the B and C-horizons in Profile P4 with the underlying saprolite suggests that some degree of hydromorphic transport has occurred.

Unlike copper, gold values do not appear to have been effected by weathering and the development of a supergene enrichment zone. Molybdenum contents appear to mimic iron values for Profiles P2, P3 and P4, suggesting the presence of ferrimolybdate ($\text{Fe}_2(\text{MoO}_4)_3 \cdot 8\text{H}_2\text{O}$) which is insoluble in oxidizing, acidic solutions (Anderson, 1982). The stronger association of molybdenum and copper with aluminum in the -230-mesh fraction of Profile S2 indicates that these elements may be associated more with secondary clays than iron oxides.

CONCLUSIONS

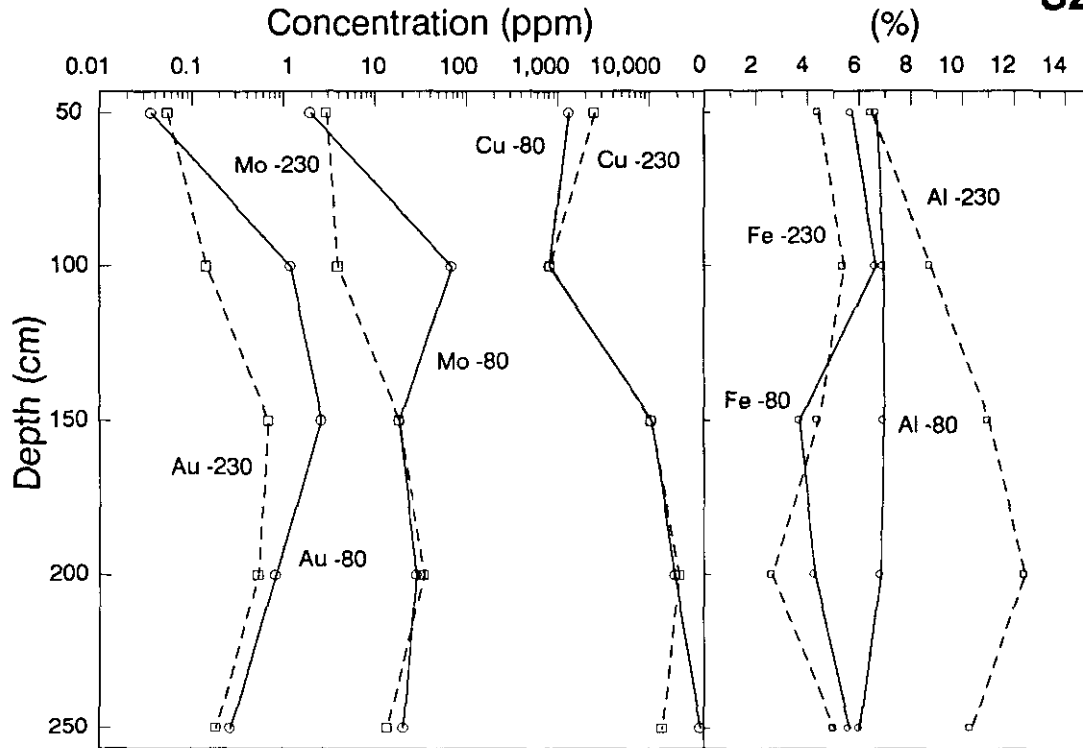
The principal residence sites for copper within soils and the saprolitic hypogene bedrock of Profiles P2, P3 and P4 are secondary iron oxide minerals. Within the upper leached cap of the supergene zone (Profile S2), which has been exposed to Holocene (postglacial) weathering, oxidation of sulphides has resulted in the development of secondary minerals which retain upwards of 70 per cent of the copper,

TABLE 3-7-1
CONCENTRATIONS OF GOLD, COPPER, MOLYBDENUM, IRON AND ALUMINUM FOR THE -80+230 AND -230-MESH FRACTIONS

Sample	Depth (cm)	Media	Minus 80+230 mesh data					Minus 230 mesh data				
			Au (ppb)	Cu (ppm)	Mo (ppm)	Fe (%)	Al (%)	Au (ppb)	Cu (ppm)	Mo (ppm)	Fe (%)	Al (%)
S2 - 50	50	Bf	37	1353	2	5.75	6.73	56	2580	3	4.47	6.54
S2 - 100	100	sap.	1220	825	70	6.67	6.97	148	838	4	5.44	8.80
S2 - 150	150	sap.	2670	10900	19	3.76	7.00	709	10700	19	4.46	11.06
S2 - 200	200	sap.	840	19400	29	4.32	6.87	544	21700	35	2.68	12.45
S2 - 250	250	sap.	271	36800	21	5.65	6.06	190	14200	14	5.09	10.37
P1 - 30	30	Bf	6	212	8	3.37	6.33	10	164	8	3.91	7.54
P1 - 60	60	till	6	77	1	2.87	6.02	21	127	1	3.95	7.50
P1 - 90	90	till	1	55	<1	2.85	6.22	20	123	3	4.33	7.70
P1 - 90D	90	till	930	930	72	6.43	6.75	11	1099	43	5.57	8.82
P1 - 130	130	till	1	53	3	3.06	6.32	14	122	2	4.40	7.99
P1 - 180	180	till	49	59	1	2.95	6.22	20	138	<1	4.48	7.93
P2 - 20	20	Bf	575	747	34	6.12	7.26	1820	1077	40	5.61	8.90
P2 - 40	40	BC	32	901	72	6.37	6.80	1820	1348	93	6.48	8.85
P2 - 50	50	BC	1090	376	3	4.20	6.19	2000	1141	76	5.70	9.25
P2 - 60	60	sap.	1060	1137	98	5.61	8.33	2880	1448	128	6.90	9.53
P2 - 90	90	sap.	783	2818	259	7.59	7.10	1850	3774	386	10.60	8.71
P3 - 20	20	Bf	457	962	138	6.82	7.71	972	1669	139	6.98	9.25
P3 - 40	40	BC	510	1919	276	7.50	7.97	1070	2749	312	9.40	9.02
P3 - 70	70	trans.	426	1819	242	6.26	8.45	1340	3354	419	12.15	8.79
P3 - 100	100	trans.	375	1878	244	6.81	8.69	1070	3582	449	13.03	8.89
P3 - 120	120	sap.	437	1003	76	3.70	8.37	769	2100	133	6.97	10.86
P3 - 150	150	sap.	324	913	98	4.75	8.82	762	2746	395	14.23	10.48
P3 - 180	180	rock	650	572	58	3.87	8.80	650	572	58	3.87	8.80
P4 - 30	30	Bf	411	837	32	4.60	6.99	551	1286	40	4.71	7.76
P4 - 30D	30	Bf	455	790	25	4.41	6.80	521	1350	43	5.08	7.64
P4 - 60	60	till	483	738	16	4.48	6.47	596	1338	23	4.37	7.55
P4 - 100	100	till	451	832	20	4.26	6.75	976	1406	30	4.73	7.53
P4 - 150	150	sap.	315	797	24	4.48	6.95	527	1346	44	5.10	7.70
P4 - 200	200	sap.	460	1404	149	6.06	7.95	896	2513	271	10.66	8.58
P4 - 240	240	rock	438	398	77	3.38	8.79	438	398	77	3.38	8.79

TABLE 3-7-2
 SEQUENTIAL PARTIAL EXTRACTION DATA FOR COPPER
 IN THE -230-MESH FRACTION OF EACH SAMPLE

SAMPLE DATA			EXTRACTION (ppm)				% EXTRACTED		
Sample	Media	Depth (cm)	NH4 Acetate	0.1M HCl	Aqua Regia	Total digestion	NH4 Acetate	0.1M HCl	Aqua Regia
S2-50	Bf	50	93	570	1790	2630	3.54	21.67	68.00
S2-100	sap.	100	44	187	610	835	5.27	22.40	73.00
S2-150	sap.	150	1210	6300	2250	10700	11.31	58.88	21.00
S2-200	sap.	200	1560	13400	5800	21700	7.19	61.75	26.70
S2-250	sap.	250	1230	4300	8000	14200	8.66	30.28	56.30
P1-30	Bf	30	1	14	110	164	0.61	8.54	67.00
P1-60	till	60	1	11	114	127	0.79	8.66	89.70
P1-90	till	90	1	11	116	123	0.81	8.94	94.30
P1-90d	till	90	1	11	120	1100	0.09	1.00	10.90
P1-130	till	130	1	12	108	122	0.82	9.84	88.50
P1-180	till	180	1	17	125	138	0.72	12.32	90.50
P2-20	Bf	20	10	51	940	1075	0.93	4.74	87.40
P2-40	BC	40	6	29	1200	1350	0.44	2.15	88.80
P2-50	BC	50	8	28	1040	1140	0.70	2.46	91.20
P2-60	sap.	60	21	60	1340	1450	1.45	4.14	92.40
P2-90	sap.	90	80	300	3340	3770	2.12	7.96	88.50
P3-20	Bf	20	3	14	1340	1670	0.18	0.84	80.20
P3-40	BC	40	12	66	2580	2750	0.44	2.40	93.80
P3-70	trans.	70	34	200	3000	3350	1.01	5.97	89.50
P3-100	trans.	100	39	319	3150	3580	1.09	8.91	87.90
P3-120	sap.	120	48	258	1540	2100	2.29	12.29	73.30
P3-150	sap.	150	63	460	1860	2750	2.29	16.73	67.60
P3-180	R	180	4	29	583	572	0.70	5.07	101.90
P4-30	Bf	30	6	62	1130	1250	0.48	4.96	90.40
P4-30d	Bf	30	6	56	1180	1350	0.44	4.15	87.40
P4-60	till	60	10	73	1100	1340	0.75	5.45	82.00
P4-100	till	100	15	84	1190	1450	1.03	5.79	82.00
P4-150	sap.	150	25	125	1080	1375	1.82	9.09	78.50
P4-200	sap.	200	61	370	1970	2510	2.43	14.74	78.40
P4-240	R	240	8	33	370	398	2.01	8.29	92.90
<i>Standards</i>									
GXR4			277	1410	4800	na	na	na	na
GXR4			278	1790	4240	6620	4.20	27.04	64.00
LEGEND									
Bf - soil BC - transitional B-C horizon soil sap. - saprolite									
R - bedrock trans. - transitional (soil to saprolite)									



(a)

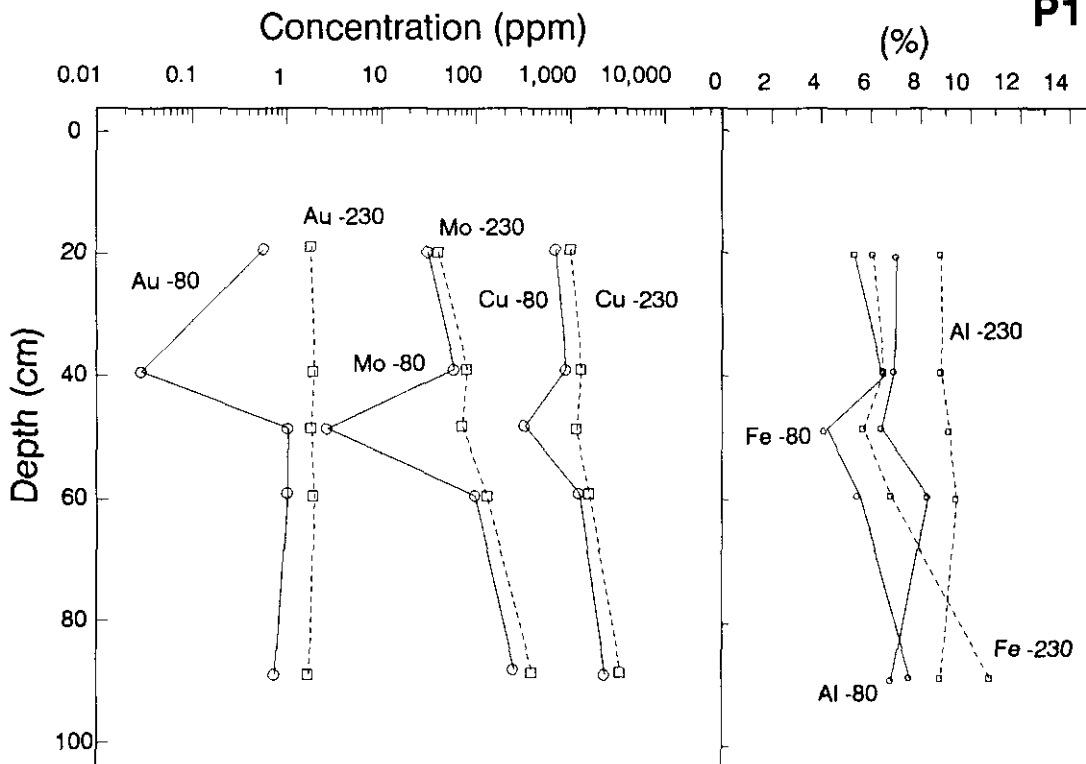
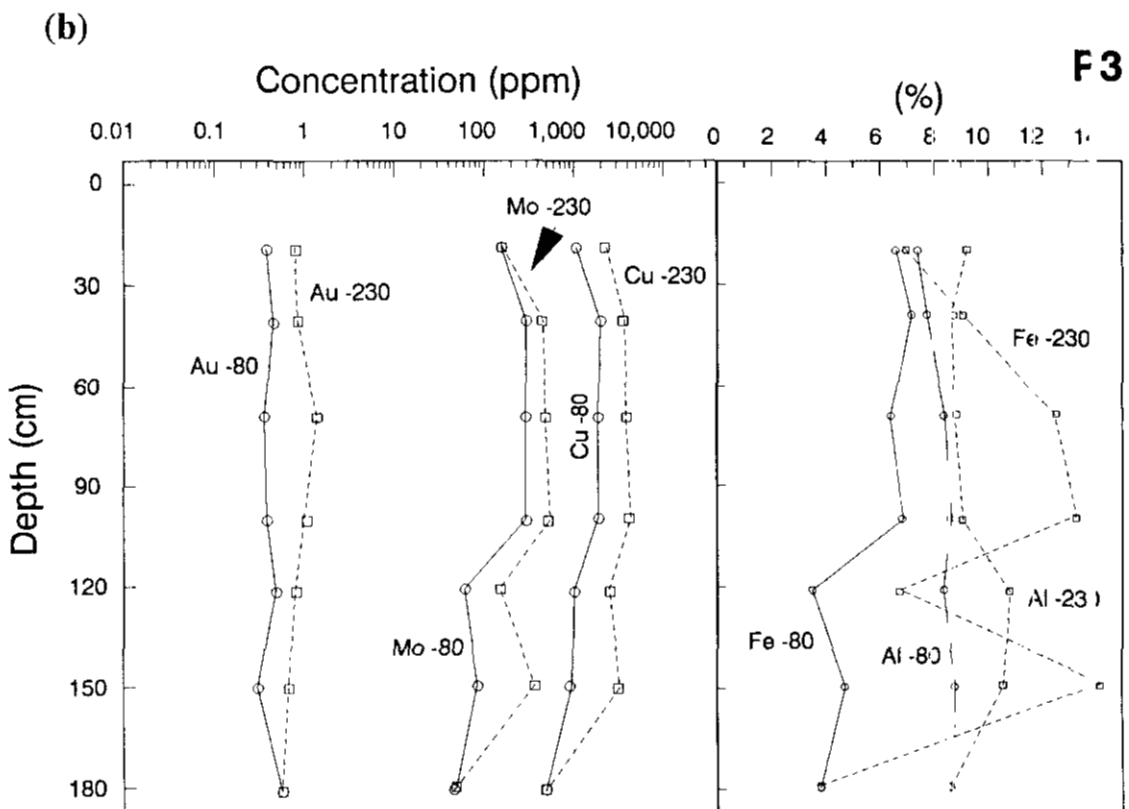
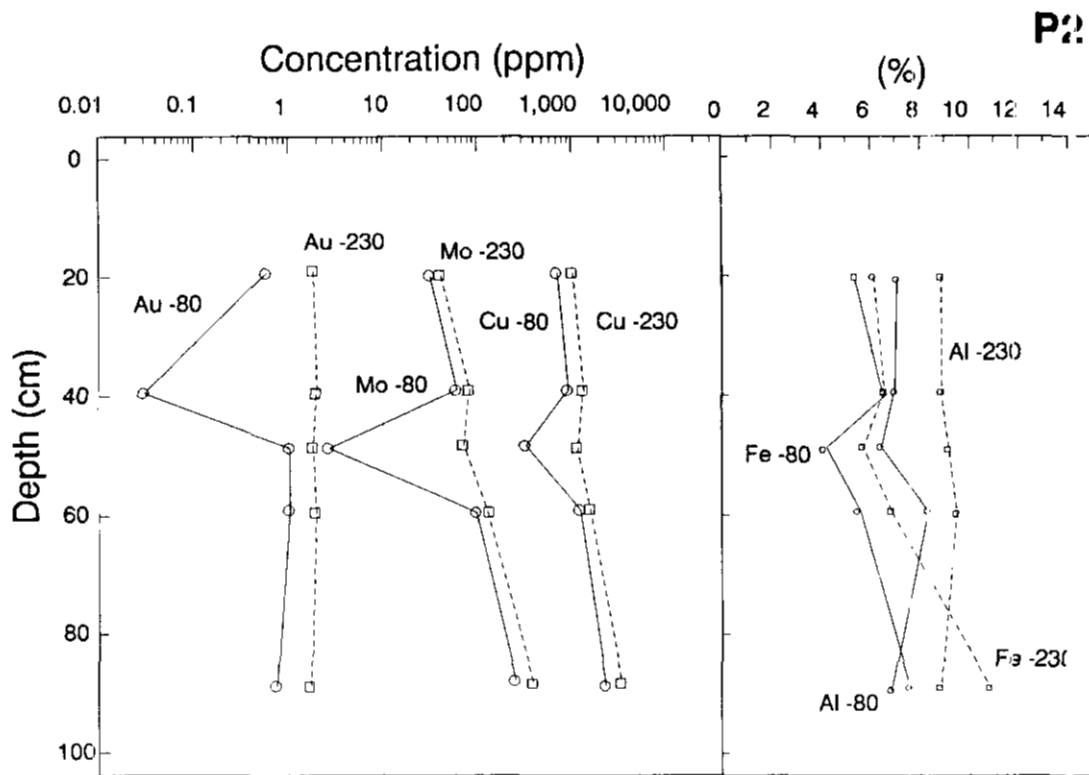
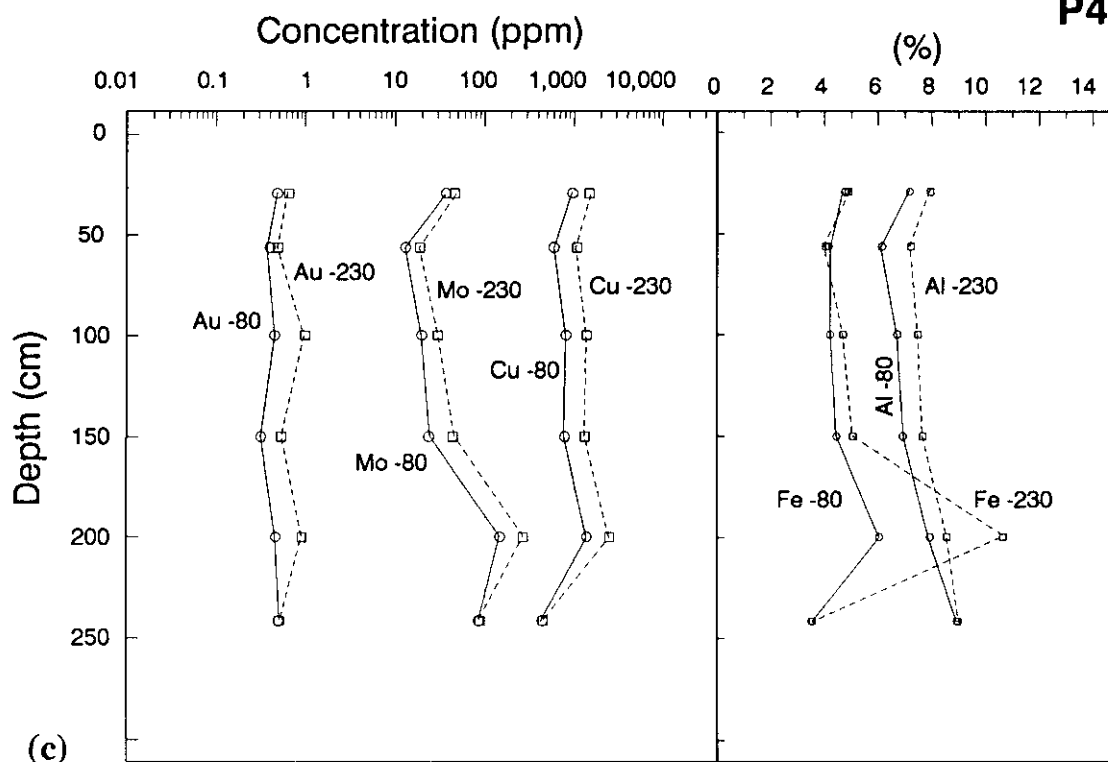


Figure 3-7-5. (a) Plots of Au, Mo, Cu, Fe and Al concentrations with depth for Profiles S2 and P1 (b) Plots of Au, Mo, Cu, Fe and Al concentrations with depth for Profiles P2 and P3 (c) Plots of Au, Mo, Cu, Fe and Al concentrations with depth for Profile P4.





probably present as native copper, chalcocite, malachite or adsorbed onto clays and iron oxides. Hydromorphic transport has increased the copper content of soils over mineralized bedrock at the Kemess South deposit. The degree of hydromorphic transport is significantly greater over the supergene enriched zone of the deposit than over the weathered hypogene bedrock.

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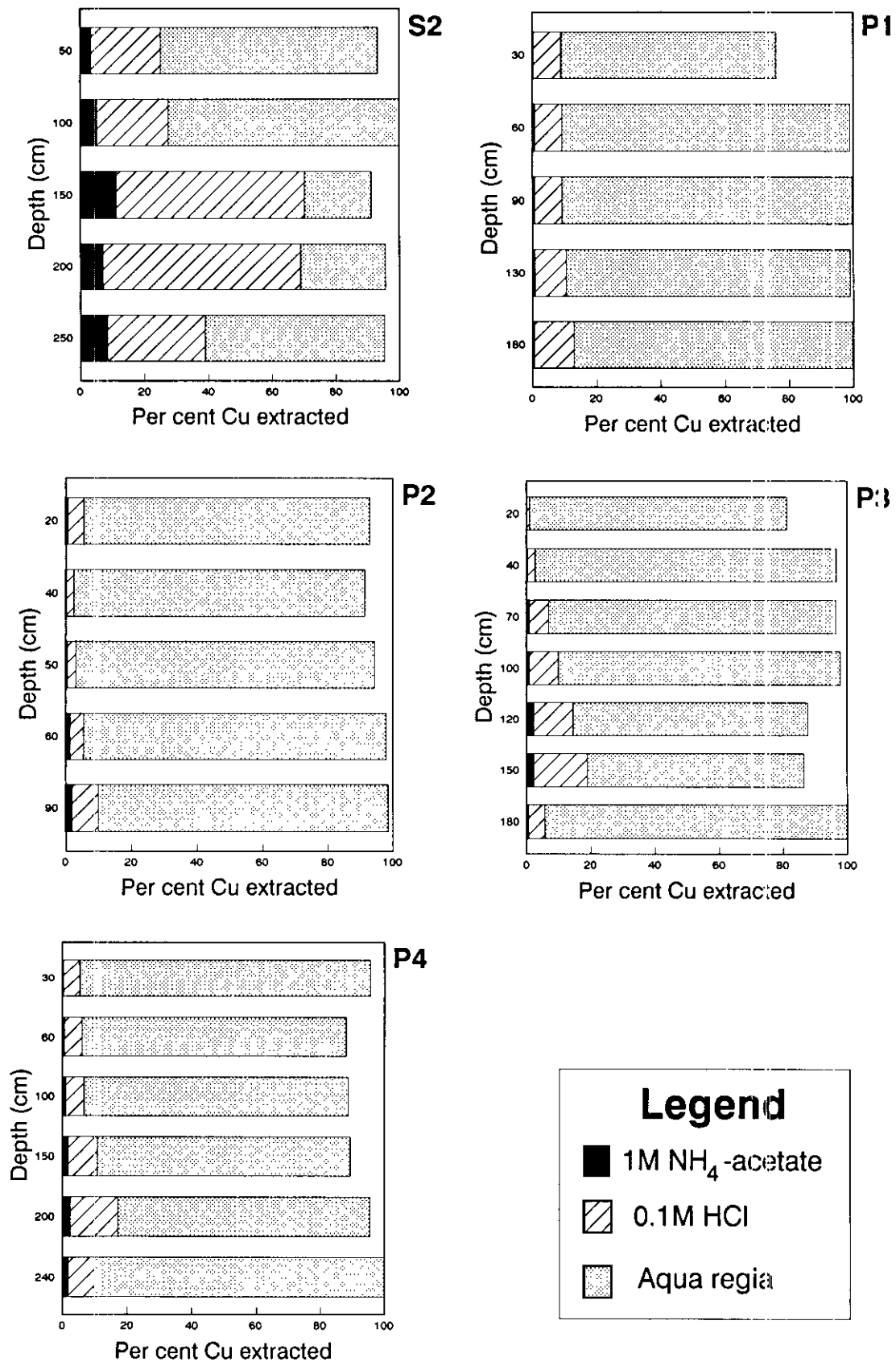


Figure 3-7-6. Plots of partial extraction results with depth, by profile.

NOTES